ALLIANCE

FARMERS' PRODUCE

SINCE 1948

ALLIANCE GROUP LIMITED

MATAURA PROCESSING PLANT

Resource Consent Applications and
Assessment of Environmental Effects

31 May 2019

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF ACRONYMS / GLOSSARY OF TERMS

AEE	Assessment of Environmental Effects
AES	Aquatic Environmental Sciences Ltd
Alliance	Alliance Group Ltd
Amm-N	ammoniacal nitrogen
ANZECC	Australian and New Zealand Environment and Conservation Council
BOD	biological oxygen demand
BPO	best practicable option
CAPEX	capital expenditure
CFU	colony-forming unit
COD	chemical oxygen demand
DAF	dissolved air floatation
DIN	dissolved inorganic nitrogen
DO	dissolved oxygen
DoC	Department of Conservation
DRP	dissolved reactive phosphorus
EMP	Environmental Monitoring Plan
EPT	Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly)
ES	Environment Southland
FIB	faecal indicator bacteria
FMU	freshwater management unit
Freshwater NPS	National Policy Statement for Freshwater Management 2014
FRE3 flows	the average annual frequency at which flows exceed three times the median
FTEs	full time equivalent staff

FWS	Freshwater Solutions Ltd
GDC	Gore District Council
kW	kilowatt
MALF	Mean annual low flow
MCI	Macroinvertebrate Community Index
MfE	Ministry for the Environment
MIE	Mataura Industrial Estate
MoU	Memorandum of Understanding
NPS	National Policy Statement
Operative Plan	Operative Regional Water Plan
OPEX	operating expense
PDP	Pattle Delamore Partners
Proposed Plan	Proposed Southland Water and Land Plan
QMCI	Quantitative Macroinvertebrate Community Index
QMRA	Quantitative Microbial Risk Assessment
RMA	Resource Management Act 1991
RPS	Southland Regional Policy Statement
TAMI	Te Ao Marama Inc
Te Tangi a Tauira	Ngāi Tahu ki Murihiku Natural Resource and Environmental Iwi Management Plan 2008: *Te Tangi a Tauira - The Cry of The People*
the Act	Resource Management Act 1991
the Plant	Alliance Mataura Plant
TKN	Total Kjeldahl nitrogen
TN	total nitrogen
TP	total phosphorus
TSS	total suspended solids
TWCG	Tangata Whenua Consultation Group

UV	ultra violet
WCO	Water Conservation (Mataura River) Order 1997

A

PART A

Resource Consent Applications

FORM 9

APPLICATION FOR RESOURCE CONSENT OR FAST-TRACK RESOURCE CONSENT

Sections 87AAC, 88, and 145, Resource Management Act 1991

To Environment Southland

1. Alliance Group Limited (Alliance) apply for the following resource consents:

Water Permit - To take water from the hydro race which is fed by the Mataura River for cooling water purposes.

Water Permit - To take water from the hydro race which is fed by the Mataura River for meat processing and truck wash activities.

Discharge Permit - To discharge condenser cooling water from the meat works to the Mataura River.

Discharge Permit - To discharge treated meat works wastewater to the Mataura River

2. The activity to which the application relates (the proposed activity) is as follows:

Alliance owns and operates the Mataura Meat Processing Plant (the Plant) on the true right bank of the Mataura River in the Mataura township.

The Plant currently operates under 10 resource consents issued by Southland Regional Council (Environment Southland). Three of these consents expire on 6 December 2019. They authorise:

1. *The take and use of water for cooling and processing purposes;*
2. *The discharge of cooling water; and*
3. *The discharge of wastewater.*

This Assessment of Environmental Effects is in support of applications to 're-consent' these activities such that the Plant can continue to operate and contribute in a major way to the social and economic wellbeing of the surrounding community. Of note, the proposed conditions require a substantial staged upgrade of the Plant's wastewater treatment plant to improve the quality of the Plant's discharge to the Mataura River, and a reduction in water use. These will be significant capital investments and will add significant annual costs to the wastewater plant's operation.

A 35 year term is sought for all resource consents.

3. **The site at which the proposed activity is to occur is as follows:**

The Mataura Plant and infrastructure are located on the true right bank of the Mataura River, within the Mataura township.

Map reference: *NZMS 260 F46: 911 384*

Legal description: *Lots 1-2 DP12431 Lot 1 DP 12500 Blk XIII Mataura TN*

4. **The full name and address of each owner or occupier (other than the applicant) of the site to which the application relates are as follows:**

The Alliance Group Limited is the owner and occupier of the land associated with the Mataura Plant.

The bed of the Mataura River is Crown Land.

5. **The value of the investment of the existing consent holder is considerable. The latest estimate (December 2018) for the Mataura plant's insured value is $225 million and much of this value is sunk – i.e. it could not be recovered if the plant was forced to downsize, close or be relocated.**

6. **There are no other activities that are part of the proposal to which this application relates.**

7. **No additional resource consents are needed for the proposal to which this application relates.**

8. **I attach an assessment of the proposed activity's effect on the environment that—**

   (a) includes the information required by clause 6 of Schedule 4 of the Resource Management Act 1991; and

   (b) addresses the matters specified in clause 7 of Schedule 4 of the Resource Management Act 1991; and

   (c) includes such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

9. **I attach an assessment of the proposed activity against the matters set out in Part 2 of the Resource Management Act 1991.**

10. **I attach an assessment of the proposed activity against any relevant provisions of a document referred to in section 104(1)(b) of the Resource Management Act 1991, including the information required by clause 2(2) of Schedule 4 of that Act.**

Signature:

Doyle Richardson

Group Environmental Manager

Date: 31 May 2019

Electronic address for Service: Doyle.Richardson@alliance.co.nz

Telephone: +64 27 537 815

Postal address: PO Box 845, Invercargill 9840, New Zealand

Contact person: Doyle Richardson

B

PART B

Assessment of Environmental Effects

1. INTRODUCTION

1.1 OVERVIEW OF THE ACTIVITY

Alliance Group Limited (Alliance) owns and operates the Mataura Meat Processing Plant (the Plant) on the true right bank of the Mataura River in the Mataura township.

Alliance is a farmer owned cooperative and the Plant is a vital component of Southland's agricultural sector – processing stock from the region. It is also a vital component of the local and regional economy, employing approximately 500 people in the peak of the season and contributing approximately $160 million per year to the economy (mostly in livestock payments) and approximately $22 million per year for wages and salaries for the 2017/2018 season.

Figure 1: The Alliance Mataura Plant (foreground).

The Plant currently operates under 10 resource consents issued by Southland Regional Council (Environment Southland). Three of these consents expire on 6 December 2019. They authorise:

- The take and use of water for cooling and processing purposes;
- The discharge of cooling water; and
- The discharge of wastewater.

This Assessment of Environmental Effects (AEE) is in support of applications to 're-consent' these activities such that the Plant can continue to operate and contribute in a major way to the social and economic wellbeing of the surrounding community. Of note, the proposed conditions require a substantial staged upgrade of the Plant's wastewater treatment plant to improve the quality of the Plant's discharge to the Mataura River, and a reduction in water use. These will be significant capital investments and will add significant annual costs to the wastewater plant's operation.

Alliance is seeking a 35-year consent term for all replacement consents being sought. Suitably recognising the value of Alliance's significant existing investment in the Plant, and the future investment which it has committed to via the proposed wastewater treatment plant upgrade, is vital in this context. And it is important to acknowledge that the additional capital investment involved in the wastewater treatment plant upgrades is contingent on securing a long consent term in order to enable those upgrades to be progressively implemented and the financial investment to be justified and secured over an appropriate timeframe. A long consent term also suitably reflects the significant social and economic benefits this Plant provides in the local area and gives greater certainty those benefits will endure.

The discharge to air permit for the site also expires shortly - in December 2020. Applications to replace that resource consent will be made separately, probably in the first half of 2020.

The Plant is specifically provided for in the Gore District Plan and industrial activities are permitted on the site. No consents are needed or being sought from the District Council.

1.2 REPORT STRUCTURE

This AEE addresses all of the matters Alliance is required to address in these consent applications by Schedule 4 of the Resource Management Act (RMA or the Act). It is set out in 14 sections as follows:

Section 1 Is this introduction.

Section 2 Provides background information on Alliance and its environmental management systems.

Section 3 Describes the existing environment for the proposed activities

Section 4 Provides a description of the activities for which consent is sought.

Section 5 Sets out the activity status of the resource consents sought and the scope of the relevant matters when considering the applications.

Section 6 Assesses the social and economic effects of granting the consents sought and enabling the Plant to continue to operate.

Section 7 Assesses the actual and potential effects of the abstraction of water on the environment.

Section 8	Assesses the actual and potential effects of the discharge of wastewater and cooling water on the environment.
Section 9	Provides a summary of the measures proposed by Alliance to avoid, remedy or mitigate any actual or potential effects on the environment, and proposed monitoring.
Section 10	Provides an overview of how alternative means of undertaking the proposed discharge activities have been considered and why the proposed discharge activities are considered to be the best practicable option.
Section 11	Describes the consultation undertaken in respect of these resource consent applications.
Section 12	Is an assessment of the key directives in the relevant planning documents, and how the proposed activities sit in relation to them.
Section 13	Sets out the RMA statutory framework which applies to resource consent applications and assesses the proposal against those provisions.
Section 14	Is a concluding comment.

Various technical assessments have been commissioned by Alliance to support this AEE. They are appended to this AEE and are referenced throughout this document as necessary.

2. ALLIANCE GROUP LIMITED

2.1 OVERVIEW

Alliance is a large meat processing and exporting company operating five meat processing and export plants throughout the South Island and two plants in the North Island. These plants are located at:

- Stoke, Nelson
- Smithfield, Timaru
- Pukeuri, North Otago
- Mataura, Southland
- Lorneville, Southland
- Levin, Horowhenua
- Dannevirke, Hawkes Bay

The company was established in 1948 and is now a wholly farmer-owned cooperative company. On an annual basis, Alliance processes approximately 6 million lambs, 1 million sheep, over 200,000 cattle, 115,000 deer and 270,000 calves.

This equates to approximately 30% of New Zealand's sheep meat production, 10% of beef and 30% of venison.

The company exports products to over 65 different countries. Approximately 80% of its activities are related to sheep and lamb processing, the remainder being beef, and deer processing. Processing is vertically integrated with about 80% of the meat production being further processed by boning, cutting and consumer packaging. A proportion of the production is exported in a chilled state to Europe and North America. Co-products such as wool, skins and other carcass material are also processed for export by the company, usually at the same location as the meat processing facility.

As a wholly farmer-owned co-operative company, all profits are returned to the company's farmer shareholders with a portion retained for growth. The company employs approximately 4,650 people (permanent and seasonal staff) and services about 4,340 farmer shareholders who supply livestock, with 36% of these based in Southland.

Alliance's annual turnover for the 2017/2018 season was $1.8 billion and operating profit was $8 million.

2.2 ALLIANCE'S ENVIRONMENTAL POLICY AND ENVIRONMENTAL MANAGEMENT SYSTEMS

Alliance is committed to the sustainable management of the natural and physical resources that it depends on. Alliance therefore adheres to the following environmental policy:

> *Alliance Group Ltd is committed to the sustainable management of the natural and physical resources which it depends on. In meeting this commitment, Alliance Group will align itself with applicable New Zealand and international standards and will take all practicable steps to:*
>
> - *meet or exceed internal and key stakeholder expectations and relevant regulatory requirements;*
> - *continually improve environmental performance by identifying and measuring impacts, developing clear objectives and meaningful targets, and measuring progress with effective monitoring;*
> - *optimise the use of all resources including energy, water, packaging and chemicals, to minimise the wastes produced and the overall impact of our operations;*
> - *annually review the adequacy of the environmental management programme and progress towards achieving environmental objectives and targets;*
> - *communicate regularly on environmental matters with stakeholders including shareholders, employees, customers, suppliers, communities and regulatory bodies;*
> - *allocate appropriate resources to enable effective environmental management.*

Alliance holds ISO 14001:2015 environmental management systems certifications, as well as numerous quality certifications including ISO 9001:2015. ISO 14001 is an internationally recognised environmental management standard. As part of this system, all environmental aspects and impacts of Alliance's plants are identified and prioritised for action, and processes are put in place to control these aspects. Targets and objectives are established and monitored to enable demonstration of continuous performance and improvements are driven by internal audits and management reviews.

Alliance employs a Group Environmental Manager who has authority and responsibility to co-ordinate and implement the on-site environmental management systems in conjunction with site Environmental Managers or Environmental Representatives. The Group Environmental Manager is also responsible for ensuring that all the necessary regulatory consents and approvals are held and are current, and that compliance with all conditions of the consents held is being achieved. The board of directors of Alliance receive and review on a monthly basis a report on environmental performance matters including environmental compliance. Alliance also engages expert environmental advisors.

3. THE EXISTING ENVIRONMENT

3.1 LOCATION

The Alliance Mataura Plant is in the Mataura township on the true right bank of the Mataura River (see Figure 2). The first meat processing plant was established on this site in 1893, and since that time the Plant has been a vital component of Southland's agricultural sector, processing stock from the region.

The true left bank of the river is occupied by the former Carter Holt Harvey paper mill, now an industrial site managed by the Mataura Industrial Estate (MIE).

The Mataura township has a population of 1509 (2013 census) and is a small rural service centre whose residents have a high reliance on the Mataura Plant for employment opportunities.

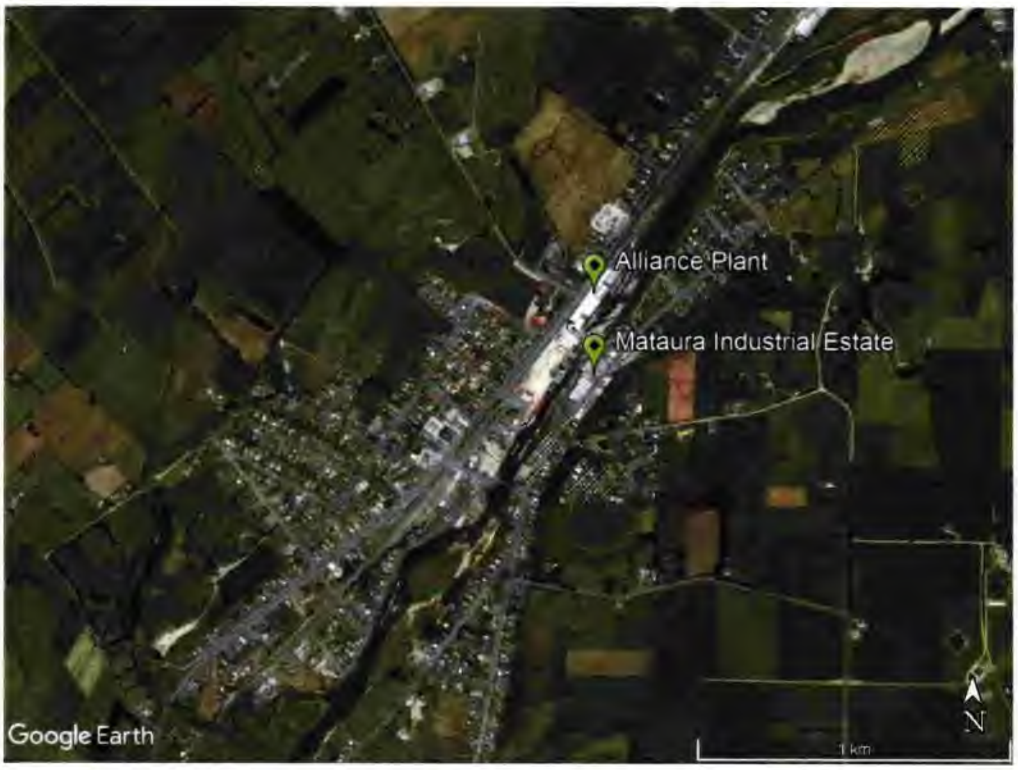


Figure 2: Mataura Township with Mataura River flowing from north to south.

3.2 THE MATAURA RIVER

3.2.1 Overview

The Mataura River catchment is the largest river catchment in the Southland Region with a catchment area of 5,400 km² which stretches from its steep alpine headwaters in the north near Lake Wakatipu, to the south coast of Southland at Toetoes Estuary, approximately 35 km east of Bluff.

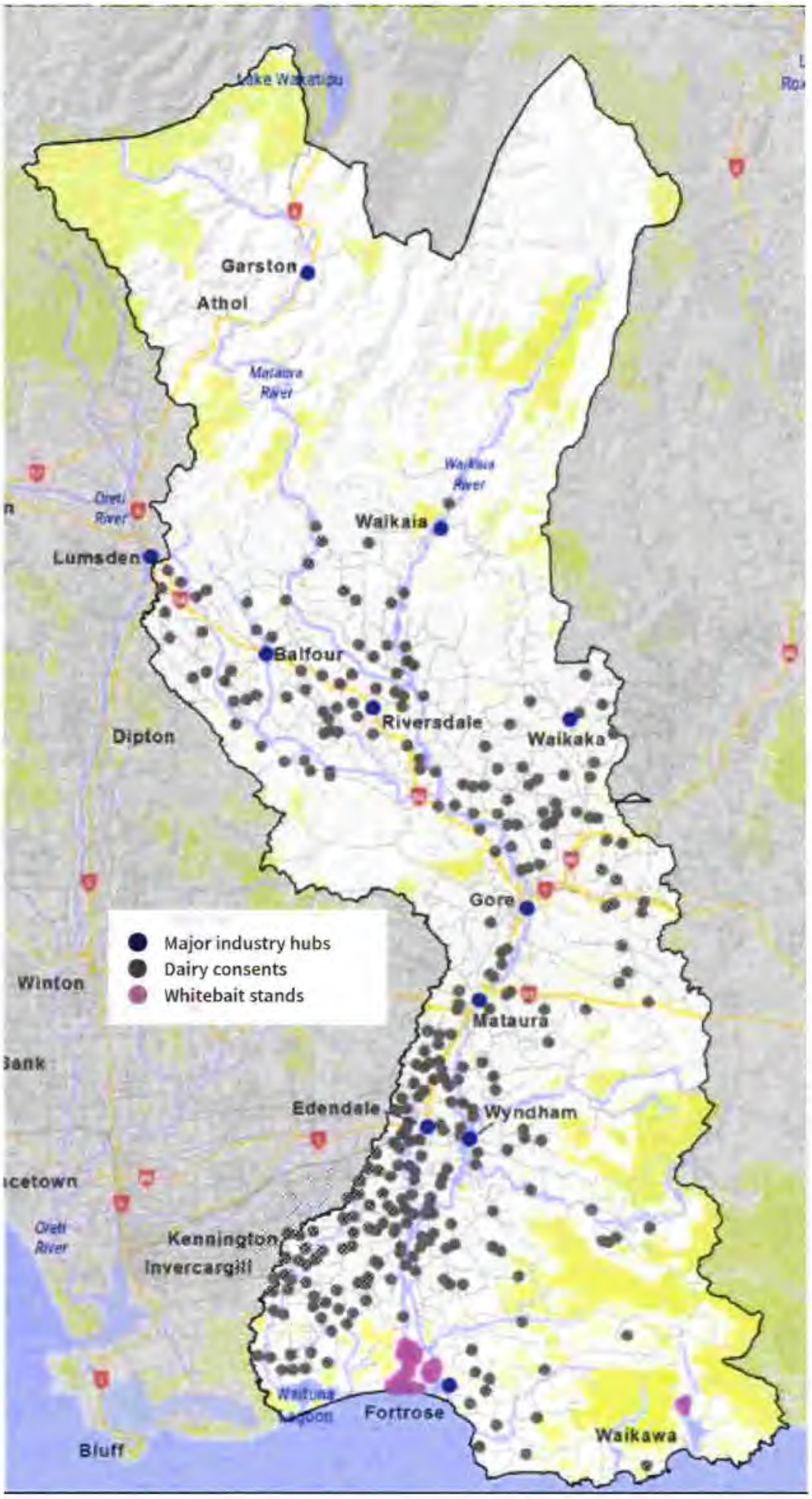


Figure 3: **The Mataura Catchment**

Over 70% of the Mataura catchment has been developed for farming (reflected in the prevalence of dairy farming related consents shown in Figure 3) and between 1940 and 1980 there was widespread willow clearing, channel straightening and artificial drainage installed which has significantly altered the catchment hydrology and water quality. The Mataura Plant is in the lower section of the Mataura Catchment, approximately 12 km downstream of Gore, and 44 km upstream of the Toetoes Estuary (at Fortrose). This lowland section is the most heavily modified section with water quality influenced by the cumulative effects of land use and diffuse and point source discharges.

The Gore District Plan lists the Mataura River as a significant natural feature, and in 1997 a water conservation order was made over the river recognising the fishery values as being nationally outstanding.

3.2.2 The Mataura Weir and Hydro Race

Immediately upstream of the Mataura Plant is an existing concrete U-shaped weir. This weir is believed to have been constructed in the 1920s or 1930s (see Figure 4).

Water is diverted by the weir along the true right bank of the river into a diversion channel adjacent to the Plant. From there it is directed through a turbine system which generates around 72,000 kW per week, supplying around 25% of the meat processing plant's electricity needs before being returned to the Mataura River approximately 400 m downstream of the weir below the Mataura Falls. A similar diversion and hydro plant exists on the true left bank adjacent to the MIE site.

On the Alliance Plant's side of the river, the damming, diversion and use of water using the weir and hydro race, and its discharge back to the Mataura River, is authorised by existing resource consents AUT.20171566-01 and AUT.20171566-02 and this activity forms part of the existing environment for these applications.

Figure 4: **Weir, hydro race and discharge.**

3.2.3 Hydrology

The flow within the Mataura River is highly variable, mostly because of its alpine headwaters and also its considerable catchment size. The Mataura River flow is continuously monitored by Environment Southland at Tuturau approximately 6 km downstream of the Plant. Summary flow statistics from this flow recorder for the period 1982 – 2018 are presented in Table 1.

Table 1: **Summary flow statistics for the Mataura River.**

Statistic	Value
Minimum flow	10.1 m^3/s
Maximum flow	1820.9 m^3/s
Mean flow	74.2 m^3/s
Median flow	56.8 m^3/s
Coefficient of variation[1]	89%
7 day mean annual low flow	19.0 m^3/s

The flow regime is characterised by long periods of low flow interspersed with high magnitude but low frequency flood events. Key points to note in that respect:

- FRE3 events (events where flows > 3x annual median flow, and generally considered to be a flood event which can disturb the river bed and cause ecological disturbance): ranged from 9 in 1982, 1998 and 2001 to 48 in 2013 with an average of 21 events per year.
- Accrual periods (the time between bed-moving floods, when high benthic biomass can develop): The number of 20+ day accrual periods ranged from 2 (in 1982) to 8 (in 1999) while the number of very long accrual periods (100+ days) when nuisance periphyton growths are more likely to occur ranged from 0–2 per year.
- Minimum flows occur between January and April with maximum flows during May and June. Minimum monthly median flows occur in February.

The Water Conservation (Mataura River) Order 1997 (Mataura WCO) places restrictions on the rate of flow in the Mataura River. The relevant part of the Mataura WCO states:

> *The minimum rate of flow at any point in the Mataura River and the Waikaia River above the Mataura Island Road Bridge (approximate map reference NZMS 260 F46:850158), where the flow is estimated by the Southland Regional Council from measurements taken at that point, must be 95% of—*
>
> *(a) the flow so estimated by the Southland Regional Council at that point; plus*
>
> *(b) water taken in accordance with the Act from the protected waters upstream of that point and not returned to the protected waters—*

---

[1] A measure of flow variability.

less authorised inflows upstream of that point which did not have their source in the protected waters.

3.2.4 Water Quality

Surface water quality in the Mataura catchment has undergone significant changes over the past 30 years. Point-source discharges and associated effects (Biological Oxygen Demand **(BOD)**, ammoniacal nitrogen (**Amm-N**) and dissolved oxygen (**DO**)) in the lower catchment were a major issue in the 1970's (as shown in Figure 3, there are several industry hubs in the catchment), but improvements to the quality of wastewater discharges have significantly reduced these effects. However, over the corresponding period, an increase in contaminants (particularly nutrients) associated with the intensification of agricultural land use has occurred across much of the catchment.[2]

The surface water quality monitoring data that Alliance has obtained generally supports these findings. It shows water quality in the vicinity of Mataura is characterised by:

- Water temperature (between 2.3–23.2°C) and DO levels (>6 g/m^3) suitable for protecting river ecosystem health;
- Variable visual clarity (0.07m – 3.29m).
- Nitrate and Amm-N concentrations which meet National Policy Statement for Freshwater Management 2014 (**Freshwater NPS**) Attribute State A or B for toxicity, but which exceed the relevant ANZECC (2000) 'physical and chemical stressor' trigger values which relate to nuisance plant growth;
- Nutrient indicators (e.g. Dissolved Inorganic Nitrogen (**DIN**) and Dissolved Reactive Phosphorus **(DRP)**) which regularly exceed the Ministry for the Environment periphyton guideline for protecting benthic biodiversity; and
- Very high *E.coli* concentrations which mean the Mataura River sits in the Red Freshwater NPS Attribute State for *E.coli.*

However, while water quality is clearly degraded for some parameters, water quality monitoring data collected by Environment Southland does not suggest further deterioration is occurring in this catchment in the vicinity of the Plant (refer to Table 2).

---

2 *Mataura Catchment Strategic Water Study*, Report prepared for Environment Southland. May 2011. Liquid Earth Aqualinc Research Harris Consulting.

Table 2: Water quality state and trends in the lower Mataura River

Parameter	Commentary on Current State	Trend from ES Water Quality Data[3]		
		Period	Gore	Mataura
Clarity	Variable clarity at Gore (median 1.18, range 0.08 m - 3.82 m) and Mataura (median 1.11 m, range 0.07–3.15 m).	2012 - 2016	Deterioration	Indeterminate
		2007 - 2016	Indeterminate	Indeterminate
		2000 - 2016	Indeterminate	Improvement
Nitrate nitrogen	Freshwater NPS Attribute State A for nitrate-nitrogen at Gore (annual median range 0.78 – 0.94 g/m³) and Mataura (annual median range 0.76–0.90 g/m³). Median nitrate nitrogen concentrations exceeded the ANZECC (2000) 'physical and chemical stressor' trigger for lowland rivers (0.444 g/m³) at both sites.	2012 - 2016	Indeterminate	Indeterminate
		2007 - 2016	Indeterminate	Indeterminate
		2000 - 2016	Deterioration	Deterioration
Amm-N	Amm-N concentrations are in the Freshwater NPS Attribute State A for toxicity at Gore, and are below the ANZECC (2000) 'physical and chemical stressor' trigger value for Amm-N in lowland rivers (0.021 g/m³).	2012 - 2016	Indeterminate	Indeterminate
		2007 - 2016	Improvement	Improvement

[3] Hodson R., Dare J., Merg M., Couldrey, M. (2017), Water Quality in Southland: Current State and Trends. Environment Southland publication No: 2017-04.

Parameter	Commentary on Current State	Trend from ES Water Quality Data[3]		
		Period	Gore	Mataura
	Freshwater NPS Attribute State B for toxicity at Mataura (annual median range 0.035–0.050 g/m³), which is a slight increase in ammoniacal nitrogen concentrations compared with Gore. Annual median concentrations of Amm-N at Mataura are also higher than the ANZECC (2000) 'physical and chemical stressor' trigger values for Amm-N in lowland rivers.	2000 - 2016	Improvement	Indeterminate
Total Nitrogen	Total nitrogen concentrations at Gore and Mataura exceed the ANZECC (2000) guideline value (< 0.614g/m³)	2012 - 2016	Indeterminate	Indeterminate
		2007 - 2016	Indeterminate	Indeterminate
		2000 - 2016	Deterioration	Indeterminate
Dissolved Reactive Phosphorus (DRP)	The ANZECC (2000) DRP trigger value of 0.01 g/m³ was exceeded on 19% of sampling occasions at Gore (median 0.01 g/m³, range <0.004 – 0.04 g/m³) and 49% of sampling occasions at Mataura (median 0.010 g/m³, range <0.004 – 0.047 g/m³).	2012 - 2016	Indeterminate	Indeterminate
		2007 - 2016	Indeterminate	Improvement
		2000 - 2016	Improvement	Improvement

Parameter	Commentary on Current State	Trend from ES Water Quality Data[3]		
		Period	Gore	Mataura
Total Phosphorus	TP concentrations at Gore and Mataura did not exceed the ANZECC (2000) trigger value of 0.33 g/m^3 on any sampling occasion.	2012 - 2016	Indeterminate	Indeterminate
		2007 - 2016	Improvement	Improvement
		2000 - 2016	Indeterminate	Improvement
E.coli	*E.coli* levels are representative of Freshwater NPS Attribute State E (Red) at both Gore and Mataura. Concentrations of *E.coli* exceeded the New Zealand single sample bathing water standards 36% of the time at Gore, and 75% of the time at Mataura.	2012 - 2016	Indeterminate	Indeterminate
		2007 - 2016	Indeterminate	Indeterminate
		2000 - 2016	Indeterminate	Deterioration

3.2.5 Habitat

Habitat in the lower Mataura catchment is characterised by its cobble dominated bed and willow lined channel (see Figure 5), although coal seams and bedrock outcrops become more common in the reach below Mataura.

Figure 5: Mataura River approximately 2 km downstream of the discharge point.

3.2.6 Aquatic Flora

While water quality (DIN and DRP concentrations in particular) indicates that periphyton growths should occur, such growths are not frequent in the Mataura River below Gore. However, periphyton growths are observed during longer accrual periods.

3.2.7 Benthic Invertebrates

The benthic macroinvertebrate community in the Mataura River is typical of lowland gravel bed rivers, and supports a range of water quality sensitive and tolerant taxa. It is dominated by Ephemeroptera (mayflies) and Trichoptera (caddisflies) with Diptera (true flies) the next most common group. *Deleatidium* are the most common mayfly and the filter feeding Aoteapsyche is the most abundant caddisfly taxon recorded across all years. Alliance's ecological monitoring data has recorded poor to fair macroinvertebrate community quality class across all monitoring sites both upstream and downstream of the Plant.

When periphyton growths are observed during longer accrual periods, the Macroinvertebrate Community Index (MCI) score typically decreases.

3.2.8 Fish

The lower Mataura River supports moderate to high native fish diversity (13 native fish have been recorded) including eight species with an 'At Risk Declining' conservation status - longfin eels, torrentfish, lamprey, Gollum galaxias, galaxias southern, inanga, giant kokopu and koaro.

3.2.9 Recreational Values

The Mataura River is regarded as one of New Zealand's premier lowland brown trout fisheries and is internationally recognised. The Mataura WCO recognises the importance of the river from source to sea with its outstanding fisheries and angling amenity.

With respect to other recreational values, the Mataura River supports a very popular whitebait fishery in its lower reaches and is subject to relatively high use for swimming during the summer months, both up and downstream of Mataura. This includes a bathing site in the vicinity of the Mataura Bridge approximately 100m downstream of the most southern end of the Plant site.

The Mataura River's various riverbanks, berms, reserves and angler access points are also used for a variety of terrestrial activities, mostly around settlements.

3.3 TOETOES ESTUARY

The Mataura River flows into the Toetoes Estuary. This estuary is a medium sized "tidal lagoon" type estuary that discharges to Toetoes Beach at Fortrose, and it drains a large and primarily high productivity agricultural catchment. The shallow estuary (mean depth of around 2 m) has a large freshwater influence because the estuary is small in relation to the freshwater input. It has a wide range of habitats (extensive mudflats and saltmarsh areas, very small patches of seagrass), but has historically lost large areas of saltmarsh (estimated loss of approximately 75% (250 ha)). Virtually all of its surrounding wetland has also been lost through drainage and reclamation and conversion to pasture. This has greatly reduced the estuary's ability to filter, dilute, and assimilate nutrient and sediment inputs.

Recent Environment Southland monitoring has shown the estuary is in a "MODERATE" but declining condition in relation to eutrophication, and that the ongoing drainage and loss of saltmarsh and densely vegetated terrestrial margins is placing the estuary under pressure. Excessive nutrient inputs are the primary driver of the eutrophication symptoms being expressed.

3.4 CULTURAL LANDSCAPE

Iwi have a long association and a strong traditional relationship with the Mataura River. A Statutory Acknowledgement exists for the Mataura River in Schedule 42 of the Ngai Tahu Claims Settlement Act 1998. This Statutory Acknowledgement outlines Ngai Tahu's association with the Mataura River. Above the Mataura Falls, the river was traditionally used by the descendants of the Ngati Mamoe chief, Parapara Te Whenua, along with other famous tupuna. The Statutory Acknowledgement states that:

> *"The Mataura was an important mahinga kai, noted for its indigenous fishery. The Mataura Falls were particularly associated with the taking of kanakana (lamprey). The tupuna had considerable knowledge of whakapapa, traditional trails and tauranga waka, places for gathering kai and other taonga, ways in which to use the resources of Mataura, the relationship of people with the river and their dependence on it, and tikanga for the proper and sustainable utilisation of resources. All of these values remain important to Ngai Tahu today.*
>
> *The mauri of the Mataura represents the essence that binds the physical and spiritual elements of all things together, generating and upholding all life. All elements of the natural environment possess a life force, and all forms of life are related. Mauri is a critical element of the spiritual relationship of Ngai Tahu Whanui with the river."*

The Mataura River is also subject to a Mätaitai Reserve. This reserve status recognises the importance of the river as providing a mahinga kai resource for Ngāi Tahu Whänui because of its use as an access route between coastal Muruhiku (Southland) to Fiordland and the West Coast for the gathering of pounamu. The Mataura was particularly noted for the gathering of kanakana (lamprey) and tuna (eels), with annual fishing expeditions in season to favoured nohoanga (campsites) along the river. The bylaw for the reserve prohibits commercial fishing within the area. Customary fishing is permitted subject to approval.

The takiwā of three rūnanga (Hokonui, Waihōpai and Awarua) extend across the area of the Mataura River catchment including the headwaters, main stem and coastal area. The Plant itself is located within the takiwā of Hokonui Rūnanga.

4. DESCRIPTION OF THE MATAURA PLANT AND ACTIVITIES

This section provides a description of the activities for which consent is sought. It includes:

- A description of the Mataura Plant.
- A description of the proposed take and use of water for cooling and processing purposes.
- A description of the cooling water discharge.
- A description of the wastewater discharge.

4.1 THE MATAURA PLANT

The Alliance Mataura Plant is located on the right bank of the Mataura River at the northern end of Mataura Township (see Figure 2). A site plan is provided in Figure 6.

The Plant has historically processed up to 10,000 sheep per day and 560 beef animals per day (with additional by-products processing including casings and rendering). In 2012 the processing of sheep and rendering ceased and beef production increased to up to 1,120 beef animals per day. For the foreseeable future, it is expected that the Mataura site will continue to operate solely as a beef processing plant.

The Plant generally operates five days per week, over almost 24 hours during peak processing. Sunday processing has also been undertaken recently for mycoplasma bovis infected stock culled by the Ministry for Primary Industries. All processing of stock killed at Mataura is carried out on-site, except for some transfer of soft offal and bones off-site for further processing or rendering. Processed carcasses and meat cuts are refrigerated and stored in large on-site chillers and freezers.

Stock are held in yards prior to slaughter. Cattle yards are located at the north end of the site. Cleaning of the yards occurs regularly.

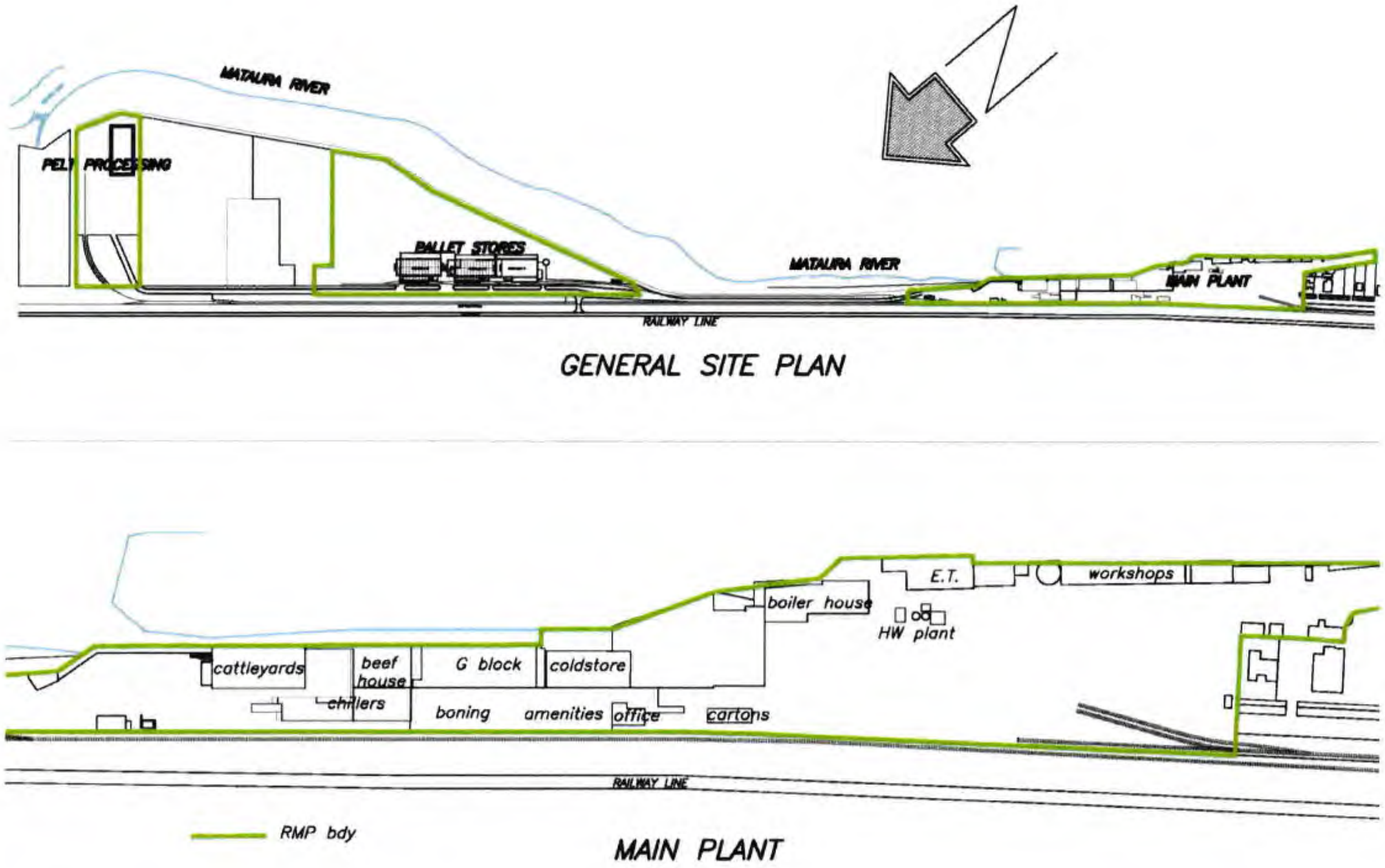


Figure 6: Alliance Mataura Site Plan.

4.2 TAKE AND USE OF WATER

Abstraction of water is essential for operations at the Plant. The existing consent authorises the taking of up to 35,600 m^3/day of water for freezing works supply. This is made up of:

- 21,200 m^3/day for cooling water; and
- 14,400 m^3/day for processing water.

Alliance is of the view that all of the water taken is non-consumptive with the exception of approximately 5% of the water taken for processing purposes and reserves its right in this regard.

The water is taken using 18 intake pumps (see Figure 7). Six of these (pumps 6 – 11) supply cooling water. The others supply process water.

Eleven of the intake pumps (No 1 – 11) are located in the hydro race and are screened with an aperture size of 5 - 6 mm to prevent debris and fish from being drawn into the takes. The remaining pumps (No. 12 – 18) are in a channel between the hydro race and the Plant. Fish and debris are prevented from entering this channel by a passive screen which has a bar spacing of 1.5 mm.

The existing consent was amended in May 2018 to require meters to be installed on all intakes which abstract processing water. The taking of engine room condenser water and engine room cooling water is not metered.

Since the processing of sheep and rendering ceased at the Plant, the amount of water taken and used for processing purposes has reduced significantly from the 14,400 m^3/day provided for in the existing consent. This is reflected in the proposed conditions which allow only 8,000 m^3/day of process water to be abstracted.

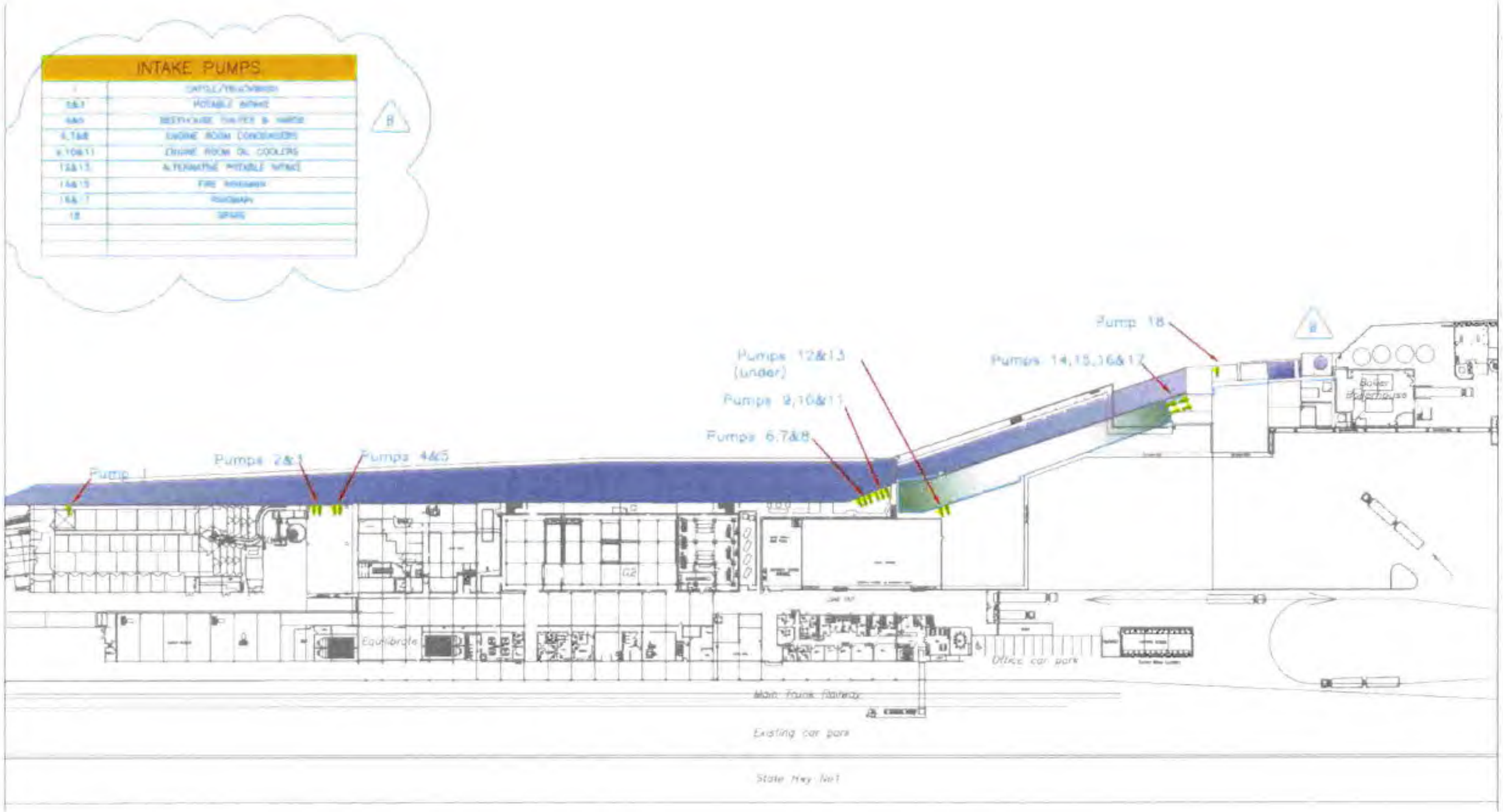


Figure 7: **Plant location, hydro race and pump locations.**

4.3 THE COOLING WATER DISCHARGE

The Plant contains large on-site chillers and freezers and the take, use and discharge of water from and to the hydro race adjacent to the Plant is essential to their operation.

The condenser cooling water pumps operate continuously because the demand for refrigeration at the site is continuous. The estimated total condenser cooling water take is 21,200 m^3/day based on pump capacities. The cooling water system takes water from the race, passes through the condensers once and then discharges water back into the hydro race (see Figure 7).

There are water temperature monitoring requirements upstream and downstream of the discharge.

4.4 THE WASTEWATER DISCHARGE

4.4.1 Synopsis

Two waste streams are generated on-site;

- green waste from the stockyards, gut cutting and tripe processing; and
- non-green wastes which are sourced from the slaughter floor, further processing and hide wash overflow.

Wastewater from staff amenities is separated at source and discharged to the Gore District Council wastewater system.

The wastewater treatment system at Mataura is designed to remove suspended solids, including associated organic matter, oil and grease and some nitrogen and phosphorus from the wastewater prior to its discharge. It comprises preliminary treatment (screening), primary treatment (settling) and physio-chemical treatment via a dissolved air floatation (DAF) system of the wastewater prior to it being discharged to the Mataura River.

All solids are transported from site where they are composted by third parties, however there is contingency for discharge to land, the Lorneville treatment plant, or landfill in the event the material is not suitable for composting

The green and non-green waste streams are subject to a more advanced different treatment process with the green waste stream being subject to an additional alkali DAF stage (ie. pH is lifted through the addition of lime) to remove phosphorus due to its comparatively high phosphorus load (Figure 8). The non-green waste does not contain high concentrations of phosphorus.

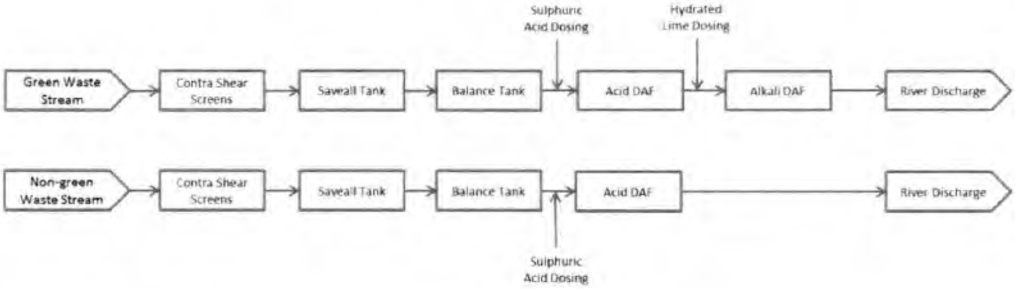


Figure 8: Existing wastewater treatment process at the Mataura Plant.

Treated wastewater is discharged through two 200 mm diameter pipes that exit the Plant approximately 100 m below the hydro race discharge and drop approximately 10 m to the river bed.

Figure 9: Final dried DAF solids ready to be taken off-site for composting.

4.4.2 Discharge Quality

Wastewater is discharged into the Mataura River on the true right bank. A summary of the discharge quality since the cessation of sheep and lamb processing at the Plant occurred in 2012/2013 is provided in Table 3.

Table 3: Summary of the discharge quality since November 2012 (all units g/m^3 unless stated).

	pH	Conductivity[4]	TSS	Sulphide	COD	BOD	TKN	Amm-N	TP	DRP
Med.	8.5	130	67	0.48	340	190	40	15	3.5	0.20
Min.	5.5	46	30	<0.4	50	30	10	2.1	1.0	0.013
Max.	9.6	470	220	2.1	1600	430	140	40	8.0	2.2
5%-ile	6.8	58	42	<0.4	180	83	19	5.9	1.5	0.06
95%-ile	9.3	360	100	1.1	520	290	59	29	5.9	0.88

With respect to the microbial content of the discharge, monitoring shows it contains very high *E.coli* concentrations, up to 10^6 CFU/100mL. However, whilst *E.coli* are the key faecal indicator bacteria ('**FIB**') used for regulatory purposes in NZ freshwaters, it is the pathogens for which they are intended to indicate that are of most concern for human health risk assessment. The two key groups of pathogens of most concern in animal wastewater are bacteria and protozoans[5]. Monitoring of the wastewater from the Mataura Plant has shown levels of these pathogens is much lower and more variable (Table 4).

Table 4: Pathogen monitoring data for treated wastewater from the Mataura Plant.

Pathogen	May 18	Dec 18	Jan 19	Feb 19
Salmonella (CFU/100ml)	1	21	4	<3
Campylobacter (CFU/100ml)	24	<3	9	4
E.coli 0157: H7 (CFU/100ml)	0	<3	<3	*
Giardia (oocysts /1,000ml)	<1	32	150	2
Cryptosporidium (oocysts /1,000ml)	<1	310	250	1
E.coli (CFU/100ml)	1,460,000	300,000	4,500,000	90,000

* E. coli O157 was detected in this sample, however quantification was not possible due to the presence of inhibitory substances in the matrix

[4] Units: mS/m.

[5] literature indicates there are no substantial human health risks established for transmission of fungi and viruses through animal wastewater discharge.

4.5 RECENT AND PLANNED UPGRADES

4.5.1 Past Upgrade – Phosphorus Reduction

Since the existing resource consents were granted in 2004, Alliance has completed a significant upgrade to its wastewater treatment plant to reduce phosphorus (particularly DRP) concentrations in the discharge. The key elements of this upgrade were:

- Improving separation of the high and low DRP waste streams entering the wastewater treatment plant; and
- Modifications to the DAF plant, such that the waste stream with high DRP levels is now subject to lime dosing and an additional alkali DAF stage to precipitate out the DRP.

4.5.2 Planned Upgrades

4.5.2.1 Year 1 – 3: Implementing water reduction opportunities and addressing existing resilience issues.

Pattle Delamore Partners (PDP) has identified potential intermittent cross contamination points between the green and non-green waste stream and potential failure points within the reticulation system. To address these resilience issues, the following will be completed in the first year of the new consent term:

- Re-route all pipework that runs above or in the water race to a location that prevents the risk of waste leaking into the water race or fresh water leaking into the treatment system;
- Re-route all pipework that runs above the river to a location that prevents the risk of waste leaking into the river;
- Modify the beef sump milli-screen overflow to prevent the risk of green waste overflows into the non-green waste stream; and
- Modify the stockyard and tripe recycle area to prevent the risk of green waste overflows into the non-green waste stream.

PDP has also identified scope to reduce the Plant's water use, and the volume of the wastewater discharge by approximately 37% by recycling white water within the wastewater treatment plant, although there are issues relating to discharge quality that need to be worked through, and which may mean this extent of reduction may not be able to be realised prior to installation of the biological treatment system described in Section 4.5.2.3 below. The proposed conditions require Alliance to complete this process within the first three years of the new consent term.

4.5.2.2 Year 5: Tertiary Disinfection of Microbial Contaminants.

Within five years of the commencement of the new consent, Alliance proposes that any wastewater discharged to the Mataura River is treated via a UV plant (or equivalent disinfection unit), in order to inactivate pathogens.

This upgrade is expected to incur capital costs of approximately $4.14 million, and additional annual operational expenditure of $230,000.

Following installation of the treatment system the proposed conditions require the *E.coli* concentration in the discharged wastewater to not exceed an annual median of 1,000 CFU/100ml and 95th percentile of <10,000 CFU/100mL. This is a substantial reduction relative to the concentrations set out above in Table 4.

4.5.2.3 Year 15: Biological Treatment System

By Year 15, Alliance proposes to install a full biological treatment system to treat the Plant's wastewater. This system will reduce BOD, ammoniacal nitrogen and total nitrogen loads.

Detailed design of the new biological treatment system will be completed closer to the installation date. However, it is currently anticipated a large, lagoon based, biological reactor will be installed. Due to the large lagoon size (approximately 8,500 m^3), it will likely be located 2 km away on land currently owned by Alliance Group Ltd, with wastewater being pumped to the lagoon for treatment, and then back to the Plant for discharge via the existing outfall.

The additional capital cost of installing tertiary disinfection of microbial contaminants and a biological treatment system is significant and estimated to be $13.98 million with annual operating costs of $1.06 million.

Following installation of the biological treatment system, the discharge concentrations of each parameter are expected to significantly reduce, and this is reflected in the allowable concentrations in the proposed conditions following installation of the biological treatment system (refer to **Appendix 1**).

More detail on these upgrades and the associated consent limits on discharge quality is provided in Section 9.3 of this AEE.

5. RESOURCE CONSENT REQUIREMENTS AND ASSESSMENT MATTERS

There are currently two regional plans which contain rules relevant to the proposed activity:

- The Operative Regional Water Plan for Southland (**Operative Plan**); and
- The Proposed Southland Water and Land Plan (**Proposed Plan**).

Table 5 identifies the resource consents required from the Regional Council for the proposed activities and the activity status of those consents under the Operative and Proposed Plans.

Table 5: Resource consent requirements and activity status.

Activity	Operative Plan	Proposed Plan	Activity Status
To discharge 14,400m^3/day of treated meat works wastewater, including treated wastewater from hide and skin processing to the Mataura River.	Rule 1 of the Operative Plan states that the discharge of any contaminant to water into a surface water body is a discretionary activity provided the discharge does not reduce the water below any standards set for the relevant water body in Appendix G "Water Quality Standards" after reasonable mixing. The Water Plan classifies the Mataura River as being "Mataura 3", and includes water quality standards for suspended solids, grease and oil, water temperature, pH, colour, clarity, oxygen concentration, toxicity, bacterial and slime growths, fish palatability, faecal coliforms and *E.coli*. The monitoring identifies that the discharge will achieve the prescribed standards with the exception of *E. coli*. Although the monitoring of *E. coli* upstream indicates that water	Rule 5 of the Proposed Plan provides for the discharge of any contaminant, or water into a surface waterbody as a discretionary activity provided the discharge does not reduce the water quality below any standards set for the relevant water body in Appendix E "Water Quality Standards" at the downstream edge of the reasonable mixing zone. The Proposed Plan classifies the Mataura River as being "Mataura 3", and includes water quality standards for suspended solids, grease and oil, water temperature, pH, colour, clarity, oxygen concentration, toxicity, bacterial and slime growths, fish palatability, faecal coliforms and *E.coli*. Compliance with these conditions can be achieved, with the exception of the *E. coli* limits). Consent is	Non-complying activity

Activity	Operative Plan	Proposed Plan	Activity Status
	quality being received by the Plant can at times already exceed the water quality standard of 1000 *E. coli* per 100ml, monitoring indicates that it can be further affected downstream of the discharge point, beyond the zone of reasonable mixing. Further, as set out in Table 4 above, monitoring indicates that the key human health risk pathogens for which E. coli acts as an indicator are at low levels in the discharge. Rule 2 provides that where a discharge cannot meet the conditions in Rule 1 it is a non-complying activity.	therefore also required as a non-complying activity pursuant to Rule 6 of the Proposed Plan.	
To discharge condenser cooling water from freezing works to the Mataura River.	The discharge of cooling water into the hydro race is governed by Rule 1 of the Water Plan. The cooling water discharge can comply with the limits set out in Appendix G (refer above) and therefore retains a discretionary activity status.	The discharge of cooling water is a discretionary activity pursuant to Rule 5 of the Proposed Plan, due to compliance with the water quality standards set out in Appendix E.	Discretionary activity
To take water from the hydro race which is fed by the Mataura River for cooling water purposes.	As outlined in Section 4.3, cooling water is taken from and discharged to the hydro race. Rule 18(d)(iii) provides that where water is returned in the vicinity of the abstraction point, it is a restricted discretionary activity.	Rule 18(b)(ii) provides that the taking of water is a restricted discretionary activity where the water is returned within 100 metres of the take or diversion point.	Restricted discretionary.
To take water from the hydro race which is fed by the Mataura River meat	Approximately 14,400m^3/s of the abstracted water is used for meat processing and truck wash activities. A large proportion of this water is	The return point for the processing water is beyond 100m downstream of the abstraction point. The take is consistent with the flow	Discretionary.

Activity	Operative Plan	Proposed Plan	Activity Status
processing and truck wash activities.	returned via the processing discharge back to the Mataura River, however as it is further than 100m downstream of the abstraction point, it is arguably "not within vicinity". Rule 18(d) classifies the taking and use of water from any surface water body where the total volume of water allocated at any time is less than 10 percent of the mean annual low flow at any downstream point in the catchment as a restricted discretionary activity. Alliance understands that is the case here.	regime and allocation specified in the WCO and is therefore assessed to be in accordance with Rule 49(c) as a discretionary activity.	

6. SOCIAL AND ECOMOMIC EFFECTS OF ALLOWING THE ACTIVITIES

When considering these applications, the RMA requires the consent authority to have regard to the actual and potential effects of allowing the activity, including positive effects.

A detailed assessment of the economic benefits of the Plant continuing to operate has been completed by Brown, Copeland & Co Ltd (the economic assessment). A copy of the economic assessment is provided in **Appendix 6** of this AEE.

The economic assessment has confirmed there are significant economic benefits accruing from the Plant, and that it is an asset for the Gore District and Southland region. Obtaining resource consents which allow the Plant to continue to operate would allow these benefits to continue.

The Plant employs 500 full time salaried staff and seasonal workers at the peak. This equates to 340 full time equivalent staff (FTEs). The Plant pays out $22 million in wages and salaries per annum and spends an estimated additional $12.3 million per annum in the Southland region on goods and services. These are quantified as direct economic impacts for the region's economy arising from the Plant's operation.

Figure 10: Beef boners at the Mataura Plant.

In addition, the economic assessment has identified a number of indirect impacts arising from:

- The effects on suppliers of goods and services provided to the Plant from within the region (i.e. the "forward and backward linkage" effects); and
- The supply of goods and services from within the region to employees at the Plant and to those engaged in supplying goods and services to the Plant (i.e. the "induced" effects). For example, there are additional jobs and incomes for employees of supermarkets, restaurants and bars as a consequence of the additional expenditure by employees directly employed at the Plant.

When these indirect effects are accounted for, the total contribution of the Plant's operation is assessed to be 595 FTE jobs for Southland residents, and $38.5 million per annum in wages and salaries for local Southland residents.

The economic assessment notes that the Mataura meat processing plant gives the Gore District greater critical mass and, as a consequence, the residents and businesses within the District benefit from economies of scale, greater competition, increased resource utilisation and better central government provided services. This is also true for the Southland region, although to a lesser extent given the economic activity generated by the Plant is proportionately less for the region as compared to the Gore District.

Continuation of the Plant at its current site, on a longer consent term (i.e. 35 years) also generates a number of economic efficiency benefits. The economic assessment identifies these as including:

- the continued use of existing plant and equipment with an insured value of $225 million (much of this value is sunk – i.e. it could not be recovered if the plant was forced to downsize, close or be relocated);
- the minimisation of transport costs (and carbon footprint) due to the proximity of the Plant to producers of livestock and finished product dispatch;
- the availability of a trained and experienced workforce and businesses with appropriate expertise and experience within close proximity of the Plant; and
- greater certainty for investment and management of the Plant.

If the Plant were to cease operation and Southland farmers had to truck cattle out of the region for processing, it would add to farmers' costs, reduce their disposable incomes and reduce spending in the Gore District and elsewhere within the region.

Alliance also contributes directly to the economic and social wellbeing of the community via its rates payments and other community contributions.

7. EFFECTS OF ALLOWING THE ABSTRACTION

7.1 INTRODUCTION

A detailed assessment of the potential effects of the proposed water abstraction is included in the Freshwater Solutions (FWS) / Aquatic Environmental Sciences (AES) report – a copy of which is provided in **Appendix 2** of this AEE.

The potential effects of the proposed abstraction identified by the FWS/AES report are:

- Effects associated with the entrainment of fish in the intake; and
- Effects associated with the reduction in flows in the Mataura River.

Each is addressed below.

7.2 ENTRAINMENT

In total the Plant abstracts up to 35,600 m^3/day of water using 18 pumps located in the hydro race. As outlined above, the intakes are fitted with screens. The water velocity within the hydro race is high which creates a high sweep velocity across the face of the intake at the screen faces. This reduces the potential for entrainment of juvenile fish compared to many intakes. However, despite this, the FWS/AES report recommends that all the intakes that are currently fitted with 5 – 6 mm screen mesh be fitted with 2 - 3 mm screens to further reduce the potential for entrainment and to meet best practice standards for screening intakes. Alliance propose to implement this recommendation. This is reflected in the proposed conditions.

7.3 INSTREAM FLOWS

Resource consents 20171566-01 and 20171566-02 enable the diversion of water to the hydro race and its discharge from the hydro race discharge (see Figure 11). The effect of this diversion on river hydrology, allocation, natural character, instream habitat and water quality have all been considered via those consents. As is set out in Section 3.2.2, these effects form part of the existing environment.

Of the 35,600 m^3/day Alliance is authorised to abstract from the Mataura River, 21,200 m^3/day is used for cooling purposes. This water is returned to the Mataura River via the hydro race outlet (see Figure 11). The remaining 14,400 m^3/day is used for various process activities on-site, and [nearly] all of that water is returned to the Mataura River a further 100 m below the hydro race discharge via the wastewater treatment plant outfall (see Figure 11).

Figure 11: Take and discharge points.

The additional effect of the process water abstraction reducing baseflows in the Mataura River for an additional 100m is minimal, particularly considering it represents no more than 2% of minimum flow and 1% of MALF, and the Mataura WCO requires 95% of the naturalised flow to remain in the river at this point in order to maintain the river's outstanding features and characteristics. It will only have very minor effects on dissolved oxygen, contaminant concentrations and river water temperature and is not expected to significantly alter the water quality. The results of the benthic invertebrate community monitoring over many years and the large population of resident brown trout indicate that the water take does not adversely affect the benthic invertebrate community (an important food source for fish), fish habitat or fish migration.

8. EFFECTS OF ALLOWING THE WASTEWATER AND COOLING WATER DISCHARGES

8.1 INTRODUCTION

This section addresses the effects of the wastewater and cooling water discharges on the environment. They include effects on:

- Water quality in Mataura River;
- Aquatic ecology in Mataura River;
- Toetoes Estuary;
- Human health;
- Recreation; and
- Cultural values.

8.2 EFFECTS ON WATER QUALITY IN MATAURA RIVER

8.2.1 Introduction

A detailed assessment of the effects of the wastewater and cooling water discharges on the water quality is contained in the FWS/AES report, which is included in **Appendix 2** of this AEE. A summary of the report's key findings is provided below.

The FWS/AES report is informed by extensive monitoring data collected by Alliance over a number of years in accordance with the requirements of its existing resource consents. This is described further in Section 9 of this AEE. Additional detailed and focused monitoring was also undertaken to inform this consent application, including longitudinal surveys of water quality at multiple points upstream and downstream of the Plant, and additional monitoring of periphyton, benthic invertebrates and fish.

8.2.2 Zone of Reasonable Mixing

The existing consent conditions set the mixing zone for the wastewater discharge 250m downstream of the outfall (see Figure 11), and a recent Streamlined Environmental assessment (see **Appendix 4**) has shown the discharge is fully mixed before this point.

8.2.3 Physio-Chemical Parameters

The FWS/AES report analyses the monitoring data and concludes it shows no evidence that the discharge from the Plant is causing measurable effects on pH, temperature, turbidity, TSS, colour, clarity or DO.

The FWS/AES report identified DO as being particularly important for supporting healthy aquatic ecosystems with concentrations needing to be above 5 g/m^3 as a minimum over seven days and above 4 g/m^3 as a one day minimum to avoid adverse effects. At all sites on the longitudinal survey, dissolved oxygen concentrations above and below the Plant were above this measure, and depending on the survey, reflected either Freshwater NPS numeric Attribute State A or B.

The FWS/AES report has identified that on occasion, instream water temperature upstream and downstream of the Plant is close to the upper lethal temperature limit (>23°C) for some of the more sensitive benthic invertebrates' resident in this stretch of river. However, the Plant has no apparent effect on water temperature so would not exacerbate this issue.

8.2.4 Colour, Clarity, Foams and Scums

The FWS/AES report concludes that the discharge does not have an adverse effect on colour, clarity, or the generation of foams or scums. Notable observations from the monitoring include:

- The water colour upstream and downstream of the Plant is predominantly pale greenish yellow (2.5GY (32.5) 8/2).
- The Mataura River upstream and downstream of the discharge does meet the black disc visual sighting distance of >1.6 m for waterways that are managed for contact recreation.
- There is a slight decrease in clarity and a slight increase in TSS and turbidity downstream of the Plant, which may be due to the combined effect of the energy from the Mataura Falls resuspending fine material and the discharge.
- While some foam has been observed below the Mataura Falls, it has originated upstream of the Plant's wastewater discharge indicating the discharge is not causing that foam.

No changes to these effects due to the Plant's operation are expected in the future.

8.2.5 Ammonia & Nitrate Toxicity

The FWS/AES report analysis of monitoring data concludes the Plant's wastewater discharge is elevating Amm-N concentrations in the Mataura River immediately downstream of the discharge.

The monitoring data shows water quality reducing from Freshwater NPS Attribute State A for toxicity (annual medians 0.02 – 0.03 g/m^3) upstream of the Plant to Freshwater NPS Attribute State B (annual medians 0.05 – 0.06 g/m^3) downstream. The FWS/AES report has examined this in some detail and advised it does not represent an effect which requires immediate or urgent mitigation on ecological grounds.

This is because freshwater mussels are the only species protected by Freshwater NPS Attribute State A Amm-N water quality, and they do not occur in the Mataura River immediately upstream or downstream of the discharge. The Amm-N sensitive species that do occur in the Mataura River in the vicinity of the discharge are the mayfly *Deleatidium* sp. and the snail *Potamopyrgus antipodarum* and these are protected by the Attribute State B – which is achieved.

Following installation of the biological treatment system required by the proposed conditions, the concentration of Amm-N in the discharge would be significantly reduced, and it is expected the discharge will no longer elevate downstream Amm-N concentrations in the manner currently observed.

Nitrate nitrogen is also an issue in many New Zealand rivers. However, in this case the FWS/AES report notes that the discharge contains very low concentrations of nitrate nitrogen, there is little difference between concentrations upstream and downstream of the discharge, and instream concentrations meet Freshwater NPS Attribute State A for toxicity.

8.2.6 Biological Oxygen Demand (BOD)

Monitoring results show median BOD concentrations both upstream and downstream of the Plant are below the guideline of 2 g/m^3 for avoiding nuisance heterotrophic growths. Therefore, the FWS/AES report concludes that effects on aquatic biota, or the formation of heterotrophic growths, immediately downstream of the discharge due to BOD are not anticipated. This is supported by the regular visual observations during summer lower flow conditions between the discharge point and Mataura Bridge by Alliance staff.

No changes are expected in the immediate future. And following installation of the biological treatment system required by the proposed conditions, the concentration of BOD in the discharge would be further reduced.

8.2.7 Nutrient Enrichment

Algal growths in rivers are strongly influenced by a range of chemical (e.g. nutrient concentrations), biological (e.g. grazing pressure from macroinvertebrates) and physical factors (e.g. frequency of flow disturbance events). Therefore, for this assessment, the FWS/AES report used the MfE (2000) periphyton guidelines which relate nutrient concentrations to accrual periods and flow disturbance events to assess the potential effects of the nutrients from the discharge on algal growth.

The relevant DRP and DIN results are set out in Table 6 below. Concentrations are very similar between upstream and downstream sites and the FWS/AES report analysis of the monitoring data does not identify the Plant's discharge as having any notable impact on downstream concentrations.

However, the FWS/AES report does identify that the mean monthly DIN and DRP concentrations at all sites upstream and downstream exceed the MfE periphyton guideline for protecting benthic biodiversity across all growth periods (see Table 7) , and significantly so for DIN. The proposed upgrade to the wastewater treatment plant will reduce the Plant's contribution to the baseload of DIN in the catchment downstream of the Plant.

Table 6: DIN and DRP concentrations upstream and downstream of the Plant.

	DIN		DRP	
	Upstream (U1/U2)	Downstream (D1/D2)	Upstream (U1/U2)	Downstream (D1/D2)
Min	0.4/0.4	0.4/0.4	0.002/0.002	0.002/0.002
Max	1.5/1.6	1.5/1.5	0.029/0.022	0.017/0.015
Mean	0.9/0.9	0.9/0.9	0.011/0.011	0.010/0.010

Table 7: The MfE (2000) guideline maximum mean monthly DIN and DRP concentrations for preventing excessive periphyton growth

Days of accrual	DIN (g/m³)	DRP (g/m³)
20+	<0.295	<0.026
30+	<0.075	<0.006
40+	<0.034	<0.0028
50+	<0.019	<0.0017
75+	<0.010	<0.001
100+	<0.010	<0.001

8.2.8 Microbial Parameters

E.coli is the principle measure used by the Freshwater NPS (see Section 12.2) and Environment Southland's RMA plans (see Section 12.6 and 12.7) for determining the suitability of a river for contact recreation. *E. coli* is used as the indicator of possible faecal contamination because it is commonly found in human and animal faeces and it is relatively inexpensive to monitor. As is the case for a significant number of New Zealand's waterbodies in lowland farming areas, *E.coli* levels in the Mataura River, including downstream of the Plant, are high. They sit in the Red Freshwater NPS Attribute State, and exceedances of the New Zealand single sample bathing water standards[6] are common (Table 8).

Table 8: Freshwater NPS Attribute State of Mataura River based on historical *E. coli* data.

Location	% exceedances over 540	% exceedances over 260	Median concentration (cfu/100ml)	95th percentile *E.coli*/100 ml)	Attribute State
Mataura River 200m d/s Mataura Bridge	77	83	1551	12551	E (Red)
Mataura River at Gore	35	59	361	5401	E (Red)
Mataura River at Mataura Island Bridge	42	56	401	4451	E (Red)
Mataura River at Parawa	17	30	156	1066	D (Orange)
Mimihau Stream at Wyndham	39	69	391	2651	E (Red)
Mokoreta River at Wyndham River Road	35	58	321	3801	E (Red)
Oteramika Stream at Seaward Downs	55	82	601	4551	E (Red)
Waikaia River at Waipounamu Bridge Rd	20	31	161	2751	E (Red)
Waikaka Stream at Gore	42	61	331	19251	E (Red)

6 260 CFU/100mL and 540 CFU/100ml.

As outlined in Section 4.4.2, the Plant's discharge also contains relatively high concentrations of *E.coli,* and instream monitoring data shows *E.coli* concentrations increase significantly downstream of the Plant due to its wastewater discharge. For instance, at the site immediately downstream of the discharge (Mataura River 200m d/s Mataura Bridge), exceedance of the 540 CFU/100mL single sample standard increased from 35% to 77%. This suggests the Plant's discharge is having an effect on the *E.coli* levels in the river downstream of the Plant.

However, as is outlined in Section 4.4.2, despite the Plant's discharge containing relatively high *E.coli* levels, the level of pathogens in the discharge, which are of most concern when considering effects on human health, are much lower and more variable. In turn, the Plant's impact on the levels of those pathogens in the Mataura River below the discharge would also be much smaller. This is discussed further in Section 8.5 below which addresses the human health related effects of this change in water quality.

8.3 EFFECTS ON AQUATIC ECOLOGY IN MATAURA RIVER

In addition to assessing effects on water quality, the FWS/AES report assessed effects on in-stream ecological values with a view to identifying any instream effects of the Plant's discharge. Potential effects of concern which the FWS/AES report investigated included:

- Proliferation of nuisance algal growths;
- Reduced benthic invertebrate community health; and
- Reduced fish abundance, diversity and health.

A summary of the FWS/AES report's key findings is provided below.

8.3.1 Algal Growths

Nuisance algal growths include sewage fungus and periphyton. The amount of periphyton in a river is determined by interactions between flow regime, nutrient status, light and temperature, streambed substrate and benthic invertebrate grazing. Algal growths are the most direct indicator of nutrient related effects on rivers and in turn have been monitored upstream and downstream of the Plant at least annually since 2012.

This monitoring has recorded variable algal cover and biomass between sites upstream and downstream of the Plant, and among surveys. It indicates that while DRP and DIN concentrations are relatively high, this is not stimulating periphyton growths upstream or downstream of the Plant except following very long late summer – early autumn accrual periods (the most noticeable example of which was in February / March 2019). The FWS/AES report also notes the sewage fungus and periphyton monitoring data shows no effect from the Plant's wastewater discharge.

8.3.2 Benthic Invertebrates

Benthic invertebrates are a commonly used indicator of water quality with indices such as the MCI, QMCI and percent EPT[7] designed to specifically assess nutrient related effects. Benthic invertebrates have been monitored at least annually at several locations upstream and downstream of the Plant since the early 1990s.

Overall, the benthic invertebrate community upstream and downstream of the discharge reflects the cumulative effect of catchment-wide inputs upstream and is generally in fair to poor health across most benthic invertebrate indices.[8]

Total taxa number and EPT taxa number have been variable across sites and between surveys over the 2012–2019 period with no clear evidence that the discharge causes a reduction in total diversity or the diversity of water quality sensitive taxa. Prior to the most recent surveys, there had been a general increasing trend in *Deleatidium* sp. abundance at downstream monitoring locations. In February 2019, *Deleatidium* sp. abundance at the downstream monitoring sites was lower compared to upstream sites. The decline in *Deleatidium* sp. abundance at downstream sites in February 2019 is not explained by periphyton cover and biomass or Amm-N concentrations, which are all potential effects of the discharge. Rather, the FWS/AES report has assessed that this decline in abundance could be attributed to high river temperatures leading up to and at the time of the February 2019 survey and an increase in overall stress that occurred at the time. A sharp decline at upstream and less pronounced decline at downstream sites in *Deleatidium* sp. was also recorded in March 2019. This is very likely to be related to the elevated river temperature and extensive late successional stage algal growths at the time of the survey associated with the longest late summer – early autumn accrual period since 2012. It also suggests the upstream decline may have been slightly delayed compared with downstream.

MCI scores have been similar upstream and downstream of the Plant over the period between January 2012 and March 2019 and remained within the 'fair' stream health range for all sites. QMCI scores have been variable across years largely as a result of differences in the relative abundance of *Deleatidium*. Overall, the FWS/AES report concludes that results indicate the treated wastewater discharge has not resulted in a consistent decrease in MCI and QMCI scores between upstream and downstream locations over a range of accrual periods between April 2013 and December 2017. The FWS/AES report also identifies no evidence or causal links that can be associated with the discharge for the February 2019 survey and the March 2019 declines that occurred both upstream and downstream.

---

[7] EPT stands for Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) which are macroinvertebrates that are sensitive to water pollution.

[8] It is notable however, that QMCI is sometimes in the 'good' range.

8.3.3 Fish

The lower Mataura River is a migratory pathway for a range of whitebait species, brown trout, salmon. Fish abundance and health can be influenced by a wide range of factors including proximity to the coast, barriers such as the Mataura Falls, habitat quality and water quality.

Results from fish surveys indicate that the fish community in run habitat is dominated by a small number of species – longfin and shortfin eel, elvers and upland bully. Elvers were more abundant at downstream sites compared to upstream sites and could either be attributed to differences in habitat suitability, or simply the timing of the upstream migration by a particular group of new recruits into the river. The fish community in the reach between the Mataura Falls and Mataura Bridge, based on survey results, indicates that the Mataura River immediately upstream and downstream of the discharge supports a healthy longfin eel population including several very large fish (+5 kg).

Anecdotal evidence indicates that there is a large resident population of brown trout and late summer and early autumn runs of sea run brown trout and salmon are regularly seen and caught between the Mataura Falls and the Mataura Bridge. The presence of such large numbers of brown trout and seasonal migration of brown trout and salmon indicate that the water quality in this section of the river is suitable for supporting salmonids that are amongst the most water quality sensitive species present in New Zealand.

The contaminants that can make fish unsuitable for consumption are persistent pollutants such as certain metals (e.g. mercury) and persistent organic pollutants (e.g. dioxins). There are no persistent pollutants of this type in the wastewater discharge and therefore adverse effects from the discharge on fish health or the consumption of fish are not expected.

8.4 EFFECTS ON TOETOES ESTUARY

As outlined in Section 3.3, Toetoes Estuary is in declining condition in relation to eutrophication with excessive nutrient inputs being the primary driver of the eutrophication symptoms being expressed.

The TN and TP loads received by the Estuary have been estimated at 3,110 tonnes per year and 345 tonnes per year respectively.

On this basis since 2012 the contribution of the Plant's discharge to Toetoes Estuary TN loads has been assessed as being 1.1 - 1.7% and its contribution to TP has been assessed as 0.7 - 1.3%, with the majority of the TN and TP load entering Toetoes Estuary derived from other catchment inputs, particularly diffuse sources.

In turn, the FWS/AES report concludes that the effects of TN and TP in the Plant's discharge on Toetoes Estuary are no more than minor.

However, the FWS/AES report is of the view that Alliance will need to reduce its levels over time as part of catchment-wide initiatives to improve water quality.

This will occur following installation of the biological treatment system which the proposed conditions require to be commissioned within 15 years of the commencement of the new consent, which is expected to reduce the concentration of TN in the discharge by approximately 68% and annual loading by approximately 50% relative to present.

However, while this represents a significant reduction in the TN load contributed by the Plant, it represents less than 1% of the total TN load received by the Estuary. In turn, the FWS/AES report expect it to have little, if any, detectable effect on the nutrient status of Toetoes Estuary.

8.5 HUMAN HEALTH

E.coli is the principle measure used by the Freshwater NPS and Environment Southland's RMA plans for determining the suitability of a river for contact recreation. *E.coli* is used as the indicator of possible faecal contamination because it is commonly found in human and animal faeces and it is relatively inexpensive to monitor. As is the case for a significant number of New Zealand's waterbodies in lowland farming areas, *E.coli* levels in the Mataura River, including downstream of the Plant, are high. They sit in the Red Freshwater NPS Attribute State, and exceedances of the New Zealand single sample bathing water standards[9] are common. They also do not meet the relevant Southland Land and Water Plan standards. A recent Environment Southland study of Campylobacter risk in this catchment using actual instream data for that parameter (rather than levels of *E.coli* as an indicator) suggests that the health risk in this catchment may not be anywhere near as high as is suggested by the *E.coli* concentrations present,[10] and additional monitoring data collected in 2018 by Streamlined Environmental supported this finding. However, Alliance understands that baseline water quality conditions in the Mataura River (absent any contribution from the Plant) may be 'un-swimmable' at times due to the contribution of pathogens from other upstream sources.[11]

As outlined in Section 4.4.2, the Plant's discharge also contains relatively high concentrations of *E.coli*, and as outlined in Section 8.2.8, instream monitoring data shows *E.coli* concentrations increase significantly downstream of the Plant due to its wastewater discharge. However, as is also outlined in those sections, despite the Plant's discharge containing relatively high *E.coli* levels, the level of pathogens in the discharge, which are of

---

[9] 260 CFU/100mL and 540 CFU/100ml.

[10] Cressey, P., Hodson, R., Ward, R., & Moriarty, E. (2017). Use of QMRA to Assess the Human Health Risk of the Mataura River, Southland http://isrs2017.com/images/Cressey_Peter.pdf.

[11] Cressey, P., Hodson, R., Ward, R., & Moriarty, E. (2017). Use of QMRA to Assess the Human Health Risk of the Mataura River, Southland http://isrs2017.com/images/Cressey_Peter.pdf.

most concern when considering effects on human health, are much lower and more variable.

To further understand the effect of the Plant elevating downstream *E.coli* levels on human health, a Quantitative Microbial Risk Assessment (QMRA) has been undertaken by Streamlined Environmental to predict the health risk to people swimming in the Mataura River below the Plant's discharge point as a result of the Plant's discharge only. A copy of this QMRA report is included in **Appendix 3** of this AEE.

The QMRA shows that while the Plant causes *E.coli* concentrations in the Mataura River to increase significantly below the Plant's discharge point, this does not equate to a significant increase in health risk, and the risk of a person swimming below the Plant becoming ill due to the Plant's discharge is well below 1% which is considered an acceptable level. It is noted that this is broadly consistent with the aforementioned Environment Southland study which concluded the Plant's discharge contributed only a relatively small proportion of the overall Campylobacter risk in this catchment.[12]

However, while the Environment Southland and Streamlined Environmental studies show the baseline health risk in this catchment, and the Plant's contribution to that health risk, are not as significant as measured *E.coli* levels would suggest, this does not equate to there being no risk. It is evident that there are times when the Mataura River is un-swimmable and as is outlined in Section 12.2 of this AEE, Environment Southland is obliged under the Freshwater NPS to set policy and methods to improve water quality so that it is suitable for primary contact more often. The key indicator for how that is being achieved is also instream *E.coli* concentrations.

In that context, Alliance acknowledges it should contribute to any catchment-wide plan for improving water quality for contact recreation, and reducing *E.coli* concentrations in the Mataura River. This will occur following installation of the UV treatment plant required by the proposed conditions, which is expected to reduce the *E.coli* levels in the Plant's wastewater discharge by more than 99%.

8.6 EFFECTS ON RECREATION

Rob Greenaway & Associates has undertaken a qualitative and quantitative assessment in order to determine the recreational values that exist in the Mataura River and whether these are being affected by the Plant, and more specifically, the wastewater discharge to the Mataura River (the recreation report). A copy of the recreation report is provided in **Appendix 5**.

---

12 Cressey, P., Hodson, R., Ward, R., & Moriarty, E. (2017). Use of QMRA to Assess the Human Health Risk of the Mataura River, Southland http://isrs2017.com/images/Cressey_Peter.pdf.

As outlined in Section 3 of this AEE, the following key recreational values have been identified:

- The outstanding nature of the Mataura River for brown trout fishing;
- Its relatively high use for swimming, both upstream and downstream of Mataura;
- A very popular whitebait fishery in the lower reaches;
- Use of the riverbanks, berms, reserves and angler access points for a variety of terrestrial activities, mostly around settlements, and with relatively high activity levels at the Coal Pit Road angler access point;
- A low level of use of the river for salmon fishing;
- Some use of the river for jet boating and kayaking, but with no relevant data to quantify these uses.

Consultation (including formal interviews) with key recreational stakeholders and users of the Mataura River was also completed. The interviewees provided a variety of views on the changes to the above recreation values over time.

While no-one interviewed would drink from the Mataura River below Cattle Flat, all agreed that the river's water quality was far better than in the 1980s when there were a variety of untreated municipal and industrial discharges occurring. Several respondents – mostly anglers – considered the water quality now to be quite good, but potentially of decreasing quality due to farming intensification. Others considered the water quality to be poor. Many noted a variety of sources of contamination, including farming and treated municipal wastewater, particularly at Gore. The Alliance discharge did not feature as a major issue for most respondents, but was noted by kayakers.

Opinions about the quality of the fishery also varied and the presence of the Plant's discharge does not appear to be having an adverse effect on the people's use and enjoyment of the fishery. Most agreed that the mayfly rise on the Mataura River had declined in frequency and intensity, with several theories as to the cause. The most experienced angler on the river downstream of Mataura – with detailed angling diaries – considered the insect life in the river to be quite healthy, but that warmer summer temperatures (climate change) were confining the rise to evenings and night, were less frequent generally, and were occurring later in the 'summer' season ('May is the new April'). Warmer temperatures were also considered a cause in the change in the patterns of the hatch by other anglers, but nutrification and sedimentation and (therefore) fewer insects were also identified. Opinions about the number and quality of trout varied, with some considering the numbers and quality to be consistent, and others considering size, quality and numbers to have all declined. Some considered a reduction in trout size to be the result of a cleaner river. The change in the frequency, timing and duration of the mayfly hatch has influenced a change in fishing technique, with more nymphing over dry fly fishing.

Swimming appears to be, in the main, a very local activity with a small number of regular users – also influenced by the recent closure of the community swimming pool at Mataura. There appears to be no common local conversation about illnesses from contact with the river water, and bathing water quality reports issued by Environment Southland do not appear to affect many swimmers' choices. The results of the QMRA report are also important when considering the effects of the Plant's discharge on swimming.

Having considered these responses, the FWS/AES report and the QMRA the key finding of the recreation assessment is that:

- The key potential issues when considering the effects of the proposed activities on recreation values are:
  - The degree to which the proposed activities increase the risk of contracting a waterborne disease from water contact recreation, including swimming, paddling and trout and whitebait fishing;
  - The effect of the discharge on trout and whitebait abundance and quality, associated with water quality and other habitat parameters, such as the health of the in-river macroinvertebrate community and water temperature;
  - The degree to which the discharge exacerbates nuisance periphyton growths, affecting bathing quality and the risk of anglers slipping; and
  - Odour from the discharge, alterations of water colour and clarity and the generation of foams and scums, affecting water contact recreation as well as visual amenity, angling and white baiting.
- The contribution of the discharge and water take to adverse effects on recreation in the Mataura River in respect of the above are very slight and subsumed by the many other sources of nutrification and contamination.
- There appears to be no causal relationship between the discharge and levels of periphyton, macroinvertebrates, colour, clarity or the generation of foams or scums – and hence trout and whitebait habitat and the ability to catch them.
- The Plant should reduce its levels of key contaminants as part of catchment wide initiatives to improve water quality.
- While not urgent considering the existing low scale of effect on recreation amenity (and ecological values), it is recommended that options to reduce *E.coli* levels in the discharge be implemented during the life of a renewed consent.

8.7 CULTURAL EFFECTS

In order to identify and assess the cultural effects of the activities, Alliance requested Te Ao Marama Inc (**TAMI**) to prepare a Cultural Values Report. Alliance has also engaged with TAMI and Hokonui Runanga in respect of these applications and that process.

It is clear from the engagement that has occurred thus far that iwi have a long association and strong traditional relationship with the Mataura River, and mahinga kai resources, nohoanga and mātaitai are all important and relevant values here.

It is also clear that:

- The disposal of wastewater directly to water is an activity which is of potential cultural concern.
- Generally speaking, Hokonui Runanga do not believe consents should be granted for a term exceeding 25 years, as doing so is essentially making decisions for the next generation.
- Meaningful ongoing engagement and suitably recognising the role of Hokonui Runanga as kaitiaki of the Mataura River is important.

These first two of these issues were important considerations in the detailed assessment of alternative options for treatment and disposal of the Plant's wastewater which is described in Sections 9.3.1 and 10. However, for reasons set out in Section 10, a discharge to land option is not practicable here, and the proposed wastewater treatment plant upgrades, along with a consent term which allows those upgrades to be progressively implemented and the financial investment to be justified and secured over an appropriate timeframe, is considered to be the best practicable option.

Alliance welcomes the third matter and Key Alliance staff also met with key Te Ao Marama and Hokonui Runanga on 23 May 2019 to discuss the development of a Memorandum of Understanding (MoU) between the two parties, separate from this consent process. It is expected that any MoU would eventually incorporate meaningful ongoing engagement between the parties and provision for Hokonui Runanga to exercise kaitaikai over the Mataura River.

8.8 SUMMARY

A comprehensive assessment of the effects of the discharge on the receiving environment has determined that no adverse effects trigger the need for immediate or urgent mitigation.

However, that assessment has identified that the lower Mataura River contains very high levels of *E.coli*, and the Plant's discharge significantly increases those levels in the receiving water downstream. But because the level of pathogens in the discharge, which are of most concern when considering effects on human health are much lower and more variable, the Plant's discharge does not cause a significant increase in the health risk experienced by a person swimming below the Plant, and the risk of a person becoming ill due to the Plant's discharge is well below 1%, which is considered an acceptable level. It also appears the Plant's discharge is not having an adverse impact on people's use of the river for recreation purposes. However, Alliance accepts it will need to reduce its levels of *E.coli* as part of catchment-wide initiatives to improve water quality. And this will occur following the planned installation of the UV treatment plant required by the proposed conditions, which is expected to reduce the *E.coli* levels in the Plant's wastewater discharge by more than 99%.

The assessment also identifies the Mataura River is degraded in terms of the nitrogen levels present, periphyton reflects moderate to high enrichment at times, and MCI and QMCI data are representative of fair to poor (but occasionally good) health. Toetoes Estuary also continues to degrade with extensive macroalgal growth driven by very high nutrient loads from the catchment. While there is no evidence suggesting the Plant's discharge has a direct adverse effect on these stressors downstream of the discharge, it does contribute a small portion to the overall loads of Amm-N and TN downstream of the discharge.

Alliance accepts it will need to reduce its levels of Amm-N and TN as part of catchment-wide initiatives to improve water quality. And this will occur following installation of the biological treatment system required by the proposed conditions, which is expected to reduce the concentration of TN in the discharge by approximately 68% relative to present.

The Mataura River is attributed significant value by iwi. Alliance is continuing to engage with Hokonui Runanga and TAMI with a view to identifying appropriate alternate means of avoiding, remedying or mitigating the effects of the discharge on cultural values.

9. MANAGEMENT AND MONITORING OF ACTUAL AND POTENTIAL EFFECTS

9.1 INTRODUCTION

The assessment of effects in sections 6 - 8 identifies a range of positive and adverse actual and potential environmental effects that will, or are likely to arise as a result of the ongoing operation, maintenance and upgrading of the Plant. That assessment is based on the various technical assessments commissioned by Alliance. It is noted that many of the technical assessments have recommended the implementation of various measures in order to assist in avoiding, remedying or mitigating potential adverse effects from the proposed activities on the environment.

These recommendations have shaped the development of the suite of management and monitoring measures that are proposed as conditions on the resource consent applications that are being sought by Alliance. A copy of the proffered consent conditions is provided in **Appendix 1** to this AEE.

This section describes those measures.

9.2 ABSTRACTION

The main management and monitoring measures proposed are:

- Upgrading the intake screens;
- Reducing use;
- Implementation of a low flow contingency plan; and
- Monitoring the rate and volume of water abstracted.

9.2.1 Intake Screening

As set out in Section 7, the only potential effect of any consequence associated with the take of water is the potential for juvenile fish to be entrained in the intakes. FWS recommended that all the intakes that are currently fitted with 5 – 6 mm screen mesh be fitted with 2 - 3 mm screens to further reduce the potential for this to occur and to meet best practice standards for screening intakes. Alliance propose to implement this recommendation.

9.2.2 Reducing Use

PDP have identified scope to reduce the Plant's water use, and the volume of the wastewater discharge by approximately 37% by recycling white water within the wastewater treatment plant. However, for reasons outlined in Section 9.3.1 below this has implications for discharge quality which need to be carefully considered to avoid unforeseen adverse toxicity and eutrophication effects on aquatic organisms within the mixing zone and downstream.

In turn, while the conditions require water use to be reduced within 3 years of the commencement of the new consent, rather than specifying a fixed reduction percentage now, they require the actual volume reduction to be determined via a Resilience and Water Saving Strategy which determines what can be reasonably achieved:

- without increasing the total contaminant load within the discharge when measured on a daily basis when assessed against the limits which will apply from the commencement of the new consent; and
- without giving rise to unforeseen adverse toxicity and eutrophication effects on aquatic organisms within the mixing zone and downstream.

This is discussed further in Section 9.3.1 below.

9.2.3 Low Flow Contingency Plan

During times of extreme drought, when flows are low, farmers can often be forced to de-stock their farms, which leads to an influx in animals at Alliance's plants. It is therefore essential to enable Alliance's plants to continue to process stock in the interests of animal welfare during such periods.

To mitigate the effects of operating during low flows, the existing consent requires Alliance to prepare and implement a low flow contingency plan which describes the practicable measures to be taken by Alliance to minimise the abstraction of water during times when the flow of the Mataura River at the Tuturau recording site is less than 20 cubic metres per second. This will be retained.

9.2.4 Monitoring

Alliance is proposing to take up to approximately 21,200m^3 of water per day for cooling water purposes. As set out in Section 4, the cooling water system takes water from the race, passes it through the condensers and then discharges the water back into the race. No monitoring is proposed for this take, other than recording the daily volume of water taken using the existing methods deemed appropriate during a 2018 resource consent process on that matter.

The remainder of the water that is to be taken by Alliance is used in processing activities, potable water and for activities such as truck washing. The majority of this water is also returned to the river via the treated wastewater discharge. As part of the existing consent obligations, Alliance is required to install and maintain water metering devices on those takes where the water is used or associated with Plant processing activities. Alliance will continue to maintain this water metering and measure the quantum of take for processing activities as part of this proposal.

9.3 DISCHARGES

9.3.1 Three Stage Upgrade of the Wastewater Treatment Plant (Reducing Volumes and Improving Quality)

A comprehensive assessment of the effects of the discharge on the receiving environment has determined that no adverse effects trigger the need for immediate or urgent mitigation.[13]

However, that assessment has identified that:

- The lower Mataura River contains very high levels of *E.coli*, and the Plant's discharge significantly increases those levels in the receiving water downstream; and
- The Mataura River can generally be characterised as degraded in respect of its nutrient loads, and the estuary is in a "MODERATE" but declining condition in relation to eutrophication, with the Plant's discharge contributing to catchment nutrient loads.

As set out in Section 12, the planning framework which applies here also anticipates a long-term catchment-wide improvement in water quality for these key parameters. No detail is available yet on the extent of the catchment scale improvement anticipated for each parameter, or the timeframes and methods for achieving that improvement, including which parameter should be afforded priority. The planning framework anticipates these matters will be determined via a soon to be commenced collaborative planning process for the Mataura Freshwater Management Unit involving all key stakeholders. The initial outputs from that collaborative planning process are expected in 2022, and they are not expected to be formalised via the RMA Schedule 1 process until at least 2024/2025.

While the plan for improving catchment water quality will not be known for several years, it will be finalised, and implemented during the term of the resource consents being sought by Alliance. Alliance has sought detailed advice from PDP on what methods and technology could be potentially employed in order to reduce the loads of these key parameters from the Plant to the Mataura River (refer **Appendix 7** attached).

After considering the PDP assessment, a staged upgrade of the wastewater treatment plant represents the best practicable option for the disposal of the Plant's wastewater. This is addressed in more detail in Section 10 below.

The proposed upgrade represents a significant capital undertaking and it is proposed that will be completed in a staged manner as follows:

---

[13] Freshwater Solutions Ltd 2019. Assessment of the Effects of Alliance Mataura's Discharges and Water Take on Mataura River and Toetoes Estuary. Submitted to Alliance Group Ltd (DRAFT). March 2019.

Year 1 – 3: Implementing water reduction opportunities and addressing existing resilience issues.

PDP have identified potential intermittent cross contamination points between the green and non-green waste stream and, potential failure points within the reticulation system. To address these resilience issues, the following will be completed in the first 3 years of the new consent term:

- Re-route all pipework that runs above or in the water race to a location that prevents waste leaking into the water race or fresh water leaking into the treatment system;
- Re-route all pipework that runs above the river to a location that prevents waste leaking into the river;
- Modify the beef sump milli-screen overflow to prevent green waste overflows into the non-green waste stream;
- Modify the stockyard and tripe recycle area to prevent green waste overflows into the non-green waste stream.

PDP has also identified scope to reduce the Plant's water use, and the volume of the wastewater discharge by approximately 37% by recycling white water within the wastewater treatment plant. This is an essential initial step, in that any water reduction measures that are successfully implemented will influence the sizing parameters applied to any subsequent treatment upgrades required to further treat the discharge. However, as set out above PDP note that recycling of treated wastewater for white-water generation will require careful management to avoid foam generation in the inter-stage tank, and that consideration will need to be given to the implications of the decreased dilution effect of the white-water and the likely increase in concentration (but not load) of key parameters in the discharge.

To address this uncertainty, within six months of the commencement of this consent, the proposed conditions require Alliance to prepare and submit to Environment Southland a Resilience and Water Saving Strategy, the purpose of which is to identify:

- Measures to avoid potential intermittent cross contamination points between the Green and Non-Green waste streams and potential failure points within the reticulation system; and
- Methods to enable the recycling of white water within the wastewater treatment plant to reduce the total volume of wastewater discharged to the Mataura River to the extent that can be reasonably achieved:
    - without increasing the total contaminant load within the discharge when measured on a daily basis when assessed against the limits which apply from the commencement of the new consent; and

- o without giving rise to unforeseen adverse toxicity and eutrophication effects on aquatic organisms within the mixing zone and downstream.

The proposed conditions require this Strategy to include:

- The new contaminant concentration limits to be applied to meet this obligation (acknowledging that the volume of the discharge is reduced meaning that the proportion of contaminant load to discharged volume will be higher within the discharged waste stream); and
- A review by a suitably qualified and experienced ecologist which assesses the effects of the discharge in order to confirm that the newly set contaminant limits for the discharge will unforeseen adverse toxicity and eutrophication effects on aquatic organisms within the mixing zone or downstream.

The proposed conditions require Alliance to implement the measures described in the Resilience and Water Saving Strategy within three years of the commencement of the new consent. Once implemented and trialling of the new system is complete, the proposed conditions also require Alliance to commission a review by a suitably qualified and experienced ecologist to assess the effects of the discharge in order to confirm that the newly set contaminant limits within the discharge are not giving rise to adverse toxicity effects on aquatic organisms within the mixing zone. Year 5: Tertiary Disinfection of Microbial Contaminants.

Alliance proposes that within five years of the commencement of the new consent equipment will be installed (a UV plant or similar) to disinfect the wastewater discharged from the site in order to inactivate pathogens.

This upgrade is expected to incur capital costs of approximately $4.1 million, and additional annual operational expenditure of $230,000.

Following installation of the treatment system the proposed conditions would require the *E.coli* concentration in the discharged wastewater to not exceed an annual mean of 1,000 CFU/100ml and 95th percentile of <10,000 CFU/100mL. This is a substantial reduction relative to the concentrations set out above in Table 4.

Year 15: Biological Treatment System

By Year 15, Alliance proposes to install a full biological treatment system to treat the Plant's wastewater to reduce BOD, ammoniacal nitrogen and total nitrogen concentrations.

Alliance will firm up the detailed design of the new biological treatment system closer to the installation date. However, it is currently anticipated a large, lagoon based, biological reactor will be installed. Due to the large lagoon size (approximately 8,500 m^3), it will likely be located 2 km away on land currently owned by Alliance Group Ltd, with wastewater being pumped to the lagoon for treatment, and then back to the Plant for discharge via the existing outfall.

The additional capital cost of installing tertiary disinfection of microbial contaminants and a biological treatment system is significant and estimated to be $13.98 million with annual operating costs of $1,060 million.

Discharge concentrations for Amm-N and TN are expected to significantly reduce and this is reflected in the allowable concentrations in the proposed conditions following installation of the biological treatment system.

The annual TN load will also reduce significantly relative to current, even if the Plant operates at a significantly increased capacity relative to the numbers of stock processed in the past five years.

9.3.2 Discharge Limits

In accordance with the advice of Alliance's technical advisors, the proposed conditions include:

- A series of day to day compliance limits on the concentration of key parameters in the wastewater discharge; and
- Compliance limits on the total annual load of nutrients the Plant contributes to the catchment per year.

The day to day concentration limits are important in respect of the discharge's effects on the Mataura River, and are included for this purpose.

The annual load limits are important in respect of the discharge's effects on Toetoes Estuary and are included for this purpose.

9.3.2.1 Day to Day Consent Limits

Concentration based limits are included to protect the Mataura River. As set out in Table 10 below, the proposed conditions include four stages of concentration-based limits as, namely:

- **Limits which apply immediately**, and which reflect the limits on the existing consent and current discharge quality;
- **Limits which apply following the implementation of the Resilience and Water Saving Strategy** - which is expected to reduce water use by more than 30%, and wastewater discharge volumes by a similar amount. The total load of each parameter is not expected to change as a result, but the concentration of each parameter in the wastewater discharge is expected to increase due to that load being entrained within a lower volume of wastewater. The proposed conditions do not specify what the

concentration limits are following the implementation of the Resilience and Water Saving Strategy. Rather they require those limits to be determined by the Resilience and Water Saving Strategy itself, and a certification process is included in the conditions to ensure the revised limits:

  - Do not increase the total contaminant load within the discharge when measured on a daily basis when assessed against the limits which apply immediately; and
  - Do not cause unforeseen adverse toxicity and eutrophication effects on aquatic organisms within the mixing zone and downstream.

- **Limits which apply following the implementation of the Resilience and Water Saving Strategy and disinfection plant.** The only change at this stage is the addition of a limit on the *E.coli* concentrations in the discharge.
- **Limits that apply following installation of the biological treatment**. These require a substantial improvement in water quality for nearly all parameters

9.3.2.2 Annual Nutrient Loads

Alliance's technical advisors note it is the annual load of nutrients received by Toetoes Estuary that is of concern from an ecological perspective and that limits on the annual nutrient load discharged from the Plant is important in that context.

Annual load is a function of the discharge concentration of the wastewater discharged, and the total annual volume discharged. It therefore fluctuates depending on the number of stock units Alliance processes per season. And this is reflected in the annual load discharged by the Plant in recent years (see Table 9).

Table 9: Total nitrogen load discharged in the Plant's wastewater.

Season	Annual Total Nitrogen Load (tonnes)	Dressed weight (tonnes)
2010/2011	56	30,895
2011/2012	53	30,918
2012/2013	40	26,678
2013/2014	33	26,313
2014/2015	43	30,230
2015/2016	36	29,042

Season	Annual Total Nitrogen Load (tonnes)	Dressed weight (tonnes)
2016/2017	39	30,567
2017/2018	52	33,709
2018/2019 (as at 27 April 2019-	30 (equal to the same time in 2017/2018)	22,239

After Alliance ceased its sheep and lamb operation at Mataura, and commissioned its new cattle processing plant at the site it took some time for cattle processing numbers to increase, and this is reflected in the dip in TN load discharged from the Plant between 2012/2013 and 2016/2017 (see Table 9). However, since 2017/2018 stock numbers have returned to expected levels, through a combination of a general increase in cattle numbers, some processing of m. bovis infected stock, and some destocking as a result of the droughts.

Alliance expects processing levels to remain at current levels in the future. While processing of m. bovis infected cattle is only expected to continue for the next two to three years (assuming no new cases of m. bovis arise), this is expected to be offset by a continued increase in general cattle numbers and there is also a proposal to move soup stock processing from Lorneville to Mataura (to save the transport costs (and emissions) associated with transporting raw beef bones from Mataura to Lorneville).

The proposed conditions contain limits on the annual load of total nitrogen in the discharge for the period prior to and following the proposed wastewater treatment plant upgrade.

Two limits are proposed prior to the upgrade:

- A maximum annual load of 60 tonnes per year; and
- A total TN load of 780 tonnes that can be discharged prior to the wastewater treatment plant upgrade being commissioned (this is equivalent to 52 tonnes per year being discharged over a 15 year period).

These accommodate some interannual variability in stock processing numbers while capping TN loads at about the same levels as currently occur. If Alliance were to consistently discharge annual TN loads at the higher end of that allowed, it would need to bring its proposed upgrade forward to accommodate that.

The limit which applies following the wastewater treatment plant upgrade is 25 tonnes per year. This represents approximately a 50% reduction in annual load relative to that which is currently occurring.

Table 10: **Proposed limits for new discharge permit (note: consistently maintained means 4 out of 5 samples meeting the relevant limit).**

Parameter	Pre-Volume Reduction	Post Volume Reduction	Post Volume Reduction and Disinfection	Post Biological Treatment System
Discharge Concentration Limits				
Ammoniacal Nitrogen	Shall not exceed a maximum of 50 g/m^3 and consistently maintained at <30 g/m^3	No change to daily load. Concentration to be determined by the Resilience and Water Saving Strategy	No change to daily load. Concentration to be determined by the Resilience and Water Saving Strategy t	Shall not exceed a 12 month median of 5 g/m^3 95th%ile of 10g/m^3
cBOD$_5$ Load	Shall not exceed a maximum of 3,500 kg/day	Shall not exceed a maximum of 3,500 kg/day	Shall not exceed a maximum of 3,500 kg/day	Shall not exceed a maximum of 3,500 kg/day
cBOD$_5$	Shall not exceed a maximum of 300 g/m^3	No change to daily load. Concentration to be determined by the Resilience and Water Saving Strategy	No change to daily load. Concentration to be determined by the Resilience and Water Saving Strategy	Shall not exceed a rolling 12 month median of 50 g/m^3 and 95th%ile of 100 g/m^3
Total Suspended Solids	Shall not exceed a maximum of 200g/m^3 and consistently maintained at <100 g/m^3	No change to daily load. Concentration to be determined by the Resilience and Water Saving Strategy	No change to daily load. Concentration to be determined by the Resilience and Water Saving Strategy	Shall not exceed a rolling 12 month median of 20 g/m^3 and 95th%ile of 40 g/m^3
Total Kieldahl nitrogen	Shall not exceed a rolling 12 month median of 60 g/m^3 and 95th%ile of 80 g/m^3	No change to daily load.	No change to daily load.	No limit

Parameter	Pre-Volume Reduction	Post Volume Reduction	Post Volume Reduction and Disinfection	Post Biological Treatment System
		Concentration to be determined by the Resilience and Water Saving Strategy	Concentration to be determined by the Resilience and Water Saving Strategy	
Total nitrogen	No limit	No limit	No limit	Shall not exceed a rolling 12 month median of 20 g/m^3 and 95^{th}%ile of 40 g/m^3
Total Phosphorous	Shall not exceed a rolling 12 month median of 5.5 g/m^3 and 95^{th}%ile of 10 g/m^3	No change to daily load. Concentration to be determined by the Resilience and Water Saving Strategy	No change to daily load. Concentration to be determined by the Resilience and Water Saving Strategy	Shall not exceed a rolling 12 month median of 5 g/m^3 and 95^{th}%ile of 10 g/m^3
Dissolved Reactive Phosphorus	The total load of dissolved reactive phosphorus discharged to the river shall not exceed 14.4 kg/day	The total load of dissolved reactive phosphorus discharged to the river shall not exceed 14.4 kg/day	The total load of dissolved reactive phosphorus discharged to the river shall not exceed 14.4 kg/day	The total load of dissolved reactive phosphorus discharged to the river shall not exceed 14.4 kg/day
E.coli	No limit	No limit	Shall not exceed a 12 month rolling median of 1,000 CFU/100ml and 95^{th}%ile of 10,000 CFU/100ml	Shall not exceed a 95th%ile of 1,000 CFU/100ml
Annual Load Limits				
Total Nitrogen	Annual maximum load 60 tonnes.	Annual maximum load 60 tonnes.	Annual maximum load 60 tonnes.	Annual maximum load 25 tonnes.

Parameter	Pre-Volume Reduction	Post Volume Reduction	Post Volume Reduction and Disinfection	Post Biological Treatment System
	No more than 780 tonnes of nitrogen may be discharged from commencement of the new consent until the biological treatment system is commissioned.	No more than 780 tonnes of nitrogen may be discharged from commencement of the new consent until the biological treatment system is commissioned	No more than 780 tonnes of nitrogen may be discharged from commencement of the new consent until the biological treatment system is commissioned	

9.3.3 Monitoring

Central to the monitoring required by the proposed conditions, is the preparation and implementation of a comprehensive new Environmental Monitoring Plan (EMP).

The purpose of the EMP is to describe the methods for monitoring the physical characteristics and water quality parameters of the discharge, and the physical, water quality and biological characteristics and parameters of the Mataura River receiving waters.

The objectives of the monitoring are to:

- Confirm compliance with consent limits on discharge quality; and
- Understand the effects of the discharge on Mataura River water quality and instream ecology and confirm no unexpected effects are arising as a result of the exercise of this consent.

The proposed conditions require the EMP to include but not be limited to:

- A description and maps identifying the monitoring sites;
- A description of the methods and appropriate timing for undertaking the following monitoring requirements:
  - Discharge stream monitoring
  - Receiving water quality monitoring
  - Ecological instream monitoring
  - Fish health monitoring
- Reporting requirements.

As a minimum, the EMP is to require:

- The time and volume of treated wastewater discharged each day to be recorded;
- Representative weekly samples of treated wastewater at the point of discharge, and of receiving water both upstream and downstream of the point of discharge, while a discharge is occurring for the parameters set out in Table 11 below;
- Ecological monitoring to understand the effects of the discharge including by monitoring the periphyton and benthic invertebrate communities of the Mataura River at points above and below the point of the discharge;
- Provision for fish health monitoring.

Alliance currently undertakes monitoring in the river for both contaminants and ecological parameters both upstream and downstream of the discharge point (see Figure 12). It is proposed to continue to undertake monitoring at these locations in the river.

Table 11 **Parameters for which the proposed conditions require weekly sampling (Matters in bold underline are for compliance purposes)**

Parameter	Discharge Monitoring	In-River Monitoring
Enumerate *E.coli*	**Yes**[14]	Yes
Temperature	Yes	Yes
pH	Yes	Yes
Total Kjeldahl nitrogen	**Yes**	Yes
Ammoniacal nitrogen	**Yes**	Yes
Nitrate nitrogen	No	Yes
Total nitrogen	Yes	Yes
Total suspended solids	**Yes**	Yes
Total phosphorous	**Yes**	Yes
Dissolved reactive phosphorous	**Yes**	Yes
Carbonaceous BOD5	**Yes**	Yes
Dissolved oxygen concentration and saturation	No	Yes

[14] For compliance purposes only following installation of equipment to disinfect the process wastewater discharged from the site in order to inactivate pathogens.

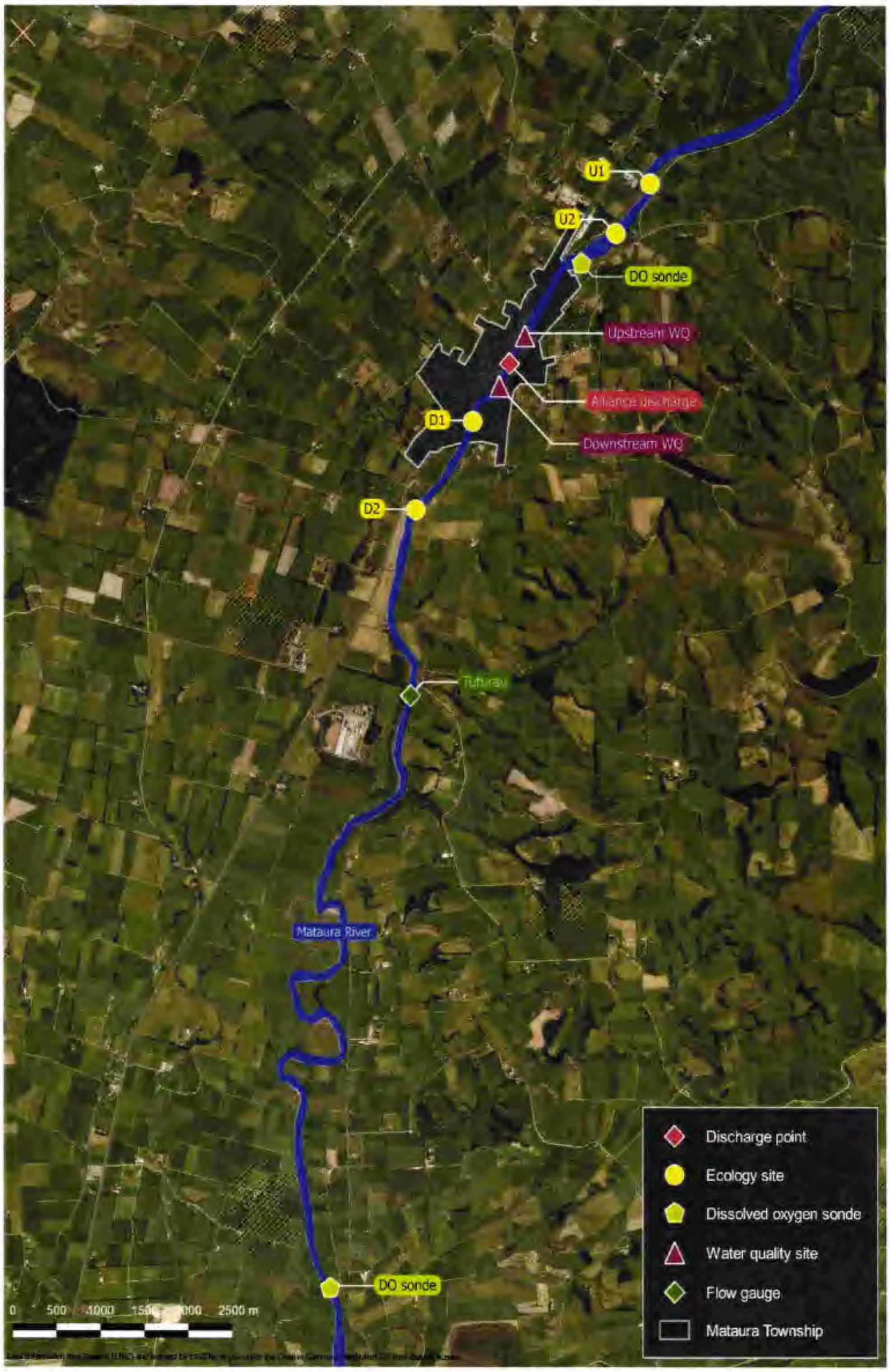


Figure 12: **Monitoring locations.**

9.4 KAITIAKI INPUT

TAMI and Hokonui Runanga have both expressed the view that meaningful ongoing engagement and suitably recognising the role of Hokonui Runanga as kaitiaki of the Mataura River is important in respect of the proposed activities.

Alliance is committed to doing this and is committed to continuing to work with TAMI and Hokonui Runanga on exactly how this should be done.

Alliance is in the process of establishing a Memorandum of Understanding with Hokonui Runanga which is expected to incorporate these principles.

9.5 SUMMARY OF MITIGATION, MONITORING AND OTHER MEASURES FOR MANAGING ADVERSE EFFECTS

A range of mitigation, remediation, management and monitoring measures are either occurring at the Plant or are recommended as part of this consent process. These measures are summarised in Table 12 below:

Table 12: **Summary of recommended mitigation, monitoring and reporting.**

Actual or Potential Effect Identified	Assessment	Mitigation Options	Monitoring and Reporting
Take and Use of Water			
Potential for fish entrainment in water intake structures.	High sweep velocity reduces the potential for entrainment of juvenile fish compared to many intakes. But some screens are 6mm which is not best practice.	All intakes to be fitted with 3 mm screens or better.	None required.
Reduced flow in the river	The only additional effect of this take on instream flows is it is remaining out of the Mataura River's main stem for a further 100 m than it would if the take did not occur and the water were discharged from the hydro race. This is not considered to have any additional or cumulative effects that are more than minor	Low flow contingency plan.	Rate and volume of water taken each day for process use monitored using water meter and datalogger. Volume of water taken each day for cooling purposes by combining the records of discharge monitoring, take monitoring, pump capacities and pump operation.
Discharge of Cooling Water			
Effects on water temperature	No measurable downstream effect.	None required.	Water temperature in the hydro race as per the existing conditions.

Actual or Potential Effect Identified	Assessment	Mitigation Options	Monitoring and Reporting
Discharge of Waste Water			
Increased microbial contamination downstream (at times) of the discharge point.	While it has been identified that the Plant discharge is having an effect on the levels of *E.coli* in the receiving water downstream of the discharge point, it has been determined that such increases do not necessarily relate to the abundance of zoonotic pathogens or individual illness risk. It is however acknowledged by Alliance that overall *E.coli* levels in the catchment are high, and these need to be improved to achieve consistency with national and regional water quality policy and outcomes for contact recreation in the river.	Installation of a disinfection system to inactivate pathogens within five years of the new consent term. This is expected to reduce the concentrations of *E.coli* in the Plant's wastewater by more than 99%	Monitoring of discharge quality and receiving river environment as part of the ongoing consent obligations.
Water temperature, BOD_5, DO, pH levels, turbidity, colour and clarity, foams and scums.	No apparent downstream adverse effect.	None required. However, following installation of the biological treatment system the amount of BOD in the discharge is expected to be significantly reduced	Monitoring of discharge quality and receiving river environment as part of the ongoing consent obligations.

Actual or Potential Effect Identified	Assessment	Mitigation Options	Monitoring and Reporting
Amm-N and Nitrate N levels downstream of the discharge point which could cause toxicity effects to biological resources.	There is an increase in Amm-N levels downstream of the discharge, however this is not considered to be of such significance that toxicity of aquatic species present in the river is likely to occur.	None required. However, following installation of the biological treatment system the concentration of Amm-N in the discharge is expected to reduce significantly.	Monitoring of discharge quality and receiving river environment as part of the ongoing consent obligations.
High nutrient (TN / TP / Amm-N / DIN / DRP) levels downstream of the discharge causing increases in nuisance algae and eutrophication.	Monitoring data shows evidence that the discharge from the Plant is elevating Amm-N and TN concentrations in the immediate vicinity downstream. The Plant's discharge will also be contributing to overall catchment loading of other nutrients downstream of the discharge. The lack of nuisance algal growths in the periphyton surveys indicates the discharge is unlikely to be stimulating nuisance algal growths despite the apparent high concentrations.	No adverse effects observed due to the discharge which trigger the need for immediate or urgent mitigation But Alliance accepts it needs to contribute to improving water quality. This will occur following installation of the biological treatment system required by the proposed conditions, which is expected to reduce the concentration of TN in the discharge by approximately 68% relative to present. The Plant already implements specific management measures (see Section 4.5.1) to reduce the TP concentrations in the discharge.	Monitoring of discharge quality and receiving river environment as part of the ongoing consent obligations.

Actual or Potential Effect Identified	Assessment	Mitigation Options	Monitoring and Reporting
Altered species composition and biomass of periphyton and benthic invertebrate community.	Overall, in terms of nutrients, periphyton and MCI and QMCI in the river, upstream and downstream of the discharge appears to generally be in fair to poor health and a degraded state, but there is no evidence linking these stressors to the discharge.	No adverse effects observed due to the discharge which trigger the need for immediate or urgent mitigation. Following installation of the biological treatment system required by the proposed conditions, Alliance's contribution to catchment loads of key parameters which contribute to this degradation (particularly TN and Amm-N) will be significantly reduced.	Monitoring of discharge quality and receiving river environment as part of the ongoing consent obligations.
Contribution of contaminants to loads within the Toetoes Estuary.	The contribution of the Plant's discharge to Toetoes Estuary TN loads has been assessed as being 1.1 - 1.7% and its contribution to TP has been assessed as 0.7 - 1.3%. The vast majority of TN and TP load entering Toetoes Estuary is derived from other catchment inputs particularly diffuse sources, and in turn, even a marked reduction of the Plant's TN and TP loads would have little, if any, detectable effect on the nutrient status of Toetoes Estuary.	No adverse effects observed due to the discharge which trigger the need for immediate or urgent mitigation. However, FWS and AES have advised that Alliance will need to reduce its levels over time as part of catchment-wide initiatives to improve water quality. This will occur following installation of the biological treatment system required by the proposed conditions, which is expected to reduce the annual TN load	None.

Actual or Potential Effect Identified	Assessment	Mitigation Options	Monitoring and Reporting
		contributed by the Plant's wastewater discharge by approximately 50% relative to present. The Plant already implements specific management measures (see Section 4.5.1) to reduce the TP concentrations in the discharge.	
Effects on fish species – salmonids and native fish.	No evidence of any adverse effects as the river supports a healthy fish population overall.	No adverse effects observed which trigger the need for immediate or urgent mitigation.	EMP to require fish health monitoring.
Effects on recreational fishing.	The assessment of effects on recreational use of the Mataura River shows that the Mataura River downstream of the discharge is currently an outstanding trout fishery, a very popular whitebait fishery.	No adverse effects observed which trigger the need for immediate or urgent mitigation.	None
Effects on cultural values and Tangata Whenua.	Alliance has commissioned Te Ao Marama Inc. to complete a cultural impact assessment of the proposed activities. TAMI have advised key points of interest would likely be the term of the consent sought, being longer than their preference for a	To be confirmed with TAMI and Hokonui Runanga	To be confirmed with TAMI and Hokonui Runanga

Actual or Potential Effect Identified	Assessment	Mitigation Options	Monitoring and Reporting
	maximum term of 25 years, and the decision to continue to discharge to water rather than land.		

10. CONSIDERATION OF ALTERNATIVES AND THE BEST PRACTICABLE OPTION

10.1 INTRODUCTION

Under the RMA, a consideration of alternative locations and methods is relevant in certain respects:

- Schedule 4 requires an AEE to include a description of any possible alternative locations or methods for undertaking the activity where it is likely that the activity will have a significant adverse effect on the environment;
- Where an activity includes the discharge of a contaminant, Schedule 4 also imposes an obligation on an applicant to provide a description of any possible alternative methods of discharge, including discharge into any other receiving environment;
- Similarly, section 105 of the RMA requires decision makers to have regard to various matters including "any possible alternative methods of discharge, including discharge into any other receiving environment"; and
- Section 108 of the RMA also sets out that a condition may be imposed on a discharge permit requiring the consent holder to adopt the best practicable option in order to prevent or minimise any actual or likely adverse effects on the environment of the discharge.

As is set out in Section 12.7.3 below, adoption of the best practicable option is also a key policy directive in the Proposed Plan for managing the treatment and discharge of contaminants derived from industrial and trade processes.

As defined in section 2 of the RMA, the best practicable option (BPO) in relation to a discharge of a contaminant means:

> *The best method for preventing or minimising the adverse effects on the environment having regard, among other things, to—*
>
> *(a) the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and*
>
> *(b) the financial implications, and the effects on the environment, of that option when compared with other options; and*
>
> *(c) the current state of technical knowledge and the likelihood that the option can be successfully applied.*

Determining what the BPO is in a given circumstance requires a decision maker to weigh competing considerations, including the nature of the discharge, sensitivity of the environment and practicalities of that and any other option. The use of the words "among other things" clearly signals that other factors can also be taken into consideration.

As noted in the quote below, the words 'BPO' do not mean the best option, the best technical option, the best economic option, or the best environmental option. Nor do they require adherence to what might be considered "best practice". A judgement needs to be made as to what is practicable and proportionate to the risks likely from a contaminant to be discharged. The key word is 'practicable' and this means not granting consents that require adherence to an option that would be prohibitively expensive or involve procedures that are unnecessarily onerous or impractical.

These considerations have been summarised by Dr Royden Somerville QC in his paper "How to give effect in regional plans to the National Policy Statement for Freshwater Management 2011", dated 20 January 2012:

> *"The words 'best practicable option' do not mean the best option, the best technical option, the best economic option, or the best environmental option. A judgement needs to be made as to what is practicable and proportionate to the risks likely from a contaminant. The Shorter Oxford English Dictionary defines "practicable" as "capable of being carried out in action; feasible".*
>
> *In Medical Officer of Health v CRC, it was held that "practicable" is the key word in the definition of BPO, and it would be wrong to impose conditions which afforded the holder no practical means of compliance.*
>
> *The words "among other things" in the definition do not limit the considerations a regional council may address, to those matters in paras (a), (b) and (c).*
>
> *The matters in paragraphs (a), (b) and (c) are relative. This approach reflects the "principle of proportionality" which allows for a dilution of absolute standards and is used in European community law. Some overseas jurisdictions put more emphasis on technical options for addressing pollution. This is sometimes known as a technologically forcing regulatory approach. The BPO is the optimum combination of all methods to manage the risk of an adverse environmental effect to the greatest extent practicable. It is necessary to consider the options and financial implications when determining how best to attain the BPO.*
>
> *Thus, what constitutes the BPO in any given case is a question of fact and degree. Regard is to be had primarily to all three subsections (a), (b) and (c) of the definition, although one or more may be given more weight than others in any given case. The environmental performance targets being aspired to by using the BPO should be set out in the documentation."*

As part of its preliminary resource consent investigations, Alliance has undertaken an extensive assessment into the availability and practicalities of alternative methods and technologies in order to minimise any actual or potential adverse effects arising from its discharges to water. This section of the report summaries these investigations and determination of the best practicable options available to be implemented now and in the future.

10.2 OPTIONS ASSESSMENT

For reasons outlined in Section 8, a comprehensive assessment of the effects of the discharge on the receiving environment determined that no adverse effects trigger the need for immediate or urgent mitigation. However, it noted the Mataura River is degraded in respect of *E.coli* and nutrients, and advised that Alliance should be reducing the amount of *E.coli*, Amm-N and TN it contributes to catchment loading as part of long term efforts to improve water quality in the catchment.

Alliance sought advice from PDP on what methods and technology could be potentially employed to do this over the term of the consent to be sought.

The PDP options assessment is included as **Appendix 7** to this AEE.

As an initial step, PDP developed a long-list of available alternative management options for the Plant. Options incorporating continued discharge to the Mataura River, irrigation to land, or a dual discharge combination, and discharge to trade waste were considered. Of the assessed long list options, those incorporating significant risk and uncertainty, and substantial lifecycle costs were removed from further assessment.

The options selected for further assessment included:

- Existing river discharge with biological treatment for BOD and nitrogen removal with UV disinfection;
- Existing river discharge with filtration and UV disinfection;
- Existing river discharge with biological treatment for BOD and nitrogen removal of the green waste stream with UV disinfection ;
- Dual discharge with the existing river discharge combined with discharge to dairy pasture with no treatment prior to river discharge; and
- Dual discharge with the existing river discharge combined with discharge to a cut and carry system with no treatment prior to river discharge.

Each of the short-listed options was then assessed further, considering the potential for the option to reduce contaminant loads to the Mataura River, practical matters, option resilience and lifecycle costs.

10.3 PROPOSED APPROACH

After considering each option through the lens of the BPO test described in Section 10.1 above, improved treatment via a staged upgrade of the Plant's wastewater treatment plant, and continued disposal to the Mataura River was selected.

As outlined in Section 4.5.2, the staged upgrade of the wastewater treatment plant includes:

- Year 1 – 3: Implementing water reduction opportunities and addressing existing resilience issues.
- Year 5: Tertiary disinfection of microbial contaminants with a UV system (or similar) to reduce *E.coli* concentrations.
- Year 15: Biological treatment of the wastewater to reduce TN, Amm-N and BOD.

The proposed option is considered to be the BPO for the following reasons:

- The technical assessments identified no adverse effects of the Alliance discharge requiring immediate or urgent redress.
- The proposed option achieves significant year-round long term reductions in the Plant's discharge of Amm-N, TN and *E.coli* which are identified as the key parameters of concern in this catchment with respect to water quality.
- The most significant effect of the Plant's discharge on instream water quality and instream contaminant loads is on *E.coli* levels, and the preferred option achieves a significant year-round reduction in the *E.coli* concentrations discharged by the Plant relatively soon.
- The magnitude of the proposed long term reductions in the Plant's discharge of the key contaminants (approximately 68% reduction in concentration and 50% reduction in load for TN, and a greater than 99% reduction in *E.coli*) are expected to be more than proportionate to the baseline reduction in these key contaminants required by the new planning framework established for this catchment to give effect to the Freshwater NPS (see Section 12.2).
- The required timeframes for the reduction of these key contaminants are also expected to be more expedient than the corresponding timeframes required by that new planning framework for achieving a meaningful reduction in the input from the diffuse sources which contribute a significant majority of overall catchment loading.
- The costs of the upgrade option will have significant financial implications for Alliance. However, the proposed timeframes allow the capital expenditure to be integrated into Alliance's long term capital expenditure plan over the first 15 years of the commencement of the new consent in a manageable way.
- The technology involved in the proposed upgrades to the wastewater treatment plant is proven and there is a high degree of certainty it will achieve the environmental outcomes anticipated. It is also subject to a lower degree of operational complexity and uncertainty than many of the other options considered, particularly options incorporating land-based disposal.

10.4 ALTERNATIVE OPTIONS

During consultation TAMI and Fish and Game both expressed an interest in why a river rather than land based discharge is proposed.

Environment Southland also expressed the view that Alliance should demonstrate why earlier installation of the biological treatment is not the best practicable option.

Over recent months, Alliance has given significant consideration to these alternative options, and an overview of why Alliance does not consider they are the best practicable option in this case is provided below.

10.4.1 Discharge to Land

As outlined in Section 12, the Operative and Proposed Plans, and Te Tangi a Tauira - The Cry of the People (the relevant iwi management plan) express a preference for wastewater being discharged to land rather than directly to water. During consultation TAMI and Fish and Game both expressed an interest in why a river rather than land based discharge is proposed.

Of relevance to this preference the PDP options assessment identified:

- Options for avoiding a discharge to the Mataura River completely; and
- Dual discharge options which would largely confine the Mataura River discharge to the period May to November inclusive.

An overview of why each is not considered the best practicable option for disposal of the Plant's wastewater is provided below.

10.4.1.1 Avoiding a River Based Discharge

PDP identified two general options for avoiding any river-based discharge:

- Year-round irrigation of the Plant's wastewater on neighbouring farmland; and
- Construction of a biological treatment and storage facility of sufficient capacity to store effluent from May to September, with irrigation to neighbouring farmland occurring exclusively between October to April.

Year-Round Irrigation

The PDP report identified two options for year-round irrigation of neighbouring farmland:

- Slow rate irrigation to dairy grazing land owned by a third party; and
- Slow rate irrigation to company owned cut and carry operation.

However, it identified significant issues with each option, namely:

- Operational complexities associated with irrigating in this environment during winter and during wet summer periods;
- Difficulty in finding suitable land; and
- A significant increase in costs for a company owned cut and carry operation due to the need to purchase land.

With respect to the first matter, PDP has identified the hydraulic capacity of the soil on farmland, and a lack of soil moisture deficit, significantly limits the ability to irrigate wastewater to that land during winter, and during wet summer periods. Irrigation to saturated land is particularly problematic from an environmental perspective due to the significant runoff of nutrients that can occur.

This hydraulic limitation would be particularly difficult to manage for any option involving irrigation of dairy grazing land owned by a third party due to the operational requirements of the dairy farm, and the lower degree of ground saturation that can be accommodated.

The large wastewater volume generated by the Plant also means a large area of land is needed for year-round irrigation (>160ha).The flatter land around Mataura does not have soils with favourable properties for irrigation, and the areas with moderate to well-draining soils are found to the east of the Plant on areas with steeper terraced topography. Due to the prevailing land parcel size in this area:

- Slow rate application to dairy grazing land would require at least 3 - 4 relatively adjacent landowners willing to accept year-round irrigation from the Plant, including during the problematic winter periods when soils in this area are often already saturated; or
- A company owned cut and carry operation would require at least 3- 4 relatively adjacent landowners willing to sell their properties to Alliance.

The cut and carry option would also incur approximately $10 million in additional capital costs relative to the preferred option due to the need to purchase land, and in turn increased financial implications.

Winter Storage – Summer Irrigation

PDP identified winter storage as an option for avoiding the discharge of wastewater to the river during the winter period when the hydraulic capacity of surrounding soils makes wastewater irrigation prohibitively difficult.

However, it also identified significant issues associated with this option, including:

- It would still require Alliance to obtain access to a large area of land for irrigation (160 ha) and in turn the cooperation of 3 - 4 adjacent landowners willing to either integrate wastewater irrigation into their dairy farming operations, or sell their properties to Alliance;

- It would require construction of a significant new treatment and storage facility, and involve much greater operational complexity than the preferred option; and
- It would incur significant additional costs relative to the preferred option, with capital expenditure alone being approximately $12 million higher for the irrigation of third-party dairy farmland, and $23 million higher if Alliance were to purchase the irrigation area and operate a cut and carry operation.

10.4.1.2 Dual Discharge Options

PDP identified four options for a dual discharge, whereby wastewater is discharged predominantly to land between October and April, and to the river between May and November, namely:

- Dual discharge to Mataura River (May to September) and irrigation to third party owned dairy pasture, with no additional treatment prior to the river discharge;
- As above, but with biological treatment for cBOD5 and nitrogen removal with UV disinfection prior to river discharge;
- Dual discharge to Mataura River (May to September), and irrigation to a cut and carry system (October to April) on purchased land; and
- As above, but with biological treatment for cBOD5 and nitrogen removal with UV disinfection prior to river discharge.

However, as per the full-time land-based irrigation options outlined above, PDP identified significant issues with each option, namely:

- Operational complexities due to the hydraulic capacity of the surrounding farmland;
- Significant difficulty in finding suitable land; and
- A significant increase in costs for the three options involving a company owned cut and carry operation and / or biological treatment prior to the Mataura River discharge.

With respect to the first matter, because irrigation would only occur over summer, the operational complexities due to hydraulic capacity of the surrounding farmland are not as prohibitive as the full-time land discharge options outlined above. However, these types of systems are still subject to significant operational complexities, particularly for the options involving irrigation to third party owned dairy pasture. While the Plant's wastewater would help maintain soil water conditions for pasture growth during drier periods, as seasonal rainfall increases soil water content, farmer acceptance of irrigation generally reduces due to the potential for soil conditions to be negatively impacted.

With respect to land access, avoiding winter irrigation means the amount of irrigation land required (135 ha) is a little less than a year round land discharge (160 ha). However, it would still require cooperation of 3 separate (but proximate) land owners willing to either integrate the irrigation of the Plant's wastewater into their dairy farming operations, or willing to sell their farms to Alliance.

With respect to costs, the capital expenditure required for either of the options involving further biological treatment of the effluent prior to the river-based discharge were prohibitively high (more than $10 million higher than the preferred option for the dairy farm irrigation option, and $18 million higher for the company-owned cut and carry option).

The costs associated with the two dual discharge options which do not include additional biological treatment are not as significant, and in the case of the dual discharge to third party owned dairy pasture they are less than the preferred option.

However, if biological treatment is not included, there is no significant ecological rationale for favouring the dual discharge options, noting that Alliance has received advice from its ecological specialists that:

- Nutrification is not just a summer issue, and they would not favour any option which would not result in the Plant's long-term contribution to instream Amm-N and TN concentrations being reduced during the winter and shoulder seasons as well as during the summer; and
- Total annual loading of TN is important when considering impacts on Toetoes Estuary, and in that respect, there is little difference between the reduction in the annual load achieved by the proposed option and the dual discharge option.

A dual discharge options involving no additional UV treatment would also not address the microbial contamination issue in this catchment as fully as the preferred option. While the dual discharge option would totally remove the Plant's contribution to downstream *E.coli* concentrations during the summer months (relative to the more than 99% reduction that would be achieved by the preferred option), it would not reduce the Plant's contribution at all during the river discharge season. The Plant would continue to significantly elevate downstream *E.coli* levels over those months, and compromise the effectiveness of any long term catchment-wide efforts to reduce *E.coli* concentrations, as is directed by the Freshwater NPS and Regional Council Planning documents (see Section 12.2).

10.4.1.3 Summary

The operational difficulties, establishment difficulties, and financial implications for some options outlined above mean avoiding the discharge of wastewater to Mataura River is not the best practicable option in this case.

10.4.2 Earlier Adoption of Biological Treatment

The proposed conditions require Alliance to upgrade its wastewater treatment system to disinfect the wastewater and inactivate pathogens within five years, and full biological treatment within 15 years of any new consent term.

Alliance considered earlier adoption of these wastewater treatment plant upgrades, however, it was not deemed the best practicable option because:

- The relative difference in the effects on the environment from earlier adoption of biological treatment do not provide a strong justification for this alternative; and
- The financial implications of adopting the biological treatment system earlier are significant.

The main difference in the adverse effects of the discharge pre and post the biological treatment system upgrade will be a reduction in the Plant's contribution to cumulative catchment degradation from mass loadings of Amm-N and TN. There are no toxicity effects associated with the current discharge quality, or any other adverse effects that trigger the need for immediate or urgent mitigation.

The reduction in the annual TN load contributed to the catchment equates to approximately a 1% reduction in the total catchment loading of this contaminant in Toetoes Estuary, with a majority of the catchment's TN load coming from diffuse sources (i.e. farms). Therefore, the main change in adverse effects achieved by earlier adoption of the biological treatment system would be to reduce TN loads in the Mataura River and Toetoes Estuary by approximately 1 % several years earlier than is proposed.

This reduction will have little, if any, detectable effect on the nutrient status of Toetoes Estuary. A meaningful improvement in environmental quality in the lower Mataura River and Toetoes Estuary, due to lower nutrient levels, will only be realised when a meaningful reduction is achieved in the nutrients contributed by the diffuse sources which contribute the majority of the catchment nutrient load. Experience from other catchments elsewhere in New Zealand suggests this is unlikely to be achieved in advance of the proposed 15-year timeframe proposed by Alliance.

With respect to financial implications, the expected capital cost of upgrading to a biological treatment system is significant, both in terms of capital expenditure (approximately $13.98 million) and annual operating costs ($1,060 million). It represents a major project, and the funds need to be budgeted and provided for alongside other capital and environmental projects Alliance needs to undertake across all its plants.

To put the required spend into perspective, Alliance typically spends approximately $15 million per year, across the business (including all seven processing plants), on safety and sustainability capital projects. This is split between projects to address health and safety requirements, food safety changes and environmental improvements, among other things.

A review of the forward picture for Alliance indicates that both forecast health and safety and environmental capital requirements are significant. Recent health and safety changes have brought more focus to managing ammonia on site (which is also an environmental issue). There are also legacy asbestos and machine guarding improvements to be made.

A risk assessment indicates Alliance is required to spend approximately $12 million across all its plants to address 'intolerable' risks (e.g. a building rated at less than 30% of building code which houses hazardous gases), an additional $68 million on 'substantial' risks (e.g. upgrading aged refrigeration plant (which contains hazardous gases) to meet current standards) and $100 million on marginal risks (e.g. developing inspection and detection process for corrosion, and rectification of defective plant containing hazardous gases) for Health and Safety alone .

Based on Alliance risk category definitions, the impacts that will be addressed by the biological upgrade would sit in the 'marginal' risk category (i.e. there is an emission (which you can measure) which is almost certain (the highest likelihood rating), but it has no observable impact on the environment). It is known from measurements that the plant is emitting nitrogen, but investigations indicate that there is no observable effect (on its own) and thus this constitutes a marginal environmental risk.

As part of this consent processing Alliance is committing to spending between $4 – 5 million on capital in the first five years of the consent improving wastewater resilience, water reduction and disinfection. Early indications suggest that Alliance will also be required to spend approximately $3-4 million to upgrade the Mataura boiler early in the upcoming air consent renewal application. Work will also be undertaken and completed on a $20 million plus upgrade of the Lorneville treatment plant in the intervening period between Year 5 and Year 12 of this consent applied for.

It is important to note that work will not start at Year 15 on the biological treatment plant, but the upgrade will be completed, operational and compliant by Year 15. This means work will be required to commence several years before this date, overlapping with the Lorneville upgrades. The challenge this represents for Alliance cannot be underestimated.

Should this upgrade be pulled forward, other projects have to be delayed or farmer payments for stock would need to be reduced, affecting the competitiveness of the business.

The cooperative nature of the company is important in this regard. Money that is set aside for this project is money which cannot be returned back to farmers and subsequently invested by them to improve on-farm environmental management, and for that reason, also needs to be approached with care. Diffuse sources of contamination contribute to the majority of the nutrient loads in this catchment and addressing that will require farmers to invest in on-farm methods to reduce nutrient runoff. That in turn relies on them having adequate access to capital which will be constrained if prices for meat and dividends received from Alliance are suppressed due to higher than anticipated capital upgrades being required at the Plant.

It is also worthwhile noting that no dividend has been paid to shareholders since the 2010/2011 season. The operating result was a relatively small operating profit of $8 million in 2018, $20.2 million in 2017, $10.1 million in 2016 and $7.9 million in 2015.

It is also worth adding in that at this stage there are no meaningful and practical opportunities available for staging of the wastewater treatment plant upgrade.

11. CONSULTATION

11.1 INTRODUCTION

Alliance initiated consultation on these consents in October 2017. It commenced with meetings with the Technical Working Party and representatives of Environment Southland.

As technical work and preparation of the AEE was nearing completion, individual meetings were held with key stakeholders to share findings of the technical assessment and details of the proposed application and to receive feedback.

In addition, surveys of recreational users of the Mataura River were undertaken.

Details of this consultation is provided below.

11.2 TECHNICAL WORKING PARTY

11.2.1 Background

The Technical Working Party (TWP) was established a number of years prior to the current consent being granted.

The Technical Working Party is made up of representatives from the following organisations:

- AGL;
- Southland Fish and Game;
- Department of Conservation;
- Te Ao Marama Incorporated;
- Hokonui Runanga Incorporated;
- Public Health South;
- Southland District Council;
- Gore District Council; and
- Environment Southland.

An annual report is distributed to the TWP members every year. This report details:

- All wastewater and receiving water monitoring results, including biological monitoring results;
- Identification of non-compliances and measures taken to address the non-compliances;

- An assessment of the effects of the discharge on river water quality, periphyton and benthic communities; and
- A progress report on projects and investigations being undertaken.

Following this, Alliance invites all members of the TWP to an annual meeting to take them through the report, providing an opportunity to discuss the results. It also provides an opportunity for the TWP to recommend reviews of consent conditions, if necessary.

Alliance prepares meeting minutes which are distributed to all members.

This meeting is generally well attended with most organisations represented.

In the years since sheep and lamb processing ceased, the results shared in the annual reports have generally been considered acceptable regarding Alliance's impact on the Mataura River, in particular, comparing upstream with downstream. Based on this, there have been minimal issues raised, with discussion generally centred on any non-compliances or general matters. The exception to this is *E.coli* concentrations which are discussed most years, including whether Alliance has any plans to improve the discharge.

In November 2017, the Wyndham Angling Club resigned from the Technical Working Party. They advised that the decision was not reached lightly, but it was reached after a lengthy discussion at one of their monthly meetings.

The Wyndham Angling Club advised that they were not providing the input they should to remain a member. They advised that Fish and Game would look out for their interests in the future, but because of the excellent results the Plant was achieving in regard to its wastewater discharge, they were confident the Plant was on track as far as the wellbeing of the Mataura River was concerned. A representative of the Wyndham Angling Club recently at a public forum meeting held in Gore commended Alliance for the steps it has taken to improve its discharge of treated wastewater to the Mataura River.

11.2.2 Re-Consenting

11.2.2.1 Meeting 1

At the October 2017 TWP, the consultation process was initiated for the re-consenting. This meeting provided details regarding the consents being reapplied for, including Alliance's intention to apply for long term consents. Alliance provided:

- An overview of Alliance;
- An overview of the Mataura Plant;
- An overview of the full length of the Mataura River;
- An overview of the Mataura Plant resource consents;

- Details of the Mataura Plant's wastewater treatment, including how it works and the changes that have been made over the life of the existing consent;
- Details of compliance monitoring locations and compliance performance;
- Details of the condition of the receiving environment;
- A project plan and the members of the project team; and
- Key considerations for the applications.

Queries raised included questions on monitoring of the DO sag, the consent term to be applied for, and if Alliance was considering disinfection and alternative discharge receiving environments. These items are addressed in this application.

11.2.2.2 Meeting 2

A second meeting was held with members of the TWP in November 2017. This included a visit to the external areas of the Mataura Plant, including the routine river sampling monitoring sites, the cooling water and treated wastewater discharge sites, and some of the biological monitoring sites. Dr Mark James provided an overview of what is done during biological monitoring and identified some of the invertebrates present.

Following the visit, the TWP met back at the Mataura Plant to discuss the proposed Discharge and River Monitoring Plan for the coming year. This included a continuation of historical monitoring, and monitoring specific to the consent application.

Dr James provided the following details:

- A summary of the issues to be addressed by the AEE;
- A summary of the existing monitoring programme for the receiving environment;
- A summary of the existing monitoring regime for the wastewater discharge and proposed additional monitoring parameters; and
- Proposed additional monitoring parameters for the receiving environment.

This was followed by a discussion where the TWP were asked for input into the proposed monitoring plan. Members of the TWP indicated that they were happy with the proposed monitoring plan, including the Fish and Game representative, who commented that the proposed monitoring programme was very comprehensive.

The Public Health South representative asked if Alliance planned to test for cryptosporidium, as there had been recent outbreaks of people becoming ill with cryptosporidium. Cryptosporidium has been addressed as part of this application.

Fish and Game asked about timing of monitoring and consideration of the mixing zone. Both of these things are addressed in the AEE.

11.2.2.3 Meeting 3

The third TWP meeting for the re-consenting was held in October 2018. Alliance provided an overview of the routine monitoring results and discussion, while Dr James provided a summary of the additional information collected from monitoring the treated wastewater discharge and receiving environment for re-consenting.

E.coli, and ammonia were the key items for discussion.

It was noted that ammonia concentrations increase downstream of the discharge.

With respect to *E.coli*, the intricacies associated with it only being a faecal indicator bacteria were discussed, and Alliance outlined that further work was being undertaken for pathogens of concern. It was highlighted during this discussion that early QMRA work identified that the data suggested a low risk for recreation, which didn't reflect the high *E.coli* concentrations in the discharge.

One question was asked regarding the lower concentrations of *E.coli* observed that year, and whether that was the result of any changes on the Plant. Alliance staff responded that they did not consider this to be the case.

11.3 INDIVIDUAL CONSULTATION WITH TECHNICAL WORKING GROUP MEMBERS

In addition to the TWP consultation outlined above, individual consultation was undertaken with TWP members in early May 2019 to provide a summary of the pending resource consent application and assessment of environmental effects (Summary AEE). This Summary AEE can be found in **Appendix 9**.

The Summary AEE provided a high level overview of the technical assessments undertaken to support these resource consent applications, their key findings, and how Alliance was intending on responding to those findings.

It included a preferred option to manage the environmental effects consistent with what is proposed in this application.

Attendees and key points from these meetings are described below

11.3.1 Te Ao Marama and Hokonui Runanga

On 7 May 2019, key Alliance staff met with Stevie-Rae Blair (Iwi Environmental Officer). Penny Nicholas (Hokonui Runanga Representative) was unable to attend.

Stevie indicated that she was not able to provide comment on behalf of the Hokonui Runanga until she had reviewed the Summary AEE, and provided a draft Cultural Impact Assessment to the Hokonui Runanga for consideration.

Stevie did note that the key points of interest would likely be the term of the consent sought, being longer than their preference for a maximum term of 25 years, and the decision to continue to discharge to water rather than land. Stevie acknowledged that discharge to land may not be practicable at the Mataura Plant.

Cultural Monitoring was discussed, and Stevie advised many of the indicators of Cultural Monitoring would likely be addressed by typical monitoring that accompanies the types of activities being applied for, e.g. temperature, however the Cultural Impact Assessment would advise on this.

Alliance expressed a willingness to meet with Hokonui Runanga to discuss the application if needed.

Key Alliance staff also met with key Te Ao Marama and Hokonui Runanga on 23 May 2019 to discuss the development of a Memorandum of Understanding (MoU) between the two parties, separate from this consent process. There was mutual agreement that such an agreement would be appropriate given the importance of the Mataura River to each of the parties. Alliance committed to preparing a Draft MoU to be discussed in late June. Alliance took the opportunity to invite Hokonui Runanga to meet again regarding this consent application.

Alliance has expressed a desire to continue to consult with TAMI and Hokonui Runanga during processing of this consent application.

11.3.2 Environment Southland

Three meetings have been held with Environment Southland in preparation of this consent application.

The first was in October 2017, when Alliance met with key ES planning staff (Stephen West and Alex King). A number of items were identified for Alliance to address as part of the consent application. Refer to meeting notes in **Appendix 10**. Where required, these items have been addressed in this application.

The second meeting was attended by ES science staff (Karen Wilson and Roger Hodson), key Alliance staff and Dr James.

Dr James provided an overview of the proposed monitoring programme similar to that provided at the second TWP meeting.

Again, a number of items were identified for Alliance to address. Where required, Alliance has addressed these items in the application, including additional monitoring. Refer to meeting notes in **Appendix 10**.

In early May 2019, key Alliance staff and John Kyle (Mitchell Daysh Ltd) met with key ES staff (Michael Durand – Consents Manager, Lydia Hayward – Consents Team Leader, and Alex King – Consents Officer) to discuss the Summary AEE.

ES asked why water savings had been identified as a priority over disinfection and biological treatment. Alliance responded it was mainly so that capital upgrades could be appropriately sized, rather than sizing them for a larger volume of water, only to reduce that volume of water in the future.

Key feedback included the need to provide information on any financial reasons to undertake the biological treatment upgrade earlier as opposed to the proposed 15 years. Reasons have been provided in this application.

11.3.3 Department of Conservation

The Summary AEE was provided to the Department of Conservation on 13 May 2019. Receipt of the document was acknowledged, and Alliance was advised that it has been provided to the National RMA team who will assign a DoC planner to consider the document. No further communication has been received at the time of writing.

11.3.4 Public Health South

On 10 May 2019, key Alliance staff and John Kyle (Mitchell Daysh Ltd) met with Kate Marshall (Team Leader – Health Protection Officer) and Renee Cubitt (Health Protection Officer) from Public Health South. In a subsequent follow up email, Public Health South expressed support for all aspects of the application, including the proposed staged programme for upgrading the wastewater treatment plant.

11.3.5 Fish and Game

On 13 May 2019, key Alliance staff met with Jacob Smyth (Resource Management Officer) from Fish and Game. Mr Smyth indicated that the particular points of interest in the application would be the timeframes proposed before upgrades, the consent term and the decision to continue a discharge to water. Each of these items are addressed in this application. Mr Smyth could not comment on Fish and Game's likely position of the application until after the complete application was reviewed by Fish and Game.

11.3.6 Gore District Council

On 8 May 2019, key Alliance staff met with Matt Bayliss (Three Waters Manager) to discuss the consultation document. An apology was received by Ramesh Sharma (General Manager – Infrastructure), who was unable to attend the meeting.

GDC indicated that they were supportive of the application and did not have specific concerns.

11.4 LOCAL RESIDENTS

A leaflet (refer to **Appendix 11**) was posted to all letter boxes (approximately 700 leaflets) in the Mataura Township on 20 May 2019, inviting Mataura residents to a meeting at 7pm on the 23 May at the Mataura Community Centre to hear about the work being undertaken to re-consent key activities at the Plant.

An Attendance Register was completed by 16 Attendees.

A slideshow presentation was provided by key Alliance staff with details of the Summary AEE and the preferred wastewater upgrade option included.

Key issues raised included:

- The need for 15 years before the ultimate upgrade is complete. The response from Alliance was consistent with the details provided in this application.
- Whether there may be other opportunities to improve the discharge between the disinfection upgrade and the biological treatment upgrade. Alliance staff advised that there are only minor opportunities for optimisation of the existing wastewater treatment process, and that the next practical step for improvement is biological treatment.
- Further to the above, it was requested that Alliance consider new technology that may become available between the disinfection stage and the biological treatment stage. Alliance responded that Environment Southland have the opportunity to review the consent, should new technology become available, which may present an updated best practicable option for treating the wastewater discharge.
- Other issues were also raised that were not relevant to this application.

Many of the attendees expressed general support for the continued operation of the Mataura Plant, acknowledged the improvements made over recent years, and confirmed they supported the proposed improvements.

Mataura residents were also invited to contact Alliance if that had any questions about the application. To date, no phone calls have been received.

11.5 REGIONAL FORUM

Key Alliance staff attended the Regional Forum at a public meeting held in Gore on 10 May 2019. Mr Richardson provided a brief presentation at the meeting. This included a summary of the Plant's upcoming resource consent applications. It was identified that Alliance was proposing to 'play its part' in addressing catchment-wide issues. One question regarding the term of the consent being applied for received. Mr Richardson responded that the term being applied for was 35 years, with accompanying reasons consistent with this application.

11.6 RECREATIONAL USERS

In was recognised early in the process of preparing this AEE that the recreation values of the Mataura River are high, particularly in respect of its fishery. As such, Alliance commissioned Rob Greenaway to complete a detailed assessment of the effects of the activity on those values, including interviews and engagement with key recreational users.

The results of that assessment are summarised in Section 8.6, and detailed records of the interviews are set out in **Appendix 5**.

12. PROVISIONS OF THE RELEVANT PLANNING DOCUMENTS

12.1 RELEVANT STATUTORY PLANNING DOCUMENTS

When considering these applications for resource consents, the consent authority must, subject to Part 2, have regard to any relevant provisions of the following planning documents:

- The National Policy Statement for Freshwater Management 2014 ("**Freshwater NPS**").
- Resource Management (Measurement and Reporting of Water Takes) Regulations 2010 ("**Water Measurement Regulations**").
- The Southland Regional Policy Statement ("**RPS**").
- The Operative Regional Water Plan ("**Operative Plan**").
- The Proposed Southland Water and Land Plan ("**Proposed Plan**").

The relevant provisions of these planning documents were considered when assessing the effects of the proposed activities, and in determining how the effects of the activities could best be avoided, remedied or mitigated through the proposed conditions.

An assessment of those provisions, and how the proposed activities sit in relation to them is provided below.

In our view an analysis of the Ngāi Tahu ki Murihiku Natural Resource and Environmental Iwi Management Plan 2008: *Te Tangi a Tauira - The Cry of The People* ("**Te Tangi a Tauira**") is also reasonably necessary as the river is clearly of importance to iwi, and the plan's provisions touch directly on the issues under consideration. Therefore, we have provided an analysis of how the iwi management plan speaks to the proposal under consideration

12.2 NATIONAL POLICY STATEMENT FOR FRESHWATER MANAGEMENT 2014

12.2.1 Synopsis

The Freshwater NPS provides national direction for the management of freshwater under the RMA.

It has sections relating to the following:

- Te Mana te Wai;
- Water quality;
- Water quantity;
- Integrated management;

- National Objectives Framework;
- Monitoring Plans;
- Accounting for freshwater takes and contaminants;
- The role and interests of tangata whenua; and
- Progressive implementation programme.

Environment Southland has given public notice of its revised Progressive Implementation Programme to fully implement the Freshwater NPS by 31 December 2025.

There are two general parts to this programme:

- **The Proposed Southland Water and Land Plan**: This is intended to prevent further degradation of freshwater quality in Southland while the process for setting formal objectives, limits and targets in accordance with the collaborative planning methodology specified by the Freshwater NPS is completed. Appeals on the Proposed Plan are currently being heard by the Environment Court.
- **The freshwater objective, limit and target setting exercise**: This comprises a collaborative planning exercise whereby objectives, limits and targets are developed for the Mataura Catchment. The freshwater objectives, limits and targets developed through the collaborative planning process will then be inserted into the Water and Land Plan via a Schedule 1 plan change process. It is currently intended this plan change be notified by 2022 and be operative by 2025.

While the new framework to give effect to Freshwater NPS objectives in the Mataura Catchment has not yet been established, as per the above timeframes, it will be within the life of the consents Alliance is seeking for its wastewater and cooling water discharges. Therefore, while a direct assessment of the proposed discharge regime against the future framework is not possible, Alliance has had regard to the requirements of that framework when developing its proposed discharge regime.

In particular, that has included consideration of:

- The Freshwater NPS water quality objectives the new framework is required to give effect to;
- The compulsory values the Freshwater NPS requires that management framework include;
- The various attributes which the management framework is required to manage in respect of those values; and
- The suite of provisions inserted into the Freshwater NPS in 2017 focussed on managing water quality, so it is suitable for swimming more often.

Each is described below.

The Water Quality Objectives

The relevant water quality objectives state:

> ***Objective A1***
>
> *To safeguard:*
>
> *a) the life-supporting capacity, ecosystem processes and indigenous species including their associated ecosystems, of fresh water; and*
>
> *b) the health of people and communities, as affected by contact with fresh water;*
>
> *in sustainably managing the use and development of land, and of discharges of contaminants.*
>
> ***Objective A2***
>
> *The overall quality of fresh water within a freshwater management unit is maintained or improved while:*
>
> *a) protecting the significant values of outstanding freshwater bodies;*
>
> *b) protecting the significant values of wetlands; and*
>
> *c) improving the quality of fresh water in water bodies that have been degraded by human activities to the point of being over-allocated.*
>
> ***Objective A3***
>
> *The quality of fresh water within a freshwater management unit is improved so it is suitable for primary contact more often, unless:*
>
> *a) regional targets established under Policy A6(b) have been achieved; or*
>
> *b) naturally occurring processes mean further improvement is not possible.*
>
> ***Objective A4***
>
> *To enable communities to provide for their economic well-being, including productive economic opportunities, in sustainably managing freshwater quality, within limits.*

The Compulsory Values and Attributes

The two compulsory values which the Council is required to manage the Mataura River for, '*ecosystem health*' and '*human health for recreation*', and the compulsory attributes it is required to set limits for in respect of each of those values, are set out below.

Table 13: Compulsory values and attributes.

Value	Compulsory Attributes
Ecosystem health – The freshwater management unit supports a healthy ecosystem appropriate to that freshwater body type (river, lake, wetland, or aquifer). In a healthy freshwater ecosystem ecological processes are maintained, there is a range and diversity of indigenous flora and fauna, and there is resilience to change. Matters to take into account for a healthy freshwater ecosystem include the management of adverse effects on flora and fauna of contaminants, changes in freshwater chemistry, excessive nutrients, algal blooms, high sediment levels, high temperatures, low oxygen, invasive species, and changes in flow regime. Other matters to take into account include the essential habitat needs of flora and fauna and the connections between water bodies.	• Periphyton (Trophic state). • Nitrate (Toxicity) • Ammonia (Toxicity) • Dissolved Oxygen Note: To achieve a freshwater objective for periphyton within a freshwater management unit, the Freshwater NPS directs regional councils to at least set appropriate instream concentrations and exceedance criteria for dissolved inorganic nitrogen (DIN) and dissolved reactive phosphorus (DRP).
Human health for recreation – In a healthy waterbody, people are able to connect with the water through a range of activities such as swimming, waka, boating, fishing, mahinga kai and water-skiing, in a range of different flows. Matters to take into account for a healthy waterbody for human use include pathogens, clarity, deposited sediment, plant growth (from macrophytes to periphyton to phytoplankton), cyanobacteria and other toxicants.	• Escherichia coli (*E.coli*)

The 2017 Swimmability Provisions

In 2017, the Government introduced a suite of amendments to the Freshwater NPS focussed on managing water quality, so it is suitable for swimming more often.

The suite of provisions in the Freshwater NPS now include:

- **A national target** which describes a national-level outcome for water quality. The desired outcome is to make 80 per cent (of total river length of fourth order rivers) suitable for primary contact by 2030, and 90 per cent by 2040.[15]

  'Suitable for primary contact' in this context is described as water quality in the blue, green and yellow categories for *E.coli* as set out in Appendix 2 of the Freshwater NPS.

[15] Appendix 6.

- **A requirement to develop regional targets that describe regional outcomes, aimed at contributing to the national target.**[16] Environment Southland did this in December 2018, setting minimum primary contact targets for its region of 65.7% and 80% of rivers being suitable for primary contact by 2030 and 2040 respectively.
- **An objective to improve** (not maintain) freshwater management units so they are '*suitable for primary contact more often*' which the Freshwater NPS defines as meaning '*reducing the percentage and magnitude of E. coli exceedances for rivers ... according to the attribute tables in Appendix 2*'. This means improving water quality across all attribute states, even those that are already considered suitable for swimming (Objective A3).
- **Attribute states** which comprise a series of bands (A – E) which classify a waterbody according to how often a water body is suitable for swimming.
- **Policies requiring more specific plan content,** stating how specified rivers and lakes and primary contact sites will be improved. Councils have discretion around timeframes for achieving improvements, and where they focus their efforts (Policy A5).
- **Reporting requirements** to track efficacy of planning and progress toward regional targets over time (Policy E1(g)).
- **Surveillance monitoring requirements** at primary contact sites (Appendix 5 of the NPS).

Together these provisions place an obligation on Environment Southland to set policy and methods to improve water quality so that it is suitable for primary contact more often, and the key indicator for how that is being achieved is also instream *E.coli* concentrations. 2030 and 2040 are the key reporting timeframes for measuring progress.

12.2.2 Ecosystem Health

As outlined in Section 8, the technical assessments have concluded that there is no evidence the discharge itself is having an adverse effect on downstream water quality such that life supporting capacity or ecological values are compromised.

However, those technical assessments do identify that a cumulative catchment degradation issue is present due to nutrient enrichment to which the Alliance discharge makes a contribution. And the cumulative impact of nutrient discharges throughout the catchment may be having an adverse effect on ecosystem health. This includes high DIN and DRP concentrations in the main stem of the Mataura River, and Toetoes Estuary experiencing eutrophication symptoms due to excessive nutrient inputs, particularly TN.

[16] Policy A6.

It would therefore seem inevitable that the freshwater objective and limits. which are ultimately set for the Mataura River through the Freshwater Management Unit (FMU) process. will require an improvement in the quality of freshwater in this catchment, with a focus on periphyton levels and DIN and DRP concentrations in the river, and TN in Toetoes Estuary.

Most of the nutrients discharged into this catchment come from diffuse sources and reducing this contribution will require different farm mitigation practices and / or land use change. However, point source discharges will also need to be better managed.

Alliance acknowledges this, and that acknowledgement has influenced the decision to include in these consent applications an upgrade to the wastewater treatment plant to significantly reduce Amm-N and TN in the wastewater discharge within the first 15 years of any new consent term. Alliance expects this proffered contribution to be more than proportional to the wider catchment reduction in nutrients achieved by the diffuse sources, and is also comparatively expedient. Noting that experience from similar catchments in other parts of New Zealand (i.e. catchments with a high proportion of pastoral farming and nutrient enrichment). suggests any significant reduction in the contribution from diffuse sources will take some time.

12.2.3 Human health for Recreation

As set out in Section 3, the Mataura River, upstream, and downstream of the Plant's discharge is Attribute State Red, and the Plant's discharge significantly increases downstream *E.coli* concentrations. The Freshwater NPS attribute state considered suitable for swimming is Attribute State Yellow. Streamlined Environmental 2019 (see **Appendix 3**) has calculated moving Mataura River water quality to Attribute State Yellow absent any contribution from the Plant will require a 77% reduction in instream *E.coli* concentrations.

This magnitude of reduction will be exceedingly difficult to achieve in this catchment, and potentially difficult to justify, based on the existing Environment Southland and Streamlined Environmental studies that suggest *E.coli* levels may significantly overestimate the human health risk posed by water quality in this catchment when the dose / response relationship which underpins the Freshwater NPS attribute states is used.

It is also important to note in that regard that there is no 'national bottom line' for *E.coli* levels that Environment Southland must manage the Mataura River to achieve. Instead, the requirement is that the river be managed so it is suitable for primary contact more often. The Environment Southland commitment to make only 65.7% of rivers swimmable by 2030 is also relevant in this context and perhaps reflects the management challenges that will be faced in catchments such as the Mataura.

Irrespective of this, Alliance acknowledges that a reduction in *E.coli* concentrations needs to be achieved in this catchment, and that its discharge contributes significantly to the current *E.coli* levels downstream of the Plant. In that context, the proposed conditions commit Alliance to wastewater treatment plant upgrades which will yield more than a 99% reduction in the *E.coli* levels discharged by the Plant in the first five years of any new consent issued.

12.2.4 Conclusion

It is readily apparent that implementing the Freshwater NPS is going to require an improvement in Mataura River water quality for some key contaminants, particularly nutrients and *E.coli.*

The extent of the required improvement, how it will be achieved and the timeframes for achieving it, will be developed through the upcoming collaborative planning exercise required by the Freshwater NPS, and which Environment Southland expects to be completed by 2025.

Alliance expect that as a consequence of the measures it is proposed in this application, its contribution to catchment reductions in these key contaminants will be more than proportional to the wider reduction achieved in the catchment, and also comparatively expedient. Noting that experience from similar catchments in other parts of New Zealand (i.e. catchments with a high proportion of pastoral farming and nutrient enrichment), suggests any significant reduction in the contribution from diffuse sources will take some time.

The proposed activities undertaken in accordance with the proposed conditions are therefore consistent with the requirements of the Freshwater NPS.

12.3 RESOURCE MANAGEMENT (MEASUREMENT AND REPORTING OF WATER TAKES) REGULATIONS 2010

Water measurement requirements were recently addressed in detail in respect of these takes, with the conclusion being that:

- The take and use of water for Plant processing activities, including water that is used for cleaning, potable water supply, wastewater processing and truck washing, should be subject to water metering in accordance with the Water Measuring Regulations; but
- The take and use of water for engine room cooling water and condenser water is to be estimated and reported by combining the records of discharge monitoring, take monitoring, pump capacities and pump operation.

No changes to this approach are proposed. The proposed conditions of consent reflect that.

12.4 NEW ZEALAND COASTAL POLICY STATEMENT 2010

The NZCPS is a relevant consideration on the basis that the ultimate receiving environment of the Plant's discharge to the Mataura River includes the Toetoes Estuary. The quality of the Toetoes Estuary is being affected by the cumulative impacts of non-point and point source discharges throughout the catchment, and this is influencing the estuary's ecosystem values. The most relevant policy in the NZCPS when considering this matter in the context of these resource consent applications is Policy 21, which directs that:

- priority be given to improving water quality where the quality of water in the coastal environment has deteriorated so that it is having a significant adverse effect on ecosystems; and
- where practicable, water quality be restored to at least a state that can support such ecosystems and natural habitats.

In order to see an improvement in the quality of the Toetoes Estuary in the manner sought by Policy 21, a whole-of-catchment response will be required. The proposed conditions respond to this policy direction by requiring a substantial reduction in the TN load from the Plant within the first 15 years of the new consent.

12.5 SOUTHLAND REGIONAL POLICY STATEMENT

The RPS was made operative on 9 October 2017. It outlines objectives, policies and methods, which guide the management of Southland's natural resources. It is required to give effect to the Freshwater NPS and postdates it (although not the most recent update in 2017). In turn, its water related provisions prescribe the overarching framework for how the Freshwater NPS framework is to be implemented in Southland.

When considering the proposed take and discharge activities, the most relevant provisions are contained in:

- Chapter 3: Tangata Whenua;
- Chapter 4: Part A Water Quality; and
- Chapter 4: Part B Water Quantity.

Each is addressed below.

12.5.1 Tangata Whenua

Chapter 3 of the RPS sets out the resource management issues of significance to Ngāi Tahu; and sets out the objectives, policies and methods to address those issues.

The objectives and policies that are relevant to the proposed activities state:

Objective TW.2 – Provision for iwi management plans

All local authority resource management processes and decisions take into account iwi management plans.

Objective TW.3 – Tangata whenua spiritual values and customary resources

Mauri and wairua are sustained or improved where degraded, and mahinga kai and customary resources are healthy, abundant and accessible to tangata whenua.

Objective TW.4 – Sites of cultural significance

Wāhi tapu, wāhi taonga and sites of significance are appropriately managed and protected.

Policy TW.1 – Treaty of Waitangi

Consult with, and enhance tangata whenua involvement in local authority resource management decision-making processes, in a manner that is consistent with the principles of the Treaty of Waitangi/Te Tiriti o Waitangi.

Policy TW.3 – Iwi management plans

Take iwi management plans into account within local authority resource management decision making processes.

Policy TW.4 – Decision making

When making resource management decisions, ensure that local authority functions and powers are exercised in a manner that:

(a) recognises and provides for:

- *(i) traditional Māori uses and practices relating to natural resources (e.g. mātaitai, kaitiakitanga, manaakitanga, matauranga, rāhui, wāhi tapu, taonga raranga);*
- *(ii) the ahi kā (manawhenua) relationship of tangata whenua with and their role as kaitiaki of natural resources;*
- *(iii) mahinga kai and access to areas of natural resources used for customary purposes;*
- *(iv) mauri and wairua of natural resources;*
- *(v) places, sites and areas with significant spiritual or cultural historic heritage value to tangata whenua;*
- *(vi) Māori environmental health and cultural wellbeing.*

(b) recognises that only tangata whenua can identify their relationship and that of their culture and traditions with their ancestral lands, water, sites, wāhi tapu and other taonga.

Iwi have a long association and strong traditional relationship with the Mataura River, and mahinga kai resources, nohoanga and mātaitai are all important and relevant values here.

And in accordance with the overarching direction in the above provisions, Alliance has, and continues to consult with Te Ao Marama and Hokonui Runanga on how the proposed take and discharge activities may adversely affect these values, and how those adverse effects can be avoided, remedied or mitigated.

12.5.2 Water Quality

Chapter 4, Part A of the RPS contains overarching direction for managing water quality in the Region. The objectives and policies most relevant to the proposed discharge activities state:

Objective WQUAL.1 – Water quality goals

Water quality in the region:

(a) safeguards the life-supporting capacity of water and related ecosystems;

(b) safeguards the health of people and communities;

(c) is maintained, or improved in accordance with freshwater objectives formulated under the National Policy Statement for Freshwater Management 2014;

(d) is managed to meet the reasonably foreseeable social, economic and cultural needs of future Generations

Objective WQUAL.2 – Lowland water bodies

Halt the decline and improve water quality in lowland water bodies and coastal lakes, lagoons, tidal estuaries, salt marshes and coastal wetlands in accordance with freshwater objectives formulated in accordance with the National Policy Statement for Freshwater Management 2014.

Policy WQUAL.1 – Overall management of water quality

(a) Identify values of surface water, groundwater, and water in coastal lakes, lagoons, tidal estuaries, salt marshes and coastal wetlands, and formulate freshwater objectives in accordance with the National Policy Statement for Freshwater Management 2014; and

(b) Manage discharges and land use activities to maintain or improve water quality to ensure freshwater objectives in freshwater management units are met.

Policy WQUAL.2 – All waterbodies

Maintain or improve water quality, having particular regard to the following contaminants:

(a) nitrogen;

(b) phosphorus;

(c) sediment;

(d) microbiological contaminants.

Policy WQUAL.5 – Improve catchment water quality

Improve water quality by:

(a) identifying water bodies that are not meeting freshwater objectives, including identifying priority freshwater management units;

(b) specifying targets to improve water quality within those water bodies within defined timeframes;

(c) implementing management frameworks to meet the targets taking into account;

(i) the values supported by the water body/ies;

(ii) national or legislative standards and requirements;

(iii) the benefits and costs associated with achieving improvement in water quality.

Maintaining or improving water quality through FMU processes is an overarching theme of these provisions. A particular focus is placed on nitrogen, phosphorus, sediment and microbial contaminants.

The Mataura Catchment FMU process has not yet occurred, and it is therefore uncertain what the freshwater objectives, limits and timeframes for the Mataura FMU will be. However, as set out in Sections 8 and 9.3 of this AEE, the technical assessments have identified high nutrient and *E.coli* levels in the catchment and it would seem highly likely that the planning framework stemming from the FMU process will require a significant reduction in these contaminants in the Mataura catchment over time. This is consistent with Policy WQUAL.2. Diffuse runoff from pastoral land use contributes considerably to this degraded state, and any significant improvement in water quality for these parameters will require a significant change to how this activity occurs in the catchment. This will likely take some time. However, the Plant also contributes to instream concentrations of these key contaminants downstream of Mataura, and the wastewater treatment plant upgrades required by the proposed conditions of consent will ensure Alliance does its part in improving the quality of Mataura River water. This aligns with the expectations of the above provisions.

Other relevant provisions in Chapter 4 Part A are:

Policy WQUAL.8 – Preference for discharge to land

Prefer discharges of contaminants to land over discharges of contaminants to water, where:

(a) a discharge to land is practicable;

(b) the adverse effects associated with a discharge to land are less than a discharge to water.

Policy WQUAL.9 – Untreated human and animal wastes

Avoid the direct discharge of sewage, wastewater, industrial and trade waste and agricultural effluent to water unless these discharges have undergone treatment.

The proposed discharge regime sits comfortably with these provisions noting that:

- For reasons set out in Section 10 of this AEE, the discharge of Plant wastewater to land is not practicable; and
- The wastewater discharge will undergo treatment prior to being discharged to the Mataura River.

12.5.3 Water Quantity

The RPS contains two objectives for water quantity:

Objective WQUAN.1 – Sustainably managing the region's water resources

Flows, levels and allocation regimes of surface water and groundwater in the region are developed in accordance with the National Policy for Freshwater Management 2014 to:

(a) safeguard the life-supporting capacity of water, catchments and related ecosystems;

(b) support the maintenance or improvement of water quality in accordance with Policy WQUAL.1;

(c) meet the needs of a range of uses, including the reasonably foreseeable social, economic and cultural needs of future generations;

(d) comply with limits or targets set to achieve freshwater objectives.

Objective WQUAN.2 – The efficient allocation and use of water

The allocation and use of Southland's water resources:

(a) is efficient;

(b) recognises and makes provision for the Monowai and nationally significant Manapōuri hydroelectric generation schemes in the Waiau catchment and the resultant modified flows and levels.

The associated policies contain various directions for achieving these objectives in the Region, most of which are targeted at future regional plan processes and establishing Freshwater NPS compliant flow and allocation regimes through the upcoming FMU processes.

These provisions are not directly relevant to activities entailing the proposed take and use of water. However, the activity will be undertaken in accordance with the flow and allocation regime set by the Mataura WCO, which will achieve Objective WQUAN.1. Improving water efficiency is also an important aspect of the proposed activities, and the

Plant's allocation and use will be consistent with the associated outcome sought by Objective WQUAN.2.

12.5.4 Summary

The proposed activities are broadly consistent with the RPS, and will help, rather than hinder, Environment Southland's efforts to implement it, particularly in respect of improving water quality.

12.6 OPERATIVE WATER PLAN

The Operative Water Plan was made operative in April 2010. In that respect, it predates both the Freshwater NPS and the RPS. Of most relevance to the proposed activities are its objectives and policies which address water quality and water quantity. An assessment of the proposed take and discharge activities against those provisions is provided below.

12.6.1 Water Quality

The planning framework for water quality matters in the Operative Plan is relevant when considering the proposed discharge of cooling water and wastewater.

Objectives

The water quality objectives most relevant to the proposed activities state:

> ***Objective 2 – Maintain water quality***
>
> *To manage water quality so that there is no reduction in the quality of the water in any surface water body, beyond the zone of reasonable mixing for discharges, below that of the date this Plan became operative (January 2010).*
>
> ***Objective 3 – Surface water bodies other than in Natural State Waters***
>
> *To maintain and enhance the quality of surface water bodies so that the following values are protected where water quality is already suitable for them, and where water quality is currently not suitable, measurable progress is achieved towards making it suitable for them.*
>
> *In surface water bodies classified as ... Mataura 3:*
>
> *(a) bathing, in those sites where bathing is popular;*
>
> *(b) trout where present, otherwise native fish;*
>
> *(c) stock drinking water;*
>
> *(d) Ngāi Tahu cultural values, including mahinga kai;*
>
> *(e) natural character including aesthetics.*
>
> ***Objective 4 – Gradual improvement in surface water quality parameters***
>
> *To manage the discharge of contaminants and encourage best environmental practice to improve the water quality in surface water bodies classified as hill,*

lowland (hard bed), lowland (soft bed) and spring fed, and in particular to achieve a minimum of 10 percent improvement in levels of the following water quality parameters over 10 years from the date this Plan became operative (January 2010):

(a) microbiological contaminants

(b) nitrate

(c) phosphorus

(d) clarity

Key matters to note in respect of these objectives are:

- Environment Southland water quality data suggests that while Objective 2 has been largely achieved in the Mataura River at Mataura (as per Table 2 – Environment Southland monitoring data shows no statistical change in water quality for key parameters at its monitoring site 200m downstream of Mataura Bridge since the Plan became operative in 2010), and over this period the quality of the Plant's discharge has also not degraded.
- That same Environment Southland water quality data suggests the 10 percent improvement in certain water quality parameters sought by Objective 4 has not been achieved. However, when considering the Plant's wastewater discharge the following is relevant:
    - The contribution of the Plant to instream phosphorus concentrations has been significantly reduced since 2010;
    - While no change to the microbial contaminants discharged from the Plant has occurred since 2010, a significant reduction in the concentration of *E.coli* is required by the proposed conditions; and
    - Nitrate concentrations in the Plant's discharge are very low, and nitrate and clarity do not appear to be in a degraded state in the Mataura River at Mataura.
- With respect to Objective 3(a), while the Mataura River downstream of the Plant may be un-swimmable at times, the risk of a person swimming below the Plant becoming ill due to the Plant's discharge is well below 1%, which is considered an acceptable level. The risk due to the Plant's discharge will also be further reduced following the installation of the UV disinfection required by the proposed conditions, although this will have limited effect on reducing the baseline risk in the river as it is mainly affected by upstream land use.
- As described in FWS (2019), water quality in Mataura River downstream of the discharge is suitable for trout and native fish, as sought by Objective 3(b).
- As described in FWS (2019), water quality in Mataura River downstream of the discharge is suitable for stockwater, as sought by Objective 3(c).

- With respect to aesthetic and natural character values (Objective 3(d)), key matters of concern for this type of discharge would include any changes to the natural colour and clarity of the water, and the formation of bacterial or fungal slime growths visible to the naked eye as obvious plumose growths or mats. In respect of these matters:
  - Environment Southland monitoring data shows clarity at Mataura is better than the relevant ANZECC 2000 guideline, and FWS (2019) conclude the discharge does not cause a conspicuous change in clarity;
  - FWS (2019) concludes the discharge does not appear to result in the generation of conspicuous foams, scums or heterotrophic growth; and
  - Periphyton growths, which are reflective of moderate to high enrichment, occur during long accrual periods, however this occurs upstream and downstream of the discharge. Addressing this effect will require a whole-of-catchment response to reduce nutrient loads, and the Plant's contribution to that is included in the proposed conditions.

Policies

Central to the Plan's provisions for managing water quality are the following policies which set out how the effects of the discharge are to be managed, relative to upstream water quality, and a suite of specified water quality standards (noting that the Plant is located in the Mataura 3 water body class):

> ***Policy 1 – Surface water body classes***
>
> *(a) Recognise the different characteristics of the following surface water body classes when managing discharges:*
>
> *(x) Mataura 3*
>
> *(b) Apply water quality standards established under any Water Conservation Order.*
>
> ***Policy 3 – No reduction in water quality***
>
> *Notwithstanding any other policy or objective in this plan, allow no discharges to surface water bodies that will result in a reduction of water quality beyond the zone of reasonable mixing, unless it is consistent with the promotion of the sustainable management of natural and physical resources, as set out in Part 2 of the Resource Management Act 1991, to do so.*
>
> ***Policy 4 – Surface water bodies outside Natural State Waters***
>
> *For surface water bodies outside Natural State Waters, manage point source and non-point source discharges to meet or exceed the water quality standards referred to in Rule 1 and specified in Appendix G "Water Quality Standards", unless it is consistent with the promotion of the sustainable management of natural and physical resources, as set out in Part 2 of the Resource Management Act 1991, to do so and so avoid levels of contaminants in water and sediments that*

could harm the health of humans, domestic animals including stock and/or aquatic life.

Policy 9 Zone of reasonable mixing

When determining the size of the zone of reasonable mixing, minimise the size of the area where the relevant water quality standards are breached. Consideration should be given to, but not be limited to, the following matters:

(a) the aquatic ecosystem values in the affected reach;

(b) the need for fish passage;

(c) the uses of the water body adjacent to and downstream of the point of discharge

The proposed discharge activities undertaken in accordance with the proposed conditions sit comfortably with these policies for the following reasons:

- As set out in Section 8.2.2, the zone of reasonable mixing for the wastewater discharge is currently set at 250 m below the outfall. Having considered the matters listed in Policy 9, this remains appropriate.
- The discharge is subject to the Mataura WCO and complies with all the water quality standards set in the Mataura WCO.
- The discharge is within the Mataura 3 surface water body class, and the only parameter in Appendix G for that class, which will not be achieved below the zone of reasonable mixing, is *E.coli*.
- The only parameters for which the discharge causes a reduction in water quality below the zone of reasonable mixing are *E.coli*, Amm-N and TN.
- Policies 3 and 4 direct, that in the above circumstances, discharges only be allowed where it is consistent with the promotion of the sustainable management of natural and physical resources, as set out in Part 2 of the RMA to do so.
- For reasons set out in Section 13.3.5, granting the applications as sought would be consistent with Part 2 of the RMA.

The Operative Plan also includes the following relevant provisions which express preference for certain methods of discharge:

Policy 7 Prefer discharges to land

Prefer discharges to land over discharges to water where this is practicable and the effects are less adverse.

Policy 8 Discharges to water

Prefer point source discharges of contaminants to water at times of high flow over discharges at normal or low flows, and ensure that where discharging does take place at low flows, the effects that could not be practically avoided are minimised.

The analysis completed by PDP on options for discharging the Plant's wastewater to land was partially in response to the expressed preference for a land-based discharge in these policies. However, for the operational, establishment, financial and environmental reasons set out in Section 10.4.1, a full time or partial discharge to land does not represent the best practicable option in this case. Therefore, as Policies 7 or 8 express a preference rather than a requirement, they do not represent a barrier to granting the consents sought.

12.6.2 Water Quantity

As outlined in Section 7.3, two water takes are proposed:

- A take and use of water for engine room cooling water and condenser water, whereby all the water taken is returned back to the hydro race from which it was abstracted.
- A take for various Plant processing activities, in which [almost] all the water taken is returned back to the river via the Plant's wastewater discharge 100 m downstream of the hydro race discharge.

Of most relevance when considering these activities are the Operative Plan provisions which address:

- Water allocation and environmental flow regimes;
- Efficient water use;
- Water metering; and
- Consent term.

Each is addressed below.

Water allocation and environmental flow regimes

The Operative Plan contains the following overarching objective addressing the allocation of water to instream and out of stream uses:

> ***Objective 5 – Sufficient water availability***
>
> *To have sufficient water to support the reasonably foreseeable needs of current and future generations and enable people and communities to provide for their social, economic and cultural wellbeing while protecting aquatic ecosystem health, life supporting capacity, natural character and historic heritage values of surface water bodies.*

When considering how this objective is to be achieved the policies of most relevance state:

> ***Policy 14 – Manage the taking, use, damming or diversion of surface water***
> *While recognising the positive effects resulting from the use and development of water resources, manage the taking, use, damming or diversion of surface water*

so as to avoid where practicable, remedy or mitigate significant adverse effects on:

(a) the quality and quantity of aquatic habitat;

(b) natural character, natural features, and amenity, aesthetic and landscape values;

(c) areas of significant indigenous vegetation and significant habitats of indigenous fauna;

(d) recreational values;

(e) the spiritual and cultural values and beliefs of the tangata whenua;

(f) water quality, including temperature;

(g) the rights of lawful existing users;

(h) groundwater quality and quantity;

(i) historic heritage

Policy 15 – Surface water abstraction, damming, diversion and use

...

(c) Apply allocation and minimum flow and level regimes established under any Water Conservation Order.

...

(e) Recognise and provide for surface water abstraction, damming, diversion and use resulting in positive effects and no net loss of water in a catchment.

...

(h) Require resource consent applications for surface water abstraction, damming, diversion and use to be supported by a level of information that corresponds to the level of risk of adverse environmental effects.

(i) Ensure that surface water abstractions, damming or diversions with a high risk of adverse environmental effects, in conjunction with existing abstractions, damming and diversions, will not:

(a) result in significant adverse ecological effects through the increase in time the relevant surface water body is at or below its minimum flows or levels;

(b) compromise the availability and reliability of water supply for existing users;

(c) result in significant adverse effects on the matters listed in Policy 16(b)(i) to (xvi)

(j) Impose monitoring on resource consents for surface water abstraction, damming, diversion and use that corresponds to the level of risk of adverse environmental effects.

Policy 16 – Environmental flow and level regimes

> *(a) When granting resource consents for surface water abstraction, damming, diversion and use, the Council where appropriate will apply by way of consent conditions environmental flow and level regimes established under:*
>
> > *(ii) any Water Conservation Order*

The proposed take and use of cooling water, and process water sit comfortably with these provisions for the following reasons:

- The sustainable flow regime in this catchment is set by the Mataura WCO, and in accordance with Policy 15(c) and Policy 16(a)(ii), the proposed abstraction will take water in accordance with that flow regime;
- The take and use of water for cooling and process use will result in no net loss of water in the catchment, and in turn, these are a type of abstraction that Policy 15(e) directs be recognised and provided for.
- Because the proposed take and use of water will only reduce flows for a short 100 m section of the Mataura River, and the Mataura WCO will ensure that baseflows through that reach are maintained at 95% of the naturalised flow, the take and use of water does not have a high risk of adverse environmental effects (Policy 15(i)), nor will it result in any of the effects of concern in Policy 15(i)(a) – (c).
- Monitoring of the water take is limited to recording the volume (cooling water) and rate (process water) of take, and this reflects the minimal risk of adverse environmental effects.

Efficiency of use

Efficiency of water use is an important part of the Operative Plan, and it includes the following provisions:

> ***Objective 7 – Efficient Water Use***
>
> *To maximise the efficiency of water use.*
>
> ***Policy 21 – Reasonable use of water***
>
> *To ensure that the rate of abstraction and abstraction volumes specified on water permits to take and use water are no more than reasonable for the intended end use.*

The proposed rate and volume of abstraction is no more than reasonable for the intended end use and is considered to represent efficient use of water. In accordance with these provisions, Alliance commissioned PDP (see **Appendix 8**) to assess the efficiency of water use on-site. For reasons outlined in Section 9.2.2, that assessment identified the use of raw river water for generation of white-water as a potential area where water use could be reduced (by approximately 2,000 m^3/day). Alliance has also determined that some of the water currently allocated to it is unnecessary for the proposed use. This is reflected in the proposed conditions allowing a significantly lower daily volume of water to be taken than the current consents.

Measurement

In 2018 Alliance applied for amendment to the water metering conditions on the existing consent to take and use water at the Plant (Resource Consent AUTH-204126), in order to bring those conditions into line with the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010.

The outcome of that process is that:

- The take and use of water for Plant processing activities, including water that is used for cleaning, potable water supply, wastewater processing and truck washing, should be subject to water metering in accordance with the Water Measurement Regulations; but
- The take and use of water for engine room cooling water and condenser water is to be estimated and reported by combining the records of discharge monitoring, take monitoring, pump capacities and pump operation.

No changes to this approach are proposed, and it is considered the proposed water measurement aligns with the expectations of the Operative Plan.

Consent Term

As set out in Section 1 of this AEE, Alliance has sought a term of 35 years for all the resource consents sought.

The Proposed Plan includes the following policy which is relevant when determining whether this consent term is appropriate:

> ***Policy 14A– Determining the term of a water permit***
>
> *To determine the term of a water permit consideration will be given, but not limited, to:*
>
> *(a) the degree of certainty regarding the nature, scale, duration and frequency of adverse effects from the activity;*
>
> *(b) the level of knowledge of the resource;*
>
> *(c) relevant tangata whenua values*
>
> *(d) the allocation sought, particularly the proportion of the resource sought;*
>
> *(e) the duration sought by the applicant, plus material to support the duration sought;*
>
> *(f) the permanence and economic life of the activity;*

(g) *capital investment in the activity;*

(h) *monitoring and review requirement in permit conditions;*

(i) *the desirability of applying a common expiry date for water permits that allocate water from the same resource; and*

(j) *the applicant's compliance with the conditions of the previous permit (where a new water permit is sought for a previously authorised activity).*

In the context of Policy 14A, the following matters would support the 35 year consent term sought:

- The activity is existing, and there is a high degree of certainty on the nature, scale, duration and frequency of its adverse effects on the environment (clauses (a) and (b)).
- The take only reduces instream flows for approximately 100 m (clause (d)).
- The Plant is a significant permanent asset with an insured value of $225 million (clauses (f) and (g)).
- The proposed conditions include provision for Environment Southland to review the consent for the purpose of changing the monitoring conditions, dealing with any unexpected adverse effects that arise from the exercise of the resource consent, or to comply with the requirement of a regional plan (which would include any new flow and allocation regime set for the Mataura River) (clause (m) and (i)).
- Alliance has historically had an excellent compliance record with the conditions of its existing consent to take and use water at the Plant (clause (j)).

With respect to clause (c), Hokonui Runanga and TAMI have expressed a preference for the term of consent to be no more than 25 years.

12.6.3 Conclusion

Water quality downstream of the discharge will achieve the Operative Plan's objectives for water quality in this part of the Mataura River.

The discharge causes levels of *E.coli*, Amm-N and TN to increase downstream of the mixing zone, and in the case of *E.coli*, to also not meet the relevant water quality standards in Appendix G of the Operative Plan. The Plan directs this type of discharge only be allowed where it is consistent with Part 2 of the RMA to do so, which, for reasons set out in Section 13.3.5, is the case here.

The proposed discharge will not be contrary to the objectives and policies of the Operative Plan, and there is nothing in the Operative Plan which means the discharge applications cannot be granted on the terms sought.

12.7 PROPOSED WATER AND LAND PLAN

The Proposed Plan is intended to provide direction and guidance regarding the sustainable use, development and protection of water and land resources in the Southland region.

The Proposed Plan was notified on 3 June 2016, and the submissions and hearing process was completed in October 2017. A decisions version of the Proposed Plan was released on 4 April 2018. It is this decisions version of the Proposed Plan that is the relevant version when considering these consent applications.

However, many of the key provisions are subject to Environment Court appeals and may change. This needs to be acknowledged when having regard to them in respect of these consent applications.

When considering these applications for resource consents, the most relevant provisions in the Proposed Plan are contained in the following sections:

- Region-wide Objectives;
- Ngai Tahu policies;
- Water Quality; and
- Water Quantity policies.

12.7.1 Region-Wide Objectives

The Proposed Plan includes the following region-wide objectives which are relevant when considering the proposed take and discharge activities:

> ***Objective 1***
>
> *Land and water and associated ecosystems are sustainably managed as integrated natural resources, recognising the connectivity between surface water and groundwater, and between freshwater, land and the coast.*
>
> ***Objective 2***
>
> *Water and land is recognised as an enabler of primary production and the economic, social and cultural wellbeing of the region.*
>
> ***Objective 3***
>
> *The mauri of waterbodies provide for te hauora o te tangata (health and mauri of the people), te hauora o te taiao (health and mauri of the environment) and te hauora o te wai (health and mauri of the waterbody).*
>
> ***Objective 4***
>
> *Tangata whenua values and interests are identified and reflected in the management of freshwater and associated ecosystems.*

Objective 5

Ngāi Tahu have access to and sustainable customary use of, both commercial and non-commercial, mahinga kai resources, nohoanga, mātaitai and taiāpure.

Objective 6

There is no reduction in the overall quality of freshwater, and water in estuaries and coastal lagoons, by:

(a) maintaining the quality of water in waterbodies, estuaries and coastal lagoons, where the water quality is not degraded; and

(b) improving the quality of water in waterbodies, estuaries and coastal lagoons, that have been degraded by human activities.

Objective 7

Any further over-allocation of freshwater (water quality and quantity) is avoided and any existing over-allocation is phased out in accordance with freshwater objectives, freshwater quality limits and timeframes established under Freshwater Management Unit processes.

Objective 9

The quantity of water in surface waterbodies is managed so that aquatic ecosystem health, life supporting capacity, outstanding natural features and landscapes and natural character are safeguarded.

Objective 9A

Surface water is sustainably managed to support the reasonable needs of people and communities to provide for their social, economic and cultural wellbeing.

Objective 11

The amount of water abstracted is shown to be reasonable for its intended use and water is allocated and used efficiently.

Objective 13B

The discharges of contaminants to land or water that have significant or cumulative adverse effects on human health are avoided.

Objective 14

The range and diversity of indigenous ecosystem types and habitats within rivers, estuaries, wetlands and lakes, including their margins, and their life-supporting capacity are maintained or enhanced.

Objective 15

Taonga species, as set out in Appendix M, and related habitats, are recognised and provided for.

Objective 17

The natural character values of wetlands, rivers and lakes and their margins, including channel and bed form, rapids, seasonably variable flows and natural habitats, are protected from inappropriate use and development.

Objective 18

All activities operate in accordance with "good management practice" or better to optimise efficient resource use, safeguard the life supporting capacity of the region's land and soils, and maintain or improve the quality and quantity of the region's water resources.

When considering the proposed activities in the context of these objectives, key matters include:

- In accordance with Objective 1, the integrated nature of the land, water and ecosystems in the Mataura catchment has been recognised and incorporated into the assessment of effects undertaken for the proposed activities, and into the proposed means for avoiding, remedying or mitigating effects.
- Objectives 2 and 9 recognise the role of water as an enabler of economic, social and cultural wellbeing of the region, and seek it be managed to support and provide for the reasonable needs of people and their social, economic and cultural wellbeing. Enabling the Mataura Plant to continue utilising the Mataura River for water supply, and as a discharge medium to deliver the social and economic benefits outlined Section 6 of this AEE, would do this.
- With respect to Objectives 3, 4 and 5, iwi have a long association and strong traditional relationship with the Mataura River, and mahinga kai resources, nohoanga and mātaitai are all important and relevant values here. Alliance has, and continues to consult with Te Ao Marama and Hokonui Runanga on how the proposed take and discharge activities effect these values, and how those effects can be avoided, remedied or mitigated. And a new condition is proposed to ensure ongoing, meaningful engagement with, and input from Hokonui Runanga regarding the ongoing monitoring of the effects of the Plant's activities on the surrounding environment.
- With respect to Objectives 6 and 7, water quality in the Mataura River and Toetoes Estuary has been degraded by human activities for certain parameters. The FMU process which is intended to manage this issue has not yet occurred, and it is therefore uncertain what the freshwater objectives, limits and timeframes for the Mataura FMU will be. However, key issues identified by FWS and AES are its high nutrient and *E.coli* levels, and it would seem inevitable that the planning framework stemming from the FMU process will require a significant reduction in these contaminants in the Mataura catchment over time. Diffuse runoff from pastoral land use contributes considerably to this degraded state, and the improvement of water

quality sought by Objective 6 will require a significant change to how this activity occurs in the catchment. This will likely take some time. However, the Plant also contributes to instream concentrations of these key contaminants downstream of Mataura, and the wastewater treatment plant upgrades required by the proposed conditions of consent will ensure Alliance does its part in improving the quality of Mataura River water in respect of these key parameters.

- The Mataura WCO specifies the environmental flow and allocation regime to achieve Objective 9 in the Mataura River. The Plant's take of water is in accordance with that flow regime.
- An independent assessment by PDP (see **Appendix 8**) has shown there are some inefficiencies in the current use of water on-site. The proposed conditions require this to be addressed over the first three years of the new consent term via implementation of a Resilience and Water Saving Strategy. In accordance with Objective 11, this means the amount of water abstracted will be reasonable for the intended use and will be used efficiently.
- The Streamlined Environmental (2019) QMRA has shown the Plant's discharge does not have significant adverse effects on human health and therefore aligns with Objective 13B. Environment Southland and Streamlined Environmental studies also show the baseline health risk in this catchment is not as significant as measured *E.coli* levels would suggest.
- The outcome sought by Objective 14 is influenced by water quantity, quality and land use. With respect to water quantity, the Mataura WCO specifies the environmental flow and allocation regime to achieve Objective 14 in the Mataura River. With respect to water quality, it is apparent that the Mataura River and Toetoes Estuary has degraded water quality for some parameters, and this may be impacting on its life-supporting capacity. The proposed consent conditions set out how the Plant will contribute to maintaining, and then enhancing water quality and life-supporting capacity over the first 15 years of the new consent.
- The only direct effect of concern on a taonga species that Objective 15 seeks to be recognised and provided for is entrainment of native fish in the Plant's water pumps. To address this concern, the proposed conditions require installation of fish screens which meet recognised standards.
- In accordance with Objective 17, the proposed take and discharge activities are not an inappropriate use and development when considering effects on natural character values. The Mataura River is a highly modified river with significantly reduced natural character values, particularly in the vicinity of the take and discharge. The proposed discharges to water will maintain the quality of the existing riverine environment and are not considered to cause any conspicuous change in the colour or clarity of the receiving water, or generation of foams or scums. Likewise, the take and use of water

will have minimal effects on instream flows and will abide by the environmental flow regime set for this river by the Mataura WCO.

12.7.2 Ngāi Tahu Policies

The relevant Ngāi Tahu policies state:

> ***Policy 2 – Take into account iwi management plans***
>
> *Any assessment of an activity covered by this Plan must:*
>
> 1. *take into account any relevant iwi management plan; and*
> 2. *assess water quality and quantity, taking into account Ngāi Tahu indicators of health.*
>
> ***Policy 3 – Ngāi Tahu ki Murihiku taonga species***
>
> *To manage activities that adversely affect taonga species, identified in Appendix M.*

With respect to Policy 2(1), the relevant provisions of *Te Tangi a Tauira - The Cry of the People* are addressed in Section 12.8 of this AEE. And with respect to Policy 3 as outlined above, the only direct effect of concern on a taonga species is entrainment of native fish in the Plant's water pumps. To address this concern, the proposed conditions require installation of fish screens which meet recognised standards.

12.7.3 Water Quality Policies

As required of it by the Freshwater NPS, the Proposed Plan includes the following policy which specifies certain matters to which regard must be had when considering an application for a discharge:

> ***Policy A4 of the National Policy Statement for Freshwater Management 2014 (as amended in 2017)***
>
> 1. *When considering any application for a discharge the consent authority must have regard to the following matters:*
>   - *(a) the extent to which the discharge would avoid contamination that will have an adverse effect on the life-supporting capacity of freshwater including on any ecosystem associated with freshwater; and*
>   - *(b) the extent to which it is feasible and dependable that any more than minor adverse effect on freshwater, and on any ecosystem associated with freshwater, resulting from the discharge would be avoided.*
> 2. *When considering any application for a discharge the consent authority must have regard to the following matters:*
>   - *(a) the extent to which the discharge would avoid contamination that*

will have an adverse effect on the health of people and communities as affected by their contact with freshwater; and

(b) the extent to which it is feasible and dependable that any more than minor adverse effect on the health of people and communities as affected by their contact with freshwater resulting from the discharge would be avoided.

Important conclusions from the technical assessments when having regard to the matters set out in this policy are:

- There is no evidence the discharge is itself having an adverse effect on the life-supporting capacity of the Mataura River or Toetoes Estuary; and
- The risk of a person swimming downstream of the discharge becoming ill due to the discharge is less than 1%, and lower than accepted levels.

The Proposed Plan also contains a relatively comprehensive suite of policies which set out how the effects of discharges are to be managed. Central to this are Policies 13, 15A, 15B and 15C, which direct discharges be managed relative to a suite of water quality standards contained in Appendix E of the Proposed Plan. They state:

Policy 13 – Management of land use activities and discharges

1. Recognise that the use and development of Southland's land and water resources, including for primary production, enables people and communities to provide for their social, economic and cultural wellbeing.

2. Manage land use activities and discharges (point source and non-point source) to enable the achievement of Policies 15A, 15B and 15C.

Policy 15A – Maintain water quality where standards are met

Where existing water quality meets the Appendix E Water Quality Standards or bed sediments meet the Appendix C ANZECC sediment guidelines, maintain water quality including by:

1. avoiding, remedying or mitigating the adverse effects of new discharges, so that beyond the zone of reasonable mixing, those standards or sediment guidelines will continue to be met; and

2. requiring any application for replacement of an expiring discharge permit to demonstrate how the adverse effects of the discharge are avoided, remedied or mitigated, so that beyond the zone of reasonable mixing those standards or sediment guidelines will continue to be met.

Policy 15B – Improve water quality where standards are not met

Where existing water quality does not meet the Appendix E Water Quality Standards or bed sediments do not meet the Appendix C ANZECC sediment guidelines, improve water quality including by:

1. *avoiding where practicable and otherwise remedying or mitigating any adverse effects of new discharges on water quality or sediment quality that would exacerbate the exceedance of those standards or sediment guidelines beyond the zone of reasonable mixing; and*
2. *requiring any application for replacement of an expiring discharge permit to demonstrate how and by when adverse effects will be avoided where practicable and otherwise remedied or mitigated, so that beyond the zone of reasonable mixing water quality will be improved to assist with meeting those standards or sediment guidelines.*

Policy 15C – Maintaining and improving water quality after FMU processes

Following the establishment of freshwater objectives and limits under Freshwater Management Unit processes, and including through implementation of non-regulatory methods, improve water quality where it is degraded to the point where freshwater objectives are not being met and otherwise maintain water quality where freshwater objectives are being met.

The only parameters which do not meet the Appendix E Water Quality Standards or Appendix C ANZECC sediment guidelines downstream of the discharge, are faecal coliforms and *E.coli*.

In turn, Policy 15B(2) requires Alliance demonstrate how, and by when adverse effects will be avoided, where practicable, and otherwise remedied or mitigated so that beyond the zone of reasonable mixing, water quality will be improved to assist with meeting the relevant standards in Appendix E. The proposed conditions do this by requiring a three stage upgrade to the wastewater treatment plant which will significantly reduce the *E.coli* and faecal coliform concentrations in the discharge. This will improve the water quality beyond the zone of reasonable mixing and assist with meeting the Appendix E water quality standards for those parameters.

Because the FMU process has not yet occurred, it is uncertain what the freshwater objectives, limits and timeframes for the Mataura FMU will be, and in turn, how Policy 15C will apply to this catchment. However, as outlined in Section 12.2.4, Alliance expects its contribution to catchment reductions in key contaminants to be more than proportional to the wider reduction achieved in the catchment, and also comparatively expedient.

Other policies which are particularly relevant to the Plant's discharges are Policies 14 and 16A which state:

Policy 14 – Preference for discharges to land

Prefer discharges of contaminants to land over discharges of contaminants to water, unless adverse effects associated with a discharge to land are greater than a discharge to water. Particular regard shall be given to any adverse effects on cultural values associated with a discharge to water.

Policy 16A – Industrial and trade processes that may affect water quality

Minimise the adverse environmental effects (including on the quality of water in lakes, rivers, artificial watercourses, modified watercourses, wetlands, tidal estuaries, salt marshes and groundwater) by requiring the adoption of the best practicable option to manage the treatment and discharge of contaminants derived from industrial and trade processes.

The directives in these policies are addressed in detail in Section 10 of this AEE, which addresses alternative methods for discharging the Plant's wastewater. For the reasons set out in Section 10, the continued discharge of wastewater to the Mataura River, but with significant treatment plant upgrade milestones within five and 15 years, is considered the best practicable option for managing the treatment and discharge of contaminants from the Plant. And in accordance with Policy 16A, the proposed conditions require this BPO to be adopted by the consent holder.

The expressed preference in Policy 14 for a discharge to land was considered in this options assessment process. However, for financial, practical and environmental reasons, neither a full nor partial discharge to land option was considered practicable.

12.7.4 Water Quantity

As required of it by the Freshwater NPS the Proposed Plan includes the following policy:

Policy B7 of the National Policy Statement for Freshwater Management 2014 (as amended in 2017)

1. When considering any application, the consent authority must have regard to the following matters:

(a) the extent to which the change would adversely affect safeguarding the life-supporting capacity of freshwater and of any associated ecosystem; and

(b) the extent to which it is feasible and dependable that any adverse effect on the life-supporting capacity of freshwater and of any associated ecosystem resulting from the change would be avoided.

The key point to note in respect of this policy is the conclusion in Section 7.3, that the effects of the proposed takes on instream flows will be limited to a minimal reduction in flows over a 100 m stretch of river, and in turn, that adverse effects on the life-supporting capacity of the Mataura River would be avoided.

The Proposed Plan also contains a relatively comprehensive suite of policies for managing the take and use of water. Those which are most relevant when considering the proposed take and use of water state:

Policy 20 – Management of water resources

Manage the taking, abstraction, use, damming or diversion of surface water and groundwater so as to:

1A. *recognise that the use and development of Southland's land and water resources, including for primary production, can have positive effects including enabling people and communities to provide for their social, economic and cultural wellbeing;*

1. *avoid, remedy or mitigate adverse effects from the use and development of surface water resources on:*

   (a) *the quality and quantity of aquatic habitat, including the life supporting capacity and ecosystem health and processes of waterbodies;*

   (b) *natural character values, natural features, and amenity, aesthetic and landscape values;*

   (c) *areas of significant indigenous vegetation and significant habitats of indigenous fauna;*

   (d) *recreational values;*

   (e) *the spiritual and cultural values and beliefs of tangata whenua;*

   (f) *water quality, including temperature and oxygen content;*

   (g) *the reliability of supply for lawful existing surface water users, including those with existing, but not yet implemented, resource consents;*

   (h) *groundwater quality and quantity;*

   (j) *mātaitai, taiāpure and nohoanga;*

   ...

3. *ensure water is used efficiently and reasonably by requiring that the rate and volume of abstraction specified on water permits to take and use water are no more than reasonable for the intended end use following the criteria established in Appendix O and Appendix L.4.*

Policy 21 – Allocation of water

Manage the allocation of surface water and groundwater by:

...

2. *determining that a waterbody is fully allocated when the total volume of water allocated through current resource consents and permitted activities is equal to either:*

   (a) *the maximum amount that may be allocated under the rules of this Plan, or*

   (b) *the provisions of any water conservation order;*

...

4. *when considering levels of abstraction, recognise the need to exclude takes for non-consumptive uses that return the same amount (or more) water to the same aquifer or a hydraulically connected lake, river, modified watercourse or natural wetland.*

Policy 42 – Consideration of water permit applications

When considering resource consent applications for water permits to take and use water:

1. *except for non-consumptive uses, consent will not be granted if a water body is over allocated or fully allocated; or to grant consent would result in a water body becoming over allocated or would not allow an allocation target for a water body to be achieved within a time period defined in this Plan; and*

2. *except for non-consumptive uses, consents replacing an expiring resource consent for an abstraction from an over-allocated water body will generally only be granted at a reduced rate, the reduction being proportional to the amount of over-allocation and previous use, using the method set out in Appendix O; and*

3. *installation of water measuring devices will be required on all new permits to take and use water and on existing permits in accordance with the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010; and*

...

5. *conditions will be specified relating to a minimum flow or level, or environmental flow or level regime (which may include flow sharing), in accordance with Appendix K, for all new or replacement resource consents (except for water permits for non-consumptive uses, community water supplies and water bodies subject to minimum flow and level regimes established under any water conservation order) for:*

   (a) surface water abstraction, damming, diversion and use; and

   (b) groundwater abstraction in accordance with Policy 23.

Policy 41 – Matching monitoring to risk

Consider the risk of adverse environmental effects occurring and their likely magnitude when determining requirements for auditing and supply of monitoring information on resource consents.

It is considered the proposed take and use of water at the Plant, in accordance with the proposed conditions set out in **Appendix 1**, sits comfortably with these provisions, noting that:

- As set out in Section 6, the take and use of water at the Plant facilitates significant positive benefits for the local community, and in accordance with Policy 20(1A), these are to be recognised when managing the take and use of surface water.
- The flow and allocation regime for the Mataura River is set in the Mataura WCO.
- The effects of the take on the matters in Policy 20(1) will be mitigated by the Plant returning almost all the water taken back to the Mataura River 100 m downstream of the hydro race discharge.

- In accordance with Policy 20(3) and Appendix O, Alliance commissioned an independent audit of its existing use of water at the Plant, and whether it is in accordance with rates and volumes sought and does not result in wastage or inefficient use of water. That assessment identified the use of raw river water for generation of white-water as a potential area where water use could be reduced (by approximately 2,000 m^3/day. The proposed conditions require this to be addressed over the first three years of the new consent term via implementation of a Resilience and Water Saving Strategy. This means the amount of water abstracted will be reasonable for the intended use and will be used efficiently.
- Alliance has not been able to obtain any information from Environment Southland confirming the allocation status of the Mataura River, and in turn it has assumed the River is not overallocated and that Policy 42(1) and (2) do not apply.
- In accordance with Policy 42(3), the current water measuring methodology is in accordance with the Resource Management (Measurement and Reporting of Water Takes) Regulations 2010.
- The Mataura River is subject to a minimum flow and level regime in the Mataura WCO, and in turn, no condition specifying a minimum flow or level is required in accordance with Policy 42(5). However, the proposed conditions do require Alliance to prepare and implement a low flow contingency plan to describe the practicable measures to be taken to minimise the abstraction of water during times when the flow of the Mataura River at the Tuturau recording site is less than 20 cubic metres per second.
- Monitoring of the water take is limited to the volume (cooling water) and rate (process water) of take which reflects the minimal risk of adverse environmental effects.

12.7.5 Consent Term

As set out in Section 1 of this AEE, Alliance has sought a term of 35 years for all the resource consents sought.

The Proposed Plan includes the following policy which is relevant when determining whether this consent term is appropriate:

> ***Policy 40 – Determining the term of resource consents***
>
> *When determining the term of a resource consent consideration will be given, but not limited, to:*
>
> 1. *granting a shorter duration than that sought by the applicant when there is uncertainty regarding the nature, scale, duration and frequency of adverse effects from the activity or the capacity of the resource;*
> 2. *relevant tangata whenua values and Ngāi Tahu indicators of health;*
> 3. *the duration sought by the applicant and reasons for the duration sought;*
> 4. *the permanence and economic life of any capital investment;*

5. *the desirability of applying a common expiry date for water permits that allocate water from the same resource or land use and discharges that may affect the quality of the same resource;*

6. *the applicant's compliance with the conditions of any previous resource consent, and the applicant's adaption, particularly voluntarily, of good management practices; and*

7. *the timing of development of FMU sections of this Plan, and whether granting a shorter or longer duration will better enable implementation of the revised frameworks established in those sections.*

In the context of Policy 40, the following matters would support the 35 year consent term sought:

- The activity is existing, and there is a high degree of certainty on the nature, scale, duration and frequency of its adverse effects on the environment (which are minimal) (clause 1).
- The significant capital investment involved in the proposed wastewater treatment plant upgrade will require and be contingent on securing a long consent term in order to enable the upgrades to be progressively implemented and allow the financial investment to be justified and secured over an appropriate timeframe (clauses 3 and 4).
- The Plant is a significant permanent asset with an insured value of $225 million (clause 4).
- Alliance has an excellent compliance record with the conditions of its existing consent to take and use water at the Plant (clause 6).
- The proferred conditions impose a requirement to make progressive upgrades to water use and treatment methods in a programmed way over the life of the consent, structured to be in step with the FMU process. A long-term consent which requires this long term and certain framework (and the significant improvements it requires) benefits Alliance and the wider community due to the certainty it provides. The proposed conditions also include provision for Environment Southland to review the consent for the purpose of complying with the requirement of a regional plan (which would include any new flow and allocation regime set for the Mataura River) (clause 5 and 7).

With respect to clause 2, Hokonui Runanga and TAMI have expressed a preference for the term of consent to be no more than 25 years.

12.7.6 Conclusion

Water quality downstream of the discharge will achieve the Proposed Plan's objectives.

The discharge causes levels of *E.coli*, Amm-N and TN to increase downstream of the mixing zone, and in the case of *E.coli* to also not meet the relevant water quality standards in Appendix E of the Proposed Plan. The Proposed Plan requires this application demonstrate how, and by when adverse effects will be avoided, where practicable, and otherwise remedied or mitigated so that beyond the zone of reasonable mixing water quality, will be improved to assist with meeting the relevant standards in Appendix E. The proposed conditions do this by requiring a three stage upgrade to the wastewater treatment plant which will significantly reduce the *E.coli* and faecal coliform concentrations in the discharge. This will improve the water quality beyond the zone of reasonable mixing and assist with meeting the Appendix E water quality standards for those parameters

The proposed discharge will be not contrary to the objectives and policies of the Proposed Plan, and there is nothing in the Proposed Plan which means the discharge applications cannot be granted on the terms sought.

12.8 TE TANGI A TAUIRA - THE CRY OF THE PEOPLE

In 2008, Te Tangi a Tauira: Ngāi Tahu ki Murihiku Natural Resource and Environmental Iwi Management Plan was published. This Iwi Management Plan consolidates Ngāi Tahu ki Murihiku values, knowledge and perspectives on natural resource and environmental management issues.

Of particular relevance when considering these consent applications are Ngā Kaupapa – policy in Te Tangi a Tauira which address:

- Wastewater disposal;
- Discharges to water;
- Water quality; and
- Water quantity.

12.8.1 Wastewater Disposal

Te Tangi a Tauira includes the following Ngā Kaupapa on wastewater disposal which are relevant to the proposed discharge of wastewater and cooling water:

> 2. *Ensure that Ngāi Tahu ki Murihiku are provided with the opportunity to participate through pre hearing meetings or other processes in the development of appropriate consent conditions for discharge consents, including monitoring conditions.*
>
> 3. *Require that sufficient and appropriate information is provided with applications to allow tangata whenua to assess cultural effects (e.g.*

nature of the discharge, treatment provisions, assessment of alternatives, actual and potential effects).

5. *Assess proposed wastewater discharge activities in terms of:*

    a. *type/ nature of the discharge;*

    b. *location and sensitivity of the receiving environment;*

    c. *cultural associations with location of operations;*

    d. *actual and potential effects on cultural values;*

    e. *available best practice technology;*

    f. *mitigation that can occur (e.g. using plants to filter waste, discharging at specific times to minimise impact, treatment options)*

    g. *community acceptability;*

    h. *cost*

6. *Avoid the use of water as a receiving environment for the direct, or point source, discharge of contaminants. Even if the discharge is treated and therefore considered "clean", it may still be culturally unacceptable. Generally, all discharge must first be to land.*

7. *Assess waste disposal proposals on a case by case basis, with a focus on local circumstances and finding local solutions.*

8. *Wastewater disposal options that propose the direct discharge of treated or untreated effluent to water need to be assessed by the kaitiaki rūnanga on a case by case, individual waterway, basis. The appropriateness of any proposal will depend on the nature of the proposal, and what waterway is involved. Individual waterways possess their individual mauri and values, and kaitiaki Rūnanga are in the best position to assess the potential impacts of a proposal on such values.*

9. *Encourage creative, innovative and sustainable approaches to wastewater disposal that make use of the best technology available, and that adopt principles of waste reduction and cleaner production (e.g. recycling grey water for use on gardens, collecting stormwater for a pond that can then be used for recreation in a new subdivision).*

10. *Require that the highest environmental standards are applied to consent applications involving the discharge of contaminants to land or water (e.g. standards of treatment of sewage).*

15. *Any discharge activity must include a robust monitoring programme that includes regular monitoring of the discharge and the potential effects on the receiving environment. Monitoring can confirm system performance, and identify and remedy any system failures.*

16. *Require that large scale wastewater disposal operations (e.g. town sewage schemes, industry) develop environmental management plans, including contingency plans to cope with any faults, breakdowns, natural disasters, or extreme weather events (e.g. cash bonds for liability).*

17. *Duration of consent for wastewater disposal must recognise and provide*

for the future growth and development of the industry or community, and the ability of the existing operations to accommodate such growth or development.

18. *Recommend a duration not exceeding 25 years, for discharge consents relating to wastewater disposal, with an assumption that upon expiry (if not before), the quality of the system will be improved as technological improvements become available. In some instances, a lesser term may be appropriate, with a condition requiring the system is upgraded within a specified time period.*
19. *Require conditions of consent that allow for a 5-year review of wastewater disposal activities. During review, consent holders should be required to consider technological improvements. If improvements are available, but not adopted, the consent holder should provide reasons why.*
20. *Encourage developers and consent applicants to provide site visits for tangata whenua representatives to observe proposed wastewater treatment systems. Site visits enable ngā rūnanga representatives to see what is proposed "on the ground".*

The key directives in these provisions were had regard to when assessing the effects of the proposed activities, and in determining how the effects of the activities should be avoided, remedied or mitigated through the proposed conditions.

In respect of these provisions, the following is noted:

- In accordance with Policy 2, Alliance has and continues to engage with TAMI and Hokonui Runanga on the development of appropriate, specific consent conditions for the discharge, including monitoring.
- In accordance with Policy 3, this AEE includes information on the nature of the discharge, treatment provisions, assessment of alternatives and actual and potential effects.
- All the matters listed in Policy 5 have been considered by Alliance in preparing this AEE, and in shaping the nature of the activities for which consent will be sought, including the mitigation measures set out in the proposed conditions.
- With respect to Policy 6, various options for discharging the Plant's wastewater were investigated but none is considered practicable here. The reasons for this include local circumstances regarding the suitability and availability of land which is recognised by Policy 7.
- Alliance recognises the role of Hokonui Runanga as tangata whenua and kaitiaki of the Mataura River and has, and continues to engage with Te Ao Marama and Hokonui Runanga in respect of the applications and how the effects of the activity should be managed (Policy 8).

- With respect to Policy 9, a robust assessment of alternative discharge options has been completed.
- In accordance with Policy 15, robust monitoring and reporting is required by the proposed conditions.
- In accordance with Policy 16, Alliance holds and will continue to hold various environmental management systems certifications.
- In accordance with Policy 18, the quality of the wastewater treatment system will be improved and the preference for a consent duration no more than 25 years is acknowledged. However, Alliance considers a longer consent duration is required here to allow the financial investment involved in the proposed wastewater treatment plant upgrade to be justified and secured over an appropriate timeframe. It is also relevant that a proposed upgrade timeline is structured to be in step with the FMU process for improving water quality in this catchment, and a long term consent which includes the long term and certain framework contained in the proposed condition (and the significant improvements it requires) benefits Alliance and the wider community due to the certainty of benefit it provides.
- In accordance with Policy 20, and as part of its ongoing engagement process, Alliance has invited representatives of TAMI and Hokonui Runanga on-site to observe the wastewater treatment system.

12.8.2 Discharges to Water

Te Tangi a Tauira includes the following Ngā Kaupapa on discharges to water:

1. *Avoid the use of water as a receiving environment for the direct, or point source, discharge of contaminants. Even if the discharge is treated and therefore considered "clean", it may still be culturally unacceptable. Generally, all discharge must first be to land. This general policy is a baseline or starting point. From this point, the Rūnanga can assess applications on a case by case basis.*
2. *Assess discharge to water proposals on a case by case basis, with a focus on local circumstances and finding local solutions.*
3. *Consider any proposed discharge activity in terms of the nature of the discharge, and the sensitivity of the receiving environment.*
4. *When existing rights to discharge to water come up for renewal, they must be considered in terms of alternative discharge options.*
5. *When assessing the alternatives to discharge to water, a range of values, including environmental, cultural and social, must be considered in addition to economic values.*
6. *Encourage the establishment of wetland areas, where practical, as an alternative to the direct discharge to water. Discharge to a wetland area allows Papatūānuku the opportunity to filter and clean any impurities.*

7. *Any discharge activity must include a robust monitoring programme that includes regular monitoring of the discharge and the potential effects on the receiving environment.*

8. *Require robust monitoring of discharge permits, to detect non-compliance with consent conditions. Noncompliance must result in appropriate enforcement action to discourage further non-compliance.*

9. *Promote the use of the Cultural Health Index (CHI) as a tool to facilitate monitoring of stream health, and to provide long term data that can be used to assess river health over time.*

10. *Ngāi Tahu ki Murihiku consider activities involving the discharge of contaminants to water a community issue. For this reason, ngā rūnanga may, where seen as appropriate, recommend that a consent application be notified.*

Particular regard was had to the key directives in these provisions when assessing the effects of the proposed activities, and in determining how the effects of the activities should be avoided, remedied or mitigated through the proposed conditions.

In respect of these provisions, the following is noted:

- In accordance with Policy 4, a robust assessment of alternative discharge options has been completed by PDP (2019) and an assessment of the best practicable option for treating and discharging wastewater from the Plant is contained in Section 10 of this AEE.
- In accordance with Policy 5, that assessment considered a range of values, including environmental, cultural and social values, in addition to economic values. As directed by Policy 3, it also considered the nature of the discharge, and the sensitivity of the receiving environment.
- With respect to Policy 1, various options for discharging the Plant's wastewater were investigated but none is considered practicable here.
- In accordance with Policies 7 and 8, robust monitoring and reporting is required by the proposed conditions.
- With respect to Policy 10, Alliance has consulted with the local community, including Te Ao Marama and Hokonui Runanga, on the proposed discharge activities and expects the applications to be publicly notified.

12.8.3 Water Quality

Te Tangi a Tauira includes the following Ngā Kaupapa on water quality which are relevant to the proposed activities:

1. *The role of Ngāi Tahu ki Murihiku as tangata whenua and kaitiaki of water must be recognised and provided for in all water quality*

management.

2. *Strive for the highest possible standard of water quality that is characteristic of a particular place/waterway, recognising principles of achievability. This means that we strive for drinking water quality in water we once drank from, contact recreation in water we once used for bathing or swimming, water quality capable of sustaining healthy mahinga kai in waters we use for providing kai.*

3. *Require cumulative effects assessments for any activity that may have adverse effects of water quality.*

5. *Avoid the use of water as a receiving environment for the direct, or point source, discharge of contaminants. Generally, all discharge must first be to land.*

7. *When assessing the effects of an activity on water quality, where the water source is in a degraded state, the effects should be measured against the condition that the water source should be, and not the existing condition of the water source (see text box on this page).*

10. *Water quality definitions, categories, and standards must be determined, measured, and assessed with cultural values and indicators alongside scientific information. Such indicators and values centre on the ability of the waterway to support life, and the fitness of water for cultural uses.*

11. *Require robust monitoring of discharge permits, to detect non-compliance with consent conditions. Noncompliance must result in appropriate enforcement action to discourage further non-compliance.*

Particular regard was had to the key directives in these provisions when assessing the effects of the proposed activities, and in determining how the effects of the activities should be avoided, remedied or mitigated through the proposed conditions.

In respect of these provisions, the following is noted:

- Alliance recognises the role of Hokonui Runanga as tangata whenua and kaitiaki of the Mataura River and has, and continues to engage with Te Ao Marama and Hokonui Runanga in respect of the applications (Policy 1).
- The preference in Policy 5 for a discharge to land is acknowledged, however for reasons outlined in Section 10 of this AEE, it is not practicable to do so here.
- With respect to Policies 2, 3 and 7, the technical assessments have identified that water quality in the Mataura River is degraded in respect of certain parameters, and the proposed conditions require a significant reduction in the Plant's contribution to the cumulative loading of key contaminants over the first 15 years of the new consent term.
- In accordance with Policy 11, robust monitoring and reporting is required by the proposed conditions.

12.8.4 Water Quantity

Te Tangi a Tauira includes the following Ngā Kaupapa on water quantity and abstractions which are relevant to the proposed activities:

1. *Adopt the precautionary principle when making decisions on water abstraction resource consent applications, with respect to the nature and extent of knowledge and understanding of the resource.*

3. *Require that scientifically sound, understandable, and culturally relevant information is provided with resource consent applications for water abstractions, to allow Ngāi Tahu ki Murihiku to fully and effectively assess cultural effects.*

6. *Encourage water users to be proactive and use water wisely. To encourage best practice and efficient use of water, particularly in terms of:*
   - *sustainable irrigation design, delivery and management;*
   - *making best use of available water before water levels get too low;*
   - *reducing the amount of water lost through evaporation by avoiding irrigating on hot windy days.*

7. *Consideration of consent applications for water abstractions should have particular regard to questions of:*
   a. *how well do we understand the nature and extent of the water resource;*
   b. *how well can we monitor the amount of water abstracted;*
   c. *whether land capability (e.g. soil type, vulnerability of underlying groundwater resources) matches the land use enabled by irrigation;*
   d. *what might happen in the future (e.g. rainfall and recharge of aquifers, climate change).*

9. *Applications for water abstractions may be required to justify the quantities of water requested. Information may need to be provided to Te Ao Mārama Inc. regarding the proposed water use per hectare, estimated water losses, stocking rates, and the level of efficiency for the scheme. This will enable iwi to put the quantity of water sought in context, and ensure that a test of reasonableness can be applied to consents.*

10. *Require catchment based cumulative effects assessments for activities involving the abstraction of water.*

16. *Encourage the installation of appropriate measuring devices (e.g. water meters) on all existing and future water abstractions, to accurately measure, report, and monitor volumes of water being abstracted, and enable better management of water resources.*

17. *Advocate for durations not exceeding 25 years on resource consents related to water abstractions.*

19. *Require that Ngāi Tahu are provided with the opportunity to participate through pre hearing meetings or other processes in the development of appropriate consent conditions including monitoring conditions to address our concerns.*

20. *Avoid adverse effects on the base flow of any waterway, and thus on the mauri of that waterway and on mahinga kai or taonga species.*

Particular regard was had to the key directives in these provisions when assessing the effects of the proposed activities, and in determining how the effects of the activities should be avoided, remedied or mitigated through the proposed conditions.

In respect of these provisions, the following is noted:

- The proposed take and use of water is a re-consenting of an existing activity and there is a high degree of certainty about the nature and scale of the resultant effects on the environment. The effects insofar as these matters are concerned will be negligible. Therefore, there is no need to apply the precautionary principle here (Policy 1).
- In accordance with Policy 3, this AEE includes scientifically sound and understandable information on the proposed activity and its effects (Policy 2).
- Of relevance to Policies 6 and 9 is the PDP audit of existing use of water at the Plant, which identified opportunities for further water saving. The proposed conditions require this to be addressed over the first three years of the new consent term via implementation of a Resilience and Water Saving Strategy. This means the amount of water abstracted will be reasonable for the intended use and will be used efficiently.
- Of relevance to Policies 7, 10 and 20, the cumulative effects of abstraction in the Mataura River, and effects on the base flow of the River, is managed by the flow regime set down in the Mataura WCO.
- The measuring devices appropriate for the water abstractions were recently deemed appropriate considering the nature of those activities (Policy 16).
- The preference in Policy 17 for a consent duration of no more than 25 years is acknowledged. However, Alliance considers a longer consent duration is required here to allow the financial investment involved in the proposed wastewater treatment plant upgrade to be justified and secured over an appropriate timeframe. It is also relevant that a proposed upgrade timeline is structured to be in step with the FMU process for improving water quality in this catchment, and a long term consent which includes the long term and certain framework contained in the proposed condition (and the significant improvements it requires) benefits Alliance and the wider community due to the certainty of benefit it provides.

- In accordance with Policy 19, Alliance has and continues to engage with TAMI and Hokonui Runanga on the development of appropriate consent conditions for the discharge, including monitoring.

13. STATUTORY ASSESSMENT

13.1 INTRODUCTION

This section of the AEE sets out the framework under the RMA that applies to the resource consents that are being sought from Environment Southland. It addresses:

- Section 104D which specifies that Environment Southland can only grant a non-complying activity consent in certain circumstances;
- Section 104 which specifies the matters Environment Southland must have regard to when considering an application for resource consent;
- Section 105 which specifies additional matters which must be considered by Environment Southland when considering the applications for discharge permits; and
- Section 107 which specifies that Environment Southland shall not grant a discharge permit if, after reasonable mixing, the contaminant or water discharged (either by itself or in combination with the same, similar, or other contaminants or water) is likely to give rise to certain effects in the receiving waters.

13.2 SECTION 104D

As outlined in Section 6 of this AEE, the discharge of wastewater is classified as a non-complying activity under the Operative and Proposed Plans because of its impact on downstream *E.coli* concentrations.

Section 104D of the RMA establishes restrictions on the ability of a consent authority to grant resource consents for non-complying activities. It states:

> *(1) Despite any decision made for the purpose of notification in relation to adverse effects, a consent authority may grant a resource consent for a non-complying activity only if it is satisfied that either—*
>
> *(a) the adverse effects of the activity on the environment (other than any effect to which section 104(3)(a)(ii) applies) will be minor; or*
>
> *(b) the application is for an activity that will not be contrary to the objectives and policies of—*
>
> *(i) the relevant plan, if there is a plan but no proposed plan in respect of the activity; or*
>
> *(ii) the relevant proposed plan, if there is a proposed plan but no relevant plan in respect of the activity; or*
>
> *(iii) both the relevant plan and the relevant proposed plan, if there is both a plan and a proposed plan in respect of the activity.*

The objectives and policies of the relevant statutory planning documents are identified and assessed in Sections 12.6 and 12.7 of this AEE. As is noted in those sections, the proposed activities will not be contrary to the objectives and policies of the relevant statutory planning documents. It is also concluded that in most circumstances the environmental effects of the proposed activities will be appropriately managed so that they sit comfortably with the outcomes sought by the objectives and policies in the relevant statutory planning documents.

As such, the requirements of Section 104D(1)(b) of the RMA are met. The resource consent applications can, therefore, be considered in the broader context in accordance with Section 104 of the RMA.

In light of the above, it is not necessary to form an overall conclusion as to whether the adverse effects of the proposed activities on the environment will be 'more than minor' in order to satisfy the first gateway test of Section 104D(1) of the RMA.

13.3 SECTION 104

Section 104 of the RMA identifies the matters that a consent authority must have regard to, subject to Part 2 of the Act, when considering an application for resource consent. It states:

> *(1) When considering an application for a resource consent and any submissions received, the consent authority must, subject to Part 2, have regard to–*
>
> > *(a) any actual and potential effects on the environment of allowing the activity; and*
> >
> > *(ab) any measure proposed or agreed to by the applicant for the purpose of ensuring positive effects on the environment to offset or compensate for any adverse effects on the environment that will or may result from allowing the activity; and*
> >
> > *(b) any relevant provisions of—*
> >
> > > *(i) a national environmental standard:*
> > >
> > > *(ii) other regulations:*
> > >
> > > *(iii) a national policy statement:*
> > >
> > > *(iv) a New Zealand coastal policy statement:*
> > >
> > > *(v) a regional policy statement or proposed regional policy statement:*
> > >
> > > *(vi) a plan or proposed plan; and*
> >
> > *(c) any other matter the consent authority considers relevant and reasonably necessary to determine the application.*
>
> *(2) When forming an opinion for the purposes of subsection (1)(a), a consent authority may disregard an adverse effect of the activity on the environment if a national environmental standard or the plan permits an activity with that effect.*

> *(2A) When considering an application affected by section 124 or 165ZH(1)(c), the consent authority must have regard to the value of the investment of the existing consent holder.*
>
> *(2B) ...*

Section 104 of the RMA does not give primacy to any of the matters to which a consent authority is required to have regard. All of the relevant matters are to be given such weight as the consent authority deems appropriate in the circumstances, and all matters listed in section 104(1) are subject to Part 2 of the RMA.

An assessment of the proposed activities against the relevant matters set out in Section 104 of the RMA is provided in the sections below.

13.3.1 The Actual and Potential Effects of Allowing the Activities

The actual and potential effects of allowing the activities are set out in Sections 6, 7 and 8 of this AEE.

The granting of consents enabling the continued operation of the Plant will maintain the economic wellbeing of people and communities within the Gore District and the Southland region by:

- Maintaining significant direct and indirect employment opportunities for local residents (the Plant employs approximately 500 people in the peak of the season);
- Maintaining significant direct and indirect wages and salaries for local residents (the Plant contributed approximately $22 million in wages and salaries for the 2017/2018 season);
- Maintaining significant levels of direct and indirect expenditure with local businesses;
- Maintaining population and economic activity levels within local communities, thereby maintaining the breadth and quality level of services available to local residents and businesses;
- Providing greater employment choice for local residents; and
- Continuing Alliance's contributions to local community activities, in its role as a responsible employer and "good corporate citizen".

Key points of relevance when considering the water takes are:

- Fish screens will be installed in all intakes which meet or exceed industry practice.
- The water taken for cooling purposes is returned to the water race immediately downstream of where it is taken.
- The process water take only reduces flow in the Mataura River for 100 m and is not considered to have any effect that is more than minor.

Key points of relevance when considering the discharge of cooling water and wastewater are:

- A comprehensive assessment of the effects of the discharge on the receiving environment has determined that no adverse effects trigger the need for immediate or urgent mitigation.
- The lower Mataura River contains high levels of *E.coli*, and the Plant's discharge significantly increases those levels in the receiving water downstream. However, because the level of pathogens in the discharge (which are of most concern when considering effects on human health) are much lower and more variable, the Plant's discharge does not cause a significant increase in health risk, and the risk of a person swimming below the Plant becoming ill due to the Plant's discharge is below 1%, which is considered an acceptable level. However, Alliance accepts it will need to reduce its levels of *E.coli* to improve water quality. And this will occur following installation of the UV treatment plant required by the proposed conditions, which is expected to reduce the *E.coli* levels in the Plant's wastewater discharge by more than 99%
- The Mataura River is degraded in terms of the nitrogen levels present, periphyton reflects moderate to high enrichment at times, and MCI and QMCI data are generally representative of fair to poor health. Toetoes Estuary also continues to degrade with extensive macroalgal growth driven by very high nutrient loads from the catchment. While there is no evidence suggesting the Plant's discharge has a direct adverse effect on these stressors downstream of the discharge, it does contribute a small portion to the overall loads of Amm-N and TN present downstream of the discharge.
- Alliance has acknowledged it will need to reduce its levels of Amm-N and TN over time as part of catchment-wide initiatives to improve water quality. And this will occur following installation of the biological treatment system required by the proposed conditions, which is expected to reduce the concentration of TN in the discharge by approximately 68% relative to present.

13.3.2 Measures Proposed to Offset or Compensate for Any Adverse Effects on the Environment

No measures are proposed to offset or compensate for any adverse effects on the environment. All adverse effects are addressed via avoidance, remediation and mitigation.

13.3.3 Relevant Provisions of the Planning Documents

The provisions of the relevant planning documents, and an assessment of how the proposed activities sit in relation to them is provided in Section 12 of this AEE.

Key points of relevance are:

- It is evident that implementing the Freshwater NPS is going to require an improvement in Mataura River water quality for some key contaminants, particularly nutrients and *E.coli.* The extent of the required improvement, how it will be achieved and the timeframes for achieving it, will be developed through the upcoming collaborative planning exercise required by the Freshwater NPS, and which Environment Southland expects to be completed by 2025.
- Alliance expect its contribution to catchment reductions in these key contaminants to be more than proportional to the wider reduction achieved in the catchment, and also comparatively expedient. Noting that experience from similar catchments in other parts of New Zealand (i.e. catchments with a high proportion of pastoral farming and nutrient enrichment), suggests any significant reduction in the contribution from diffuse sources will take some time.
- The discharge causes levels of *E.coli*, Amm-N and TN to increase downstream of the mixing zone, and in the case of *E.coli*, to also not meet the relevant water quality standards in Appendix G of the Operative Plan, or Appendix E of the Proposed Plan.
- The Operative Plan directs this type of discharge only be allowed where it is consistent with Part 2 of the RMA to do so, which, for reasons set out in Section 13.3.5, is the case here.
- The Proposed Plan requires this application demonstrate how, and by when adverse effects will be avoided, where practicable, and otherwise remedied or mitigated so that beyond the zone of reasonable mixing, water quality will be improved to assist with meeting the relevant standards in Appendix E. The proposed conditions do this by requiring a three stage upgrade to the wastewater treatment plant which will significantly reduce the *E.coli* and faecal coliform concentrations in the discharge. This will improve the water quality beyond the zone of reasonable mixing and assist with meeting the Appendix E water quality standards for those parameters.

In summary, the proposed activities undertaken in accordance with the proposed conditions are:

- Consistent with the requirements of the Freshwater NPS, and the Freshwater NPS provisions and its obligations on Environment Southland for managing the Mataura River do not provide a reason why the consents should not be granted as sought.
- Broadly consistent with the RPS, and will assist, rather than hinder, Environment Southland's efforts to implement it, particularly in respect of improving water quality.
- Not contrary to the objectives and policies of the Operative Plan or Proposed Plan, and there is nothing in the Operative Plan or Proposed Plan which means the discharge applications cannot be granted on the terms sought.

13.3.4 Value of Investment of the Consent Holder

When considering these applications, the consent authority must have regard to the value of the investment of Alliance which is reliant on the proposed activities.

That investment is considerable. The latest estimate (December 2018) for the Mataura Plant's insured value is $225 million, and much of this value is sunk – i.e. it could not be recovered if the plant was forced to downsize, close or be relocated.

13.3.5 Part 2

13.3.5.1 Section 5

The purpose of the RMA (section 5) is to promote the sustainable management of natural and physical resources. The Act defines "sustainable management" as:

> *"managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while—*
>
> *(a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
>
> *(b) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and*
>
> *(c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment."*

In practice, there are two general elements of "sustainable management" in the context of section 5 that must be considered when assessing the resource consent application. They are:

- Enabling people and communities to provide for their social, economic and cultural wellbeing; and
- Safeguarding environmental quality and avoiding, remedying or mitigating adverse effects.

Enabling people and communities to provide for their social, economic and cultural wellbeing

With respect to the likely implications of granting the consents as sought in terms of enabling people and communities to provide for their social and economic wellbeing, it is clear from the economic report in **Appendix 6** that the Plant plays an important role in the local economy, and is also an important part of the local community. The Plant provides substantial employment, both directly and indirectly, and provides important social context to the area. The Plant is totally reliant on being able to operate under the consents sought in this application, including the ability to take water from the Mataura River, and use it as a discharge medium. Not granting the resource consents as sought would place the ongoing operation of the Plant in question.

Safeguarding Life-Supporting Capacity

As set out in Sections 7 and 8, a comprehensive assessment of the effects of the proposed activities on the receiving environment by FWS/AES has determined that no adverse effects on the life-supporting capacity of the Mataura River and its ecosystems trigger the need for immediate or urgent mitigation.

The improvement in discharge quality as a result of the proposed wastewater treatment plant upgrade will also help contribute to a long-term improvement in the life-supporting capacity of the river, if that life-supporting capacity is currently being depressed by the high baseload of nutrients in the catchment.

Requirement of Avoid, Remedy or Mitigate

Section 5(2)(c) of the RMA requires that adverse effects of activities on the environment are "avoided, remedied or mitigated". It is not required that all effects be avoided, or that there is no net effect on the environment, or that all effects are compensated for in some way. Rather, section 5(2)(c) is about doing what is reasonably necessary, given the circumstances of the particular case, to lessen the severity of effects. Some flexibility is necessary when exploring mitigation measures that can be used to reduce the impact of adverse effects, to ensure that the mitigation itself is sustainable.

The ongoing approach used in relation to avoiding, remedying or mitigating the effects of the Plant, set out in Section 9 and summarised in Section 9.4, is consistent with these principles.

13.3.5.2 Sections 6, 7 and 8

Sections 6, 7 and 8 of the RMA set out the principles to be applied in achieving the purpose of the Act. With respect to the principles contained in sections 6, 7 and 8 of the RMA:

- They are subordinate to the overriding purpose of the Act, as set out in section 5.
- Each plays a part in the overall consideration of whether the purpose of the Act has been achieved in a particular situation.
- They are not an end in themselves, but an accessory to the principal purpose.

With respect to section 6, which contains matters of national importance that shall be recognised and provided for, other than section 6(e) and section 6(g) that relate to Maori values and which are addressed below, it is considered only section 6(a), which addresses the *preservation of the natural character of the coastal environment (including the coastal* *marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development* is expressly relevant.

With respect to section 6(a), the natural character of the Mataura River has been impacted by many agricultural, industrial, urban and drainage uses. The FWS/AES report has also concluded that the discharge does not adversely impact on water quality parameters likely to have an aesthetic impact. The use of the Mataura River by the Plant is not considered to be inappropriate in this context. It is also noted that section 6(a) does not extend to the reinstatement or enhancement of the environment relative to its current state.

Section 7 contains other relevant matters to which particular regard must be given. Several of these are relevant to this application; notably section 7(b), the efficient use of natural and physical resources; section 7(c), the maintenance and enhancement of amenity values; section 7(d), intrinsic values of ecosystems; section 7(f), maintenance and enhancement of the quality of the environment; and section 7(h), the protection of the habitat of trout and salmon.

With respect to section 7(b), the economic assessment has identified a number of reasons why the continued use of the Plant represents an efficient use of natural and physical resources. The Plant is existing, and there is significant investment costs in the location and equipment at the site; the Plant has access to a skilled labour force of sufficient scale to ensure that it operates effectively; the Plant is appropriately located to receive livestock that is within the immediate and surrounding area; and the Plant has appropriate infrastructure support including access to road and rail networks.

The continued operation of the Plant in accordance with the proposed consent conditions would maintain amenity values and the quality of the environment, in accordance with sections 7(c) and 7(f). The intrinsic values of the ecosystems which section 7(d) requires particular regard be had, were considered by the various technical assessments when assessing the effects of the proposed activities. Finally, with respect to section 7(h), it is clear that the water quality within the Mataura River downstream of the Plant is suitable for trout.

Maori Relationship/Kaitiakitanga/Treaty Principles

With respect to the sections within Part 2 that relate to tangata whenua, the Mataura River and adjacent land, including the Mataura Falls in the immediate vicinity of the Plant, has high cultural significance for tangata whenua.

Alliance recognises and values the role of Hokonui Runanga as tangata whenua and kaitiaki of the Mataura River and has and continues to engage with Te Ao Marama and Hokonui Runanga in respect of the applications, and how the effects of the activity could be avoided, remedied or mitigated.

The views expressed thus far have fed into Alliance's work assessing the effects of the proposed activities and in determining how the effects of the activities should be managed through the proposed conditions, including its consideration of alternative discharge methods. As have the key directives in Te Tangi a Tauira – the relevant iwi management plan.

It is intended that through this ongoing engagement process, appropriate mechanisms will be identified which provide for sections 6(e), 7(a) and 8 matters in relation to the ongoing operation of the Plant.

13.3.5.3 Summary

After considering all the relevant matters under Part 2 and section 104, granting the resource consents with appropriate conditions would promote the purpose of the Act and would constitute sustainable management of natural and physical resources for the following reasons:

- It allows the use of natural and physical resources in a way which enable people and the community to provide for their social, cultural and economic wellbeing; and
- It safeguards the life-supporting capacity of air, water and soil, and ensures that adverse effects are appropriately avoided, remedied or mitigated.

13.4 SECTION 105

Section 105 of the RMA sets out additional matters which must be considered by a consent authority when considering an application for a discharge permit. Section 105(1) of the RMA states:

> *"If an application is for a discharge permit or coastal permit to do something that would controvene section 15 or section 15B, the consent authority must, in addition to the matters in section 104(1), have regard to—*
>
> *(a) the nature of the discharge and the sensitivity of the receiving environment to adverse effects; and*
>
> *(b) the applicant's reasons for the proposed choice; and*
>
> *(c) any possible alternative methods of discharge, including discharge into any other receiving environment.*

These matters are addressed in detail in Section 10, which outlines why the proposed discharge method represents the best practicable option.

13.5 SECTION 107

Sections 107(1)(a) and (b) of the RMA specify that the consent authority shall not grant a discharge permit allowing the discharge of water / contaminant into water or land if, after reasonable mixing, the contaminant or water discharged (either by itself or in combination with the same, similar, or other contaminants or water), is likely to give rise to all or any of the following effects in the receiving waters:

- The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
- Any conspicuous change in the colour or visual clarity;
- Any emission of objectionable odour;
- The rendering of fresh water unsuitable for consumption by farm animals; and
- Any significant adverse effects on aquatic life.

As is outlined in Section 8, neither the discharge of wastewater nor cooling water gives rise to any of these effects in the receiving waters.

14. CONCLUDING STATEMENT

This AEE is in support of applications to 're-consent' the following existing activities such that the Plant can continue to operate and contribute in a major way to the social and economic wellbeing of the surrounding community:

- The take and use of water for cooling and processing purposes;
- The discharge of cooling water; and
- The discharge of wastewater.

The proposed conditions require a substantial staged upgrade of the Plant's wastewater treatment plant to improve the quality of the Plant's discharge to the Mataura River, and a reduction in water use. These will be significant capital investments and will add significant annual costs to the wastewater plant's operation.

Alliance is seeking a 35 year consent term for all replacement consents being sought. A 35 year consent term suitably recognises the existing asset value of the Plant and the significant economic contribution it provides to the Southland Region. The significant capital investment involved in the proposed wastewater treatment plant upgrade will also require, and be contingent on, securing a long consent term in order to enable the upgrades to be progressively implemented, and allow the financial investment to be justified and secured over an appropriate timeframe.

An assessment of the potential effects of the proposal on the environment is provided in Sections 6 to 8 of this AEE, as well as the various technical assessments commissioned by Alliance. By way of summary, it is considered that the project can be undertaken in a manner that appropriately avoids, remedies or mitigates adverse effects on the environment.

With respect to the statutory planning framework that applies to the applications, it is concluded that the development of the project in the manner proposed by Alliance will for the most part align comfortably with the overall management intentions specified in the relevant national and regional planning documents. The proposed activities will not be contrary, or repugnant, to any of the relevant statutory planning documents.

Finally, it is noted that Alliance has consulted with interested / potentially affected parties with respect to these applications. This consultation has informed the various environmental assessments and will continue throughout the resource consent process and during the subsequent operation of the Plant.

1

APPENDIX 1

Proposed consent conditions

Proposed Conditions:	Take and Use Cooling Water
1	This consent authorises the taking of up to 21,200m³/day from a water race fed by the Mataura River, for the purpose of supplying engine room cooling water and engine room condenser water.
2	The consent holder shall monitor the volume of water taken each day and supply an electronic record of the daily take for the previous production season to the Council by 31 October each year. *Advice Note: An acceptable method of monitoring the volume of water taken each day is by combining the records of pump capacities and pump operation*
3	Within two years of the commencement of this consent, the Consent Holder shall be required to ensure all intake structures operated in accordance with this consent are fitted with a 2 – 3mm screen mesh and that screen is maintained in good working order throughout the remaining life of this consent.

Proposed Conditions:	Take and Use Process Water
1	This consent authorises the taking of up to 8,000 m³/day from a water race fed by the Mataura River, for the purposes of Plant operations including but not limited to cleaning, potable water, and processing activities.
2	The Consent Holder shall monitor the volume of water taken each day and supply an electronic record of the daily take for the previous production season to the Consent Authority by 31 October each year.
3	a) The Consent Holder shall be required to maintain: i. a water meter at the locations shown in Map A to record the water taken for the specified purposes, within an error accuracy range of +/-5% over the meter's nominal flow range, ii. a datalogger with at least 12 months data storage capacity to record daily water use iii. a telemetry unit to report the water take at least once per day iv. record the rate and volume of take for the nominated purposes, and the date and time this water was taken. b) Each water meter shall be installed in a location with straight length of pipe either side of the water meter. i. On the upstream side there shall be a length of straight pipe that is 10 times the diameter of the pipe, and on the downstream side there shall be a length of straight pipe that is 5 times the diameter of the pipe. ii. The meter location shall be easily accessible, and, within the distances specified in (i), the straight length of pipe shall have no fittings and obstructions in it. c) Each water meter shall be verified for accuracy within the first year of its operation,

and thereafter once every five years.

i. Each verification shall be undertaken by a Consent Authority approved operator.

ii. A Water Measuring Device Verification Form shall be completed and supplied to the Consent Authority with receipts of service within five working days of the verification.

d) The Consent Holder shall ensure the full operation of the water meter and datalogger at all times during the exercise of this consent. All malfunctions of the water meter and/or datalogger during the exercise of this consent shall be reported to the Consent Authority within five working days of observation and appropriate repairs shall be performed within five working days. Once the malfunction has been remedied, a Water Measuring Device Verification Form completed with photographic evidence must be submitted to the Consent Authority within five working days of the completion of repairs.

The Consent Holder shall record adequate data to demonstrate compliance with this condition. Data from the datalogger shall be provided once daily to the Consent Authority by means of telemetry. The Consent Holder shall ensure data is compatible with the Consent Authority's time-series database.

3	The Consent Holder shall comply with the low flow contingency plan included as Attachment 1 to this consent. *Advice note: The low flow contingency plan describes the practicable measures to be taken by the Consent Holder to minimise the abstraction of water during times when the flow of the Mataura River at the Tuturau recording site is less than 20 cubic metres per second.*
4	Within two years of the commencement of this consent, the Consent Holder shall be required to ensure all intake structures operated in accordance with this consent are fitted with a 2 – 3mm screen mesh and that screen is maintained in good working order throughout the remaining life of this consent.

Proposed Conditions: Discharge of Wastewater to the Mataura River

Discharge Volume

1 This resource consent authorises the discharge of up to 8,000m^3/day of treated wastewater from a meat processing plant into the Mataura River at the location specified above.

Pre Upgrade Discharge Limits

2 Following the commencement of this consent, the following limits apply to the treated wastewater prior to its discharge into the Mataura River:

Parameter	**Limit**
Ammoniacal Nitrogen	Shall not exceed a maximum of 50 g/m^3 and consistently maintained at <30 g/m^3
cBOD5 Load	Shall not exceed a maximum of 3,500 kg/day
cBOD5	Shall not exceed a maximum of 300 g/m^3
Total Suspended Solids	Shall not exceed a maximum of 200g/m^3 and consistently maintained at <100 g/m^3
Total Kieldahl nitrogen	Shall not exceed a 12 month rolling median of 60 g/m^3 and 95^{th} %ile of 80 g/m^3
Total Phosphorous	Shall not exceed a 12 month rolling median of 5.5 g/m^3 95^{th}%ile of 10 g/m^3
Dissolved Reactive Phosphorus	The total load of dissolved reactive phosphorus discharged to the river shall not exceed 14.4 kg/day
The limits for Ammoniacal Nitrogen and Total Suspended Solids shall be "consistently maintained" if not less than four results out of each set of five meet the lesser specified value, when a set of five results is obtained in accordance with the EMP.	

3 In the event one or more of the limits set out in conditions 2 or 13 is exceeded, the Consent Holder shall resample and/or retest that parameter as soon as practicable. In circumstances where one or more of the limits set out in conditions 2, 5 and 10 are exceeded on two consecutive sampling occasions and these results are confirmed exceedances, the Consent Holder shall report to the Consent Authority in accordance with condition 21

4 The Consent Holder shall ensure that the annual load of total nitrogen measured in the discharge between 1 October and 30 September does not exceed 60 tonnes. In circumstances where this total annual load is exceeded, the Consent Holder shall report to the Consent Authority in accordance with Condition 21.

5 No more than 780 tonnes of total nitrogen may be discharged in the wastewater prior to the wastewater treatment plant upgrade required by condition 12 being commissioned.

Advice note: This is equivalent to 52 tonnes per year being discharged over the 15 year period before the wastewater treatment plant upgrade is required.

Resilience and Water Saving Strategy

6 Within six months of the commencement of this consent, the Consent Holder shall prepare and submit to the Consent Authority a Resilience and Water Saving Strategy. The purpose of the Strategy shall be to identify:

a) measures to avoid potential intermittent cross contamination points between the Green and Non-Green waste streams and potential failure points within the reticulation system; and

b) methods to enable the recycling of white water within the wastewater treatment plant to reduce the total volume of wastewater discharged to the Mataura River to the extent that can be reasonably achieved:

i. without increasing the total contaminant load within the discharge when measured on a daily basis when assessed against the limits in Condition 2; and

ii. without giving rise to unforeseen adverse toxicity and eutrophication effects on aquatic organisms within the mixing zone and downstream.

This Strategy shall include:

c) The new contaminant concentration limits to be applied to meet this obligation (acknowledging that the volume of the discharge is reduced meaning that the proportion of contaminant load to discharged volume will be higher within the discharged waste stream); and

d) A review by a suitably qualified and experienced ecologist which assesses the effects of the discharge in order to confirm that the newly set contaminant limits for the discharge will not give rise to unforeseen adverse toxicity and eutrophication effects on aquatic organisms within the mixing zone and downstream.

7 Within three years of the commencement of this consent, the Consent Holder shall implement the measures described in the Resilience and Water Saving Strategy. Once implemented and trialling of the new system is complete, the consent holder shall commission a review by a suitably qualified and experienced ecologist to assess the effects of the discharge in order to confirm that the newly set contaminant limits within the discharge are not giving rise to unforeseen adverse toxicity and eutrophication effects on aquatic organisms within the mixing zone and downstream.

Disinfection Treatment

8 Within five years of the commencement of this consent the Consent Holder shall install equipment to disinfect the process wastewater discharged from the site in order to inactivate pathogens. Following installation of the disinfection equipment the discharged wastewater shall not exceed an annual median of 1000 colony forming units (cfu) per 100 ml and 95th percentile of 10,000 cfu/100mL.

Wastewater Treatment Upgrade Plan

9 Within five years of the commencement of this consent the Consent Holder shall prepare and submit to the Consent Authority a Wastewater Treatment Upgrade Plan. This plan shall identify the technology and wastewater treatment plant upgrades necessary to improve the quality of the wastewater discharged to the Mataura River in order to meet the standards and limits specified in condition 13.

10 The Wastewater Treatment Upgrade Plan shall include, but not be limited to, the following matters:

a) A description of the proposed technology and wastewater plant upgrades to be installed;

b) A description of the methodology of how the wastewater plant upgrades will be installed and a staged work plan describing the timing associated with the progressive implementation of these works;

c) The monitoring and reporting obligations associated with the wastewater treatment plant upgrades.

11 Once the Wastewater Treatment Upgrade Plan has been prepared and submitted to the consent authority, the Consent Holder shall commence reporting to the Consent Authority on a bi-annual basis to identify its progress towards implementation and commissioning of the wastewater treatment plant upgrade. This reporting shall describe any interim measures undertaken to improve the quality of the discharge, or physical plant works or operational changes associated with the upgrade.

12 The Consent Holder shall ensure that the Wastewater Treatment Plant Upgrade prescribed in the Wastewater Treatment Upgrade Plan is fully commissioned and operational no later than 15 years from the commencement of this consent.

13 No later than 15 years following the commencement of this consent the Consent Holder shall ensure that the treated wastewater discharged to the Mataura River complies with the following:

Parameter	Limit
Ammoniacal Nitrogen	Shall not exceed a rolling 12 month median of 5 g/m^3 and 95th percentile of 10g/m^3
cBOD5 Load	Shall not exceed a maximum of 3,500 kg/day
cBOD5	Shall not exceed a rolling 12 month median of 50 g/m^3 and 95th percentile of 100 g/m^3
Total Suspended Solids	Shall not exceed a rolling 12 month median of 40 g/m^3 and 95th percentile of 80 g/m^3
Total nitrogen	Shall not exceed a rolling 12 month median of 20 g/m^3 and 95th percentile of 40 g/m^3
Total Phosphorous (concentration)	Shall not exceed a rolling 12 month median of 5 g/m^3 95th percentile of 10 g/m^3
Dissolved Reactive Phosphorus	The total load of dissolved reactive phosphorus discharged to the river shall not exceed 14.4 kg/day
E. coli	95th percentile of 1,000 cfu/100 ml

14 Once the upgraded Wastewater Treatment Plant required by conditions 9 – 12 has been commissioned and fully operational for 12 months, the Consent Holder shall ensure that the annual load of total nitrogen measured in the discharge between 1 October and 30 September does not exceed 25 tonnes. In circumstances where this total annual load is exceeded, the Consent Holder shall report to the Consent Authority in accordance with Condition 22.

15 Once the upgraded Wastewater Treatment Plant required by conditions 9 - 12, has been commissioned and has been fully operational for twelve months, the Consent Holder shall engage an appropriately qualified and independent expert to review the post upgrade limits set out in condition 13. The purpose of this review shall be to determine whether these limits are appropriate for the purposes of maintaining and enhancing water quality in the Mataura River and the review shall include:

(a) An evaluation of the monitoring results with regard to these limits

(b) A review of relevant guidelines or standards for these parameters applicable at the date of the review, and other catchment wide improvements relating to water quality.

A copy of this review shall be provided to the Consent Authority. The Consent Holder's obligations to undertake this review and the associated reporting process shall be completed within six months after being initiated. If this review recommends that amendments to these limits are necessary, then the Consent Authority may initiate a formal review of the post upgrade limits for these parameters.

Instream Limits

16 The discharge shall not directly result in any of the following below the zone of reasonable mixing:

a. A change in the natural water temperature by more than 3 degrees Celsius:

b. The acidity or alkalinity of the waters as measured by the pH to not be within the range of 6.0 or 9.0:

c. The waters being tainted so as to make them unpalatable following treatment, nor must they contain toxic substances to the extent that they are unsafe for consumption by humans or farm animals, nor must they emit objectionable odours:

d. The destruction of natural aquatic life by reason of a concentration of toxic substances:

e. A conspicuous change in the natural colour and clarity of the waters:

f. The oxygen content in solution in the waters being reduced below 5 milligrams per litre.

For the purposes of this condition the mixing zone shall extend 250 metres downstream of the outfall

Environmental Monitoring Plan

17 No later than six months from this consent commencing the Consent Holder shall prepare and submit to the Consent Authority an Environmental Monitoring Plan (EMP) for certification.

The purpose the EMP shall be to describe the methods for monitoring the physical characteristics and water quality parameters of the discharge, and the physical, water quality and biological characteristics and parameters of the Mataura River receiving waters as prescribed by this consent.

The objectives of the EMP are to:

a. Confirm compliance with consent limits on discharge quality;

b. Understand the effects of the discharge on Mataura River water quality and instream ecology and confirm no unexpected effects are arising as a result of the exercise of this consent

The EMP shall include but not be limited to:

c. The inclusion of a description and maps identifying the monitoring sites;

d. A description of the methods and appropriate timing for undertaking the following monitoring requirements:

   i. Discharge stream monitoring

   ii. Receiving water quality monitoring

   iii. Ecological instream monitoring

   iv. Fish health monitoring

e. The reporting requirements associated with any monitoring undertaken in accordance with these conditions.

---

18 The EMP, as a minimum, shall provide for the following monitoring requirements:

a. maintenance of records of the times and volumes of treated wastewater discharged on each day the permit is exercised;

b. representative weekly samples of the treated wastewater at the point of discharge for the following parameters:

Parameter
Enumerate E.coli
Temperature
pH
Total Kieldahl nitrogen
Ammoniacal nitrogen
Total nitrogen
Total suspended solids
Total phosphorous
Dissolved reactive phosphorous
Carbonaceous BOD5

c. representative weekly samples of receiving water quality both upstream and downstream of the point of discharge while a discharge is occurring for the following parameters:

Parameter
Enumerate E.coli
Temperature
pH
Dissolved oxygen concentration and saturation
Nitrate nitrogen
Total Kieldahl nitrogen
Ammoniacal nitrogen
Total nitrogen
Total suspended solids
Total phosphorous
Dissolved reactive phosphorous
Carbonaceous BOD5

d. Ecological monitoring to understand the effects of the discharge including by monitoring the periphyton and benthic invertebrate communities of the Mataura River at points above and below the point of the discharge.

e. A fish health monitoring survey.

19 The monitoring of the discharge and receiving environment shall be undertaken at the locations and frequencies specified in the EMP. All monitoring shall be undertaken using methods and standards agreed to the Consent Authority (as outlined in the EMP required to be prepared in accordance with Condition 17) and all water samples shall be collected using laboratory supplied containers.

20 The EMP shall be reviewed by the Consent Holder at five yearly intervals. The purpose of this review shall be to confirm that it accurately reflects current on-site activities and operations and to identify if changes to procedures contained within the EMP are required. The results of the review shall be reported to the Consent Authority within 30 working days of the review being undertaken. If the review results in amendments to the EMP, the amended sections shall be provided to the Consent Authority for certification at this time.

Reporting

21 The results of the sample analysis for each five week period shall be provided to the Consent Authority within two weeks of the receiving the all of the laboratory results for that period, unless otherwise agreed with the Consent Authority.

22 When any condition of this consent requires notification of an exceedance under this condition, the Consent Authority shall be notified within 24 hours of the confirmation of any exceedance of a limit prescribed by the conditions of this consent. This notification shall include advice of any corrective actions taken by the Consent Holder. An incident report shall be provided to the Consent Authority within twenty working days of the notification of the exceedance. This report shall include:

(a) Identification of the likely cause of the limit exceedance;

(b) The resulting effects on the receiving environment likely to arise because of the limit exceedance;

(c) The management responses undertaken or which may be necessary to prevent any further limit exceedances occurring;

(d) Remedial action undertaken or which may be necessary.

23 On an annual basis the Consent Holder shall prepare and submit an Annual Monitoring Report to the Consent Authority. The report shall cover the 1 October to 30 September period and shall be provided to the Consent Authority by 30 November each year. The annual report shall include, but not be limited to the following information:

(a) presentation and summary of all wastewater and receiving water monitoring results and biological monitoring as required by this consent, including any recommendations for improved monitoring

(b) the identification of any recorded non-compliances with consent standards and the measures taken to ensure compliance is achieved.

(c) assessment of the effects of the discharge on river water quality and periphyton and benthic invertebrate communities.

Technical Working Party

24 The Consent Holder shall facilitate the continuation of the Mataura Wastewater Technical Working Party (TWP) and shall distribute the annual monitoring report described in condition 23 to the members of the working party. The purpose of the TWP shall be to receive reports, review results and initiate meetings as required.

25 The TWP shall comprise representatives from:

a) The Consent Holder

b) The Southland Fish and Game Council

c) The Department of Conservation

d) Te Ao Marama Incorporated

e) Hokonui Runanga

f) Public Health South

g) Gore District Council

h) Consent Authority

The Consent Holder shall be responsible for convening meetings, the provision of a venue for meetings and providing any necessary administrative support to the TWP.

Should any of the external parties referred to in this condition chose not to continue to be part of the TWP then the Consent Holder shall not be deemed to be in breach of these conditions.

Review

26 In accordance with section 127 of the Resource Management Act 1991, the Consent Holder may, within two years of the commissioning of the Wastewater Treatment Plant Upgrade undertaken pursuant to condition 12 apply to change or cancel the conditions of this consent to reflect the measured performance and ongoing monitoring and reporting obligations associated with the Wastewater Treatment Plant Upgrade.

27 The Consent Authority may, within three months of receiving a report required by condition 22 of this consent, serve notice on the Consent Holder under section 128 of the Resource Management Act 1991 of its intention to review the conditions of this consent. The purpose of such a review is to assess the significance of any exceedance of the discharge limits set out in conditions 2, 4, 5, 13 or 14 and/or to determine whether the limits should be altered with particular regard had to the reporting undertaken in accordance with conditions 22 or 23, or whether the exceedance has resulted in significant adverse effects needing urgent redress.

28 The Consent Authority may, within three months of receiving the report required by Condition 23 of this consent, serve notice on the Consent Holder under section 128 of the Resource Management Act 1991 of its intention to review the conditions of this consent. The purpose of this review shall be to address any issues identified in the annual reporting.

Proposed Conditions:	Discharge of Cooling Water to the Mataura River
1	This consent authorises the discharge of up to 21,200m^3/day of cooling and condenser water to a water race which discharges to the Mataura River.
2	The Consent Holder shall measure the temperature and the oxygen content of the water in the water race upstream and downstream of the point of discharge once per week when the flow of the Mataura River at Tuturau monitoring site is less than 40 cubic metres per second. The Consent Holder shall report the results of weekly temperature and dissolved oxygen (DO) monitoring for the previous production season to the Council by 31 October each year.
3	The discharge shall not directly result in any of the following below the zone of reasonable mixing: a. A change in the natural water temperature by more than 3 degrees Celsius: b. The acidity or alkalinity of the waters as measured by the pH to not be within the range of 6.0 or 9.0: c. The waters being tainted so as to make them unpalatable following treatment, nor must they contain toxic substances to the extent that they are unsafe for consumption by humans or farm animals, nor must they emit objectionable odours: d. The destruction of natural aquatic life by reason of a concentration of toxic substances: e. A conspicuous change in the natural colour and clarity of the waters: f. The oxygen content in solution in the waters being reduced below 5 milligrams per litre. For the purposes of this condition the mixing zone shall extend 250 metres downstream of the wastewater outfall

2

APPENDIX 2

Assessment of the Effects of Alliance Mataura's Discharges and Water Take on Mataura River and Toetoes Estuary,

Freshwater Solutions and Aquatic Environmental Sciences, 2019.

report

May 2019

Assessment of the Effects of Alliance Mataura's Discharges and Water Take on Mataura River and Toetoes Estuary

Submitted to:
Alliance Group Ltd

fresh water solutions
environmental consultants

Quality Assurance

This report has been prepared and reviewed by the following:

Prepared by:	Richard Montgomerie Freshwater Ecologist and Director		
	Nick Carter Freshwater Ecologist		
	Mike Fitzpatrick Environmental Scientist		
Reviewed by:	Mark James Aquatic ecologist		
Status:	Final	**Issued:**	16 May 2019

freshwater solutions

tauranga office
117 Willow st tauranga 3141
po box 13507
p: 07 5771700 f: 07 5771702

auckland office
level 1/building 8, 666 great south road, ellerslie
po box 109640, Newmarket, Auckland 1149
p: 09 5224492

www.freshwatersolutions.co.nz

Executive Summary

The Alliance Mataura Plant (the Plant) is located on the Mataura River at the Mataura township approximately 44 km upstream of the Toetoes Estuary. Alliance Group Limited (Alliance) is seeking to lodge applications for the renewal of treated wastewater discharge, cooling water discharge and water take resource consents for the Plant. This report assesses the effects of the current and ongoing discharges and take.

The Wastewater Characteristics

The processing season typically starts in October and ends in September with a short 'off season' between late September and mid-late October. Removal of sheep and lamb processing in September 2012 resulted in a significant reduction in water use and potential contaminant loads in the treated wastewater. *Micoplasma bovis* increased the number of cattle being processed in the 2017–2018 season and current season (Doyle Richardson pers. comm.) contributing to an increase in the total volume and total load, total suspended solids, biological oxygen demand, total kjeldahl nitrogen and total phosphorus loads and total phosphorus and dissolved reactive phosphorus concentrations in the current season compared previous seasons. Changes to wastewater solids processing may have also contributed to changes.

Overall Alliance achieved a very high (near 100%) compliance with its treated wastewater discharge consent limits. One or two BOD non compliances were recorded each year and the ammoniacal-nitrogen limit of 'consistently maintain' < 30 g/m^3 was not met in one five-week period between February 2015 and March 2015.

Results reported by Dada (2019a) showed a very high concentration of *E.coli*, up to 10^7 CFU/100mL in the discharge, but that the levels of the representative pathogens which are known to cause illness were very much lower and more variable.

River Water Quality Effects

The mixing zone has been estimated as approximately 100 m from the discharge. The existing consent conditions set the mixing zone at Mataura Bridge (330 m downstream), where full mixing is highly likely to have occurred.

There is no apparent effect of the discharge on river temperature or dissolved oxygen at the Mataura Bridge Site. River water temperature both upstream and downstream of the discharge exceeded the upper lethal temperature limit for the mayfly *Deleatidium* sp. (< 23 °C) over a period of days in January 2018. The continuous January–March 2019 river water temperature record in the hydro-race was not available at the time of preparing this report. The upstream temperature close to Site U2 reached 21.8 °C on 6 March 2019 and was close to the upper lethal temperature limit for *Deleatidium* sp.

Continuous dissolved oxygen results 13 km downstream of the discharge Chalmers Road between 2013 and 2017 indicated the attribute state was B or greater. Continuous dissolved oxygen results 1.2 km upstream and 13 km downstream of the discharge at Chalmers Road in January 2018 indicated the National Policy Statement – Freshwater Management attribute state was B and B upstream and downstream for the 7-day minimum and 1-day minimum respectively. Continuous dissolved oxygen results in February and March 2019 indicated the attribute state was B and B upstream and A and A downstream.

The discharge does not adversely affect pH, turbidity, total suspended solids, colour, clarity or the generation of foams or scums.

Biological oxygen demand concentrations were below the guideline of <2 g/m³ for avoiding nuisance heterotrophic growths and hence, effects on aquatic biota, or the formation of heterotrophic growths, immediately downstream of the discharge due to biological oxygen demand are not anticipated. Regular visual observations during summer low flow conditions by Alliance staff between 2013 and 2018 have not recorded sewage fungus. A small amount of sewage fungus was observed at Site D1, with the aid of an underwater viewer, during the March 2019 periphyton and benthic invertebrate survey but was not assessed as conspicuous

The change from ammoniacal nitrogen National Policy Statement – Freshwater attribute state A, upstream, to B, downstream, is a change from a 99% species protection level to a 95% species protection level, i.e., 5% of the most ammoniacal nitrogen sensitive species may be occasionally affected. Such species are exclusively freshwater mussels, which do not occur in the Mataura River immediately upstream or downstream of the discharge. Those ammoniacal nitrogen sensitive species that do occur in the Mataura River in the vicinity of the discharge are the mayfly *Deleatidium sp.* and the snail *Potamopyrgus antipodarum*, but these fall within the top 20% of sensitive species and are protected by the Attribute B state.

With regard to enrichment, mean monthly dissolved inorganic nitrogen and dissolved reactive phosphorus concentrations at biological monitoring sites upstream and downstream of the discharge exceeded the MfE periphyton guideline for protecting benthic biodiversity (50 mg chlorophyll *a*/m²) across all growth periods (MfE 2000). The lack of nuisance algal growths in the periphyton surveys undertaken since 2013 indicate the discharge is unlikely to be stimulating nuisance algal growths despite the apparent high concentrations and that either dissolved inorganic nitrogen or dissolved reactive phosphorus concentrations need to be higher than the MfE (2000) guidelines or other factors are controlling periphyton growth in the river.

The enriched and degrading state of the Toetoes Estuary reflects the cumulative effect of nutrients from the Mataura River catchment. The total nitrogen discharge contribution to the Toetoes Estuary load from the discharge is 1.1–1.7% and the estimated total phosphorus discharge contribution is 0.7–1.3% with the vast majority of total nitrogen and total phosphorus load entering Toetoes Estuary being derived from other catchment inputs particularly diffuse sources. Even a marked reduction of the discharge total nitrogen and total phosphorus loads would have little, if any, detectable effect on the nutrient status of Toetoes Estuary. However, Alliance will need to reduce its levels over time as part of catchment wide initiatives to improve water quality.

While the Plant discharge is having a significant effect on the levels of *E. coli* in the receiving water downstream, observed increases in *E. coli* concentrations as a result of the treated Plant discharge did not necessarily relate to the abundance of zoonotic pathogens neither did these increases in *E. coli* relate to the individual illness risk. However, Alliance will need to investigate a reduction in bacterial levels to meet the National Policy Statement – Freshwater Management requirements

Ecological Effects

Periphyton surveys since 2013 have shown that algal cover and biomass, whilst varied between sites and among surveys, showed no effect from the discharge but can be high upstream and downstream which along with community composition maybe affecting Macroinvertebrate Community Index and Quantitative Macroinvertebrate Community Index scores.

Deleatidium sp. abundance has been variable between sites and across surveys but has tended to be lower at downstream sites. Prior to the most recent surveys there had been a general increasing trend in *Deleatidium* sp. abundance at Site D1 since April 2013. In February 2019 *Deleatidium* sp. abundance at Sites D1 and D2 was lower compared to Sites U1 and U2. The decline in *Deleatidium* sp. abundance at downstream sites in February 2019 is not explained by periphyton cover and biomass or ammoniacal nitrogen concentrations but could reflect high river temperatures leading up to and at the time of the February 2019 survey and an increase in overall stress that occurred some weeks later. The March 2019 survey was notable for the sharp decline in *Deleatidium* sp. abundance at the upstream sites and a less pronounced decline at the downstream sites. This effect may have been related to the elevated river temperature and extensive late successional stage algal growths at the time of the survey associated with the longest late summer – early autumn accrual period since 2012.

Overall results indicate the treated wastewater discharge has not resulted in a consistent decrease in Macroinvertebrate Community Index and Quantitative Macroinvertebrate Community Index scores between upstream and downstream locations over the period between April 2013 and December 2017. There is no evidence or causal links that can be associated with the discharge for the February 2019 survey and the March 2019 declines that occurred both upstream and downstream.

Water Take

The Mataura River Conservation Order 1997 protects the river from adverse effects associated with abstraction with the exception of the weir at Mataura. The small size of the take relative to the river flow and the very minor effect of the take on minimum flow duration and flow variability will result in only negligible effects on dissolved oxygen, contaminant concentrations and river water temperature and is not expected to alter the water quality or affect fish.

The consumptive component of the take is approximately 14,400 m^3/day or 167 L/s. This represents <1 % of MALF. In terms of river flow the effect of the take is very small and the potential risk of water quality and ecological effects are therefore assessed as very low.

The results of the benthic invertebrate community monitoring over many years and the large population of resident brown trout indicate that the water take does not adversely affect the benthic invertebrate community (an important food source for fish), fish habitat or fish migration. Overall, the take is very likely to have no detectable effects on ecological communities and responses.

The abstraction of water from the hydro-race has the potential to entrain juvenile fish. Despite the low risk it is recommended that all the intakes that are currently fitted with 5–6 mm screen mesh be fitted with 2–3 mm screens to further reduce the potential for entrainment and to meet best practice standards for screening intakes.

Conclusion

The lower Mataura River is enriched by nutrients and the Toetoes Estuary is in an enriched and degrading state that reflects the cumulative effect of nutrients from the Mataura River catchment. There is no evidence that the discharge from the Plant is causing adverse effects on water quality except in the immediate vicinity downstream for ammoniacal nitrogen and total nitrogen which are elevated and for *E. coli* levels that are significantly elevated.

Observations of a decrease in the abundance of the mayfly *Deleatidium* sp. immediately downstream in February 2019 and both upstream and downstream in March 2019 and which were also observed after the last long late summer – early autumn accrual period in April 2013 are likely to be the result of a combination of stressors including higher periphyton cover and biomass, periphyton community composition and late successional stage algal growth and elevated river temperatures. Overall, in terms of nitrogen the river can be characterised as degraded, periphyton reflects moderate to high enrichment during long accrual periods, and Macroinvertebrate Community Index and Quantitative Macroinvertebrate Index scores reflect fair to poor health at these times but noting that this occurs upstream and downstream of the discharge. There is no evidence linking these stressors to adverse effects associated with the discharge.

The discharge does contribute to increased ammoniacal nitrogen and total nitrogen which will contribute to higher loads and lower water quality downstream but the contribution of the loads reaching the estuary are negligible compared with the wider catchment. The significant increase in *E. coli* downstream is not related to increased risk of illness from contamination based on a robust Quantitative Microbial Risk Analysis. Alliance will need to reduce ammoniacal nitrogen, total nitrogen and *E. coli* levels to assist in meeting the National Policy Statement – Freshwater Management and the Southland Land and Water Plan and to contribute to an improvement in water quality in the catchment.

Table of Contents

Index to Tables

Index to Figures

List of Appendices

Glossary of Terms, Abbreviations and Units

Unit/Abbreviation	Meaning
~	Approximately
%	Percent
%ile	Percentile
°C	Degrees Celsius
AEE	Assessment of Environmental Effects
AFDW	Ash Free Dry Weight
AI	Autotrophic Index
Amm-N	Ammoniacal Nitrogen
ANOVA	Analysis of Variance
ANZECC	Australian And New Zealand Guidelines for Fresh and Marine Water Quality
BOD	Biochemical Oxygen Demand
CFU/100mL	Colony Forming Units per 100 millilitres
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
D1	Sampling Site Downstream 1
D2	Sampling Site Downstream 2
DIN	Dissolved Inorganic Nitrogen
DO	Dissolved Oxygen
DRP	Dissolved Reactive Phosphorus
E.coli	*Escherichia coli*
EPT	Ephemeroptera (Mayflies), Plecoptera (Stoneflies) Trichoptera (Caddisflies)
ES	Environment Southland
FIB	Faecal indicator bacteria
g/m^3	Grams Per Cubic Metre
GY	Green Yellow
IIR	Individual Illness Risk
kg/day	Kilograms per day

LC50	Lethal dose resulting in 50% mortality over a given time.
LogCFU/100mL	Log Colony Forming Units per 100 millilitres
LMW-BOD	Low molecular weight biological oxygen demand
L/s	Litres Per Second
m	metre
mg	Milligrams
mg/sample	Milligrams per sample
mg/L	Milligrams per litre
µm	Micrometres' Or 'Microns'; 1 Mm = 1 X 10−6 Metres
m^3	Cubic Metre
m/s	Metres Per Second
m^3/d	Metres Cubed Per Day
m^3/s	Metres Cubed Per Second
MCI	Macroinvertebrate Community Index
MfE	Ministry for the Environment
mg/m^3	Concentration (As 'Milligrams Per Cubic Metre Of Air')
MoH	Ministry of Health
MPN	Most Probable Number
mS/m	Millisiemens Per Metre
MST	Molecular source tracking
N	Nitrogen
NIWA	National Institute of Water and Atmospheric Research
nMDS	Non-metric multidimensional scaling
NOF	National Objectives Framework
NO_2-N	Nitrite Nitrogen
NO_3-N	Nitrate Nitrogen
NOEC	No Observed Effects Concentration
NPS-FM	National Policy Statement for Freshwater Management
NTU	Nephelometric Turbidity Units
NZFFD	New Zealand Freshwater Fish Database
O_2	Oxygen

P	Phosphorus
p	Probability
SWLP	Southland Water and Land Plan
QMCI	Quantitative Macroinvertebrate Community Index
QMRA	Qualitative Microbial Risk Assessment
RMA	Resource Management Act
SIN	Soluble inorganic nitrogen
sp.	Species
SRC	Southland Regional Council
SQMCI	Semi-Quantitative Macroinvertebrate Community Index
t/yr	Tonnes per year
TKN	Total Kjeldahl Nitrogen
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
U1	Sampling Site Upstream 1
U2	Sampling Site Upstream 2
Y	Yellow

1.0 Introduction

1.1 Background

The Alliance Mataura Plant (the Plant) is located on the Mataura River at the Mataura township approximately 44 km upstream of the Toetoes Estuary; a tidal lagoon type estuary that discharges to Toetoes Beach at the mouth of the Mataura River (Figure 1).

Alliance Group Limited (Alliance) is seeking to lodge applications for the renewal of the following resource consents for the Plant:

- Consent 202327 - Discharge treated wastewater (the discharge) from meat works and hide and skin processing to the Mataura River. Purposes for water used onsite that makes up the discharge include cleaning, wastewater treatment (providing treatment water to the DAF's) and meat processing.
- Consent 204126 – Take water from the Mataura River for freezing works supply.
- Consent 204125 – Discharge condenser cooling water from the Plant to the Mataura River.

This report assesses the effects of the current and ongoing discharges and take and builds on the following reports:

- Environmental monitoring plan (Freshwater Solutions 2017).
- Receiving environment report (Freshwater Solutions 2019).

Freshwater Solutions (2019) provides a detailed description of the existing receiving environment including hydrology, water quality and ecology of the Mataura River above and below the Plant, the lower Mataura River and Toetoes Estuary. The results from Alliance's compliance water quality monitoring between 2012–2018 and data collected at three Environment Southland (ES) State of Environment monitoring sites (Gore, Mataura Bridge and Mataura Island sites) was described and compared against relevant water quality standards and guidelines in Freshwater Solutions (2019). A description of the results of the 2012–2018 biological surveys (aquatic habitat, periphyton, benthic invertebrates and fish) and a summary of data collected from two ES State of the Environment monitoring sites in the Mataura River (500 m downstream from Mataura Bridge and Mataura Island sites) is presented in Freshwater Solutions (2019). Refer to Figure 2 for sampling locations.

Further assessment of dissolved oxygen (DO), periphyton, benthic invertebrates and fish was undertaken in February 2019 and will be included in the final report that is submitted with the application along with monthly dissolved inorganic nitrogen and dissolved reactive phosphorus results from biological monitoring sites.

Dada (2019b) provided an assessment of the mixing zone. Dada (2019a) provided a Quantitative Microbial Risk Assessment (QMRA) of the wastewater discharge between 2007–2017. Freshwater Solutions would like to acknowledge Mr Mark James of Aquatic Environmental Sciences Ltd for his review and comments on this report.

This report is an assessment of the actual and potential effects of the discharge from the Plant, identifies what standards and guidelines are required as targets and then assesses each of the effects of the current discharge against those standards and targets. Section 2 describes the wastewater discharge quality. Section 3 assesses the effects of the discharges and water takes on river water and estuary water quality. Section 4 assesses the effects of the discharges and water takes on periphyton, benthic invertebrates and fish.

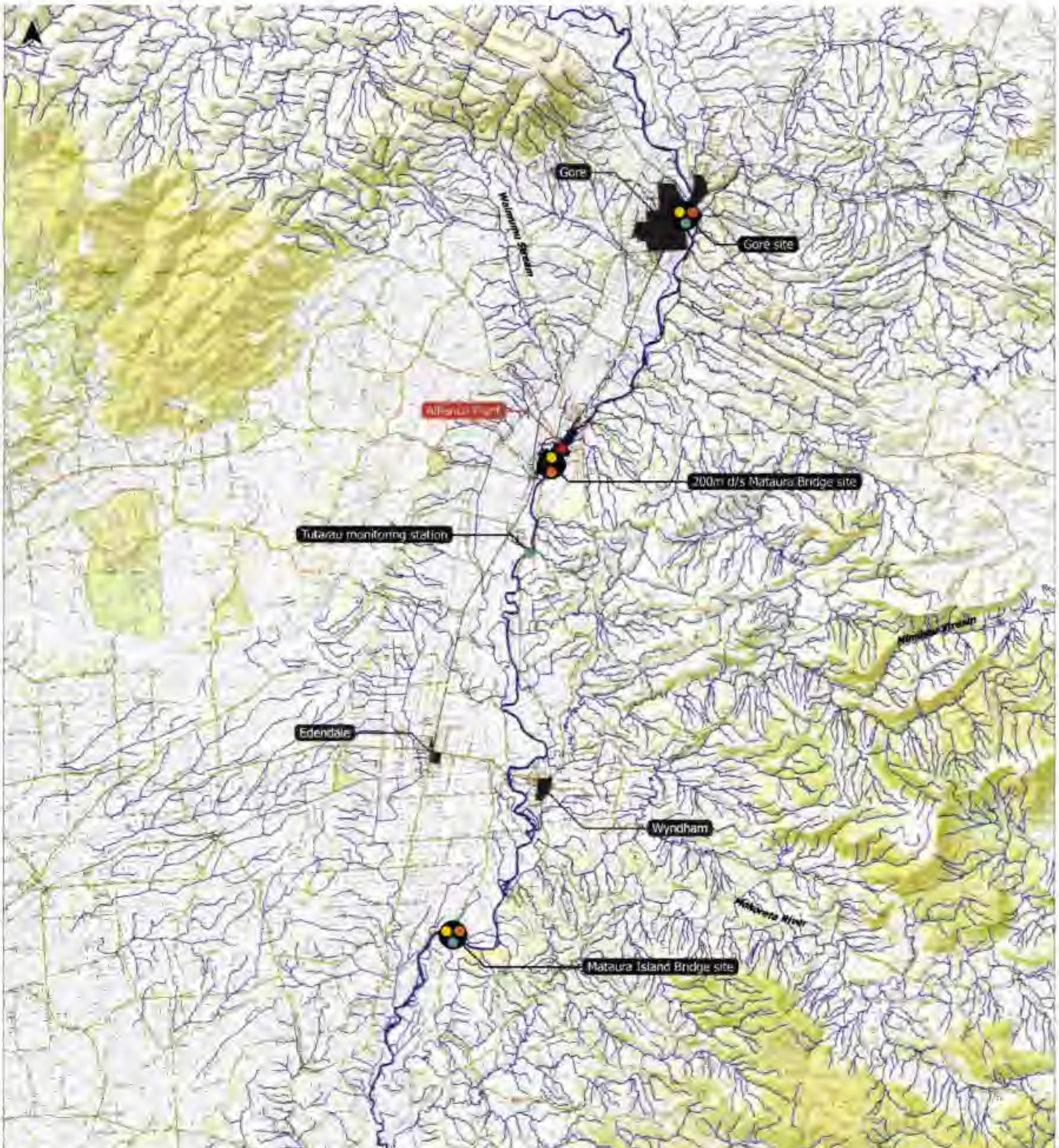


Figure 1: Location of Environment Southland monitoring sites.

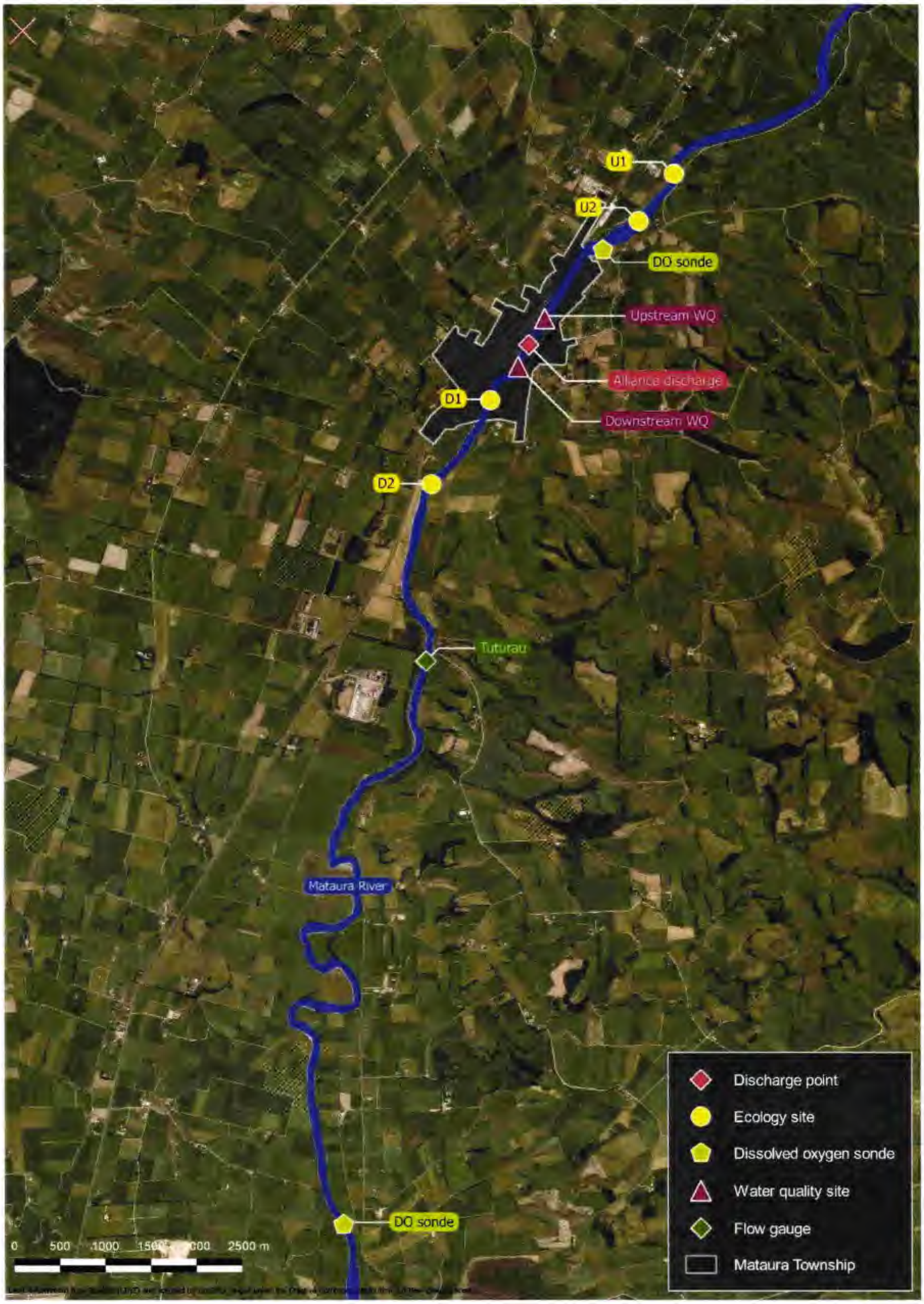


Figure 2: Location of Alliance monitoring sites.

2.0 Discharge Quality and Characteristics

2.1 Background

Prior to 26 September 2012 the Mataura Plant processed 10,000 sheep and lambs per day along with cattle and calves. Extensive work was undertaken in the mid 2000's to separate high phosphorus wastewater streams and apply targeted dissolved reactive phosphorus treatment to those streams. However, some cross contamination issues remained, meaning not all high phosphorus streams were treated as intended. The sheep and lamb operation closed on 26 September 2012 with remaining capacity shifted to Lorneville. Removing sheep and lamb processing had a number of environmental benefits including changing the processing peak for the plant from the height of summer, to autumn/early winter (Doyle Richardson pers. comm.).

Removal of sheep and lamb processing resulted in a significant reduction in water use and potential contaminant loads in the treated wastewater including reducing low molecular weight BOD, which can cause sewage fungus, sulphide and remaining issues with targeted dissolved reactive phosphorus treatment. Calf processing ceased in November 2013 and rendering ceased in January 2014 leading to further improvements in wastewater quality.

This section presents the discharge volume and water quality data for the period between October 2012 and 12 March 2019. Typical data values and distributions of the parameters in such a large data set are best understood in terms of the 50^{th} percentile, 5^{th} percentiles and 95^{th} percentiles. The medians and ranges discussed in the following sections refer to these statistics although minima and maxima are also presented for reasons of completeness and to compare to compliance requirements.

2.2 Recent Processing Seasons

The processing season typically starts in October and ends in September with a short 'off season' between late September and mid-late October (Table 1).

Table 1: Discharge period over the past six seasons.

Season	Start	End
2012/13*	1 November 2012	25 September 2013
2013/14	3 October 2013	26 August 2014
2014/15	23 October 2014	23 September 2015
2015/16	1 October 2015	19 September 2016
2016/17	25 October 2016	26 September 2017
2017/18	26 October 2017	30 September 2018
2018/19	2 October 2018	Not complete

Note: * sheep and lamb processing ceased on 26 September 2012.

2.3 Discharge Volumes

Alliance's consent requires that the discharge not exceed 14,400 m^3/day. The maximum discharge volume was 7,602 in the 2013/14 season (Table 2). The median discharge for the period between October 2012 and March 2019 was 3,305 m^3/day (5%-ile-95%-ile: 256–5,814 m^3/day) (Table 2 and Figure 3). On no occasion was the consent limit for discharge volume exceeded. The lowest completed seasonal daily median was in 2015/16 (2,994 m^3/day) and the highest in 2017/18 (4,418 m^3/day).

The median discharge volumes remained steady at around 3,000 m^3/day between the 2012/13 and 2016/17 seasons and increased to 4,418 m^3/day (approximately 47% increase) in the 2017/18 season. The median daily discharge volume in the current season up to 12 March 2019 is 5,109 m^3/day and indicates that the median discharge volume for the current season will be similar or higher than the previous season and well above the median daily discharge volume in the 2012/13 – 2016/17 seasons.

The total discharge volume up to 1 April this season was 618,793 m^3, approximately 38% higher compared to the 449,224 m^3 discharged up to 1 April 2018 and 441,057 m^3 discharged up to 1 April 2017. Increased water use is the result of a combination of factors including increase cleaning and hygiene requirements for processing *Micoplasma bovis* affected stock, increased cattle numbers and weights and changed product requirements, particularly for edible offals. For example, 30% more offal (by weight was collected between the 2016/17 processing season. Stock processed to the 1 April 2019 was 71,164 head of cattle, which compares to 52,730 for the same period to 1 April 2017. This represents an increase of over 42% over the period.

Table 2: Summary of daily discharge volumes between October 2012 and April 2018.

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19^A	2012/19
Count	323	310	303	283	292	296	158	1947
Med.	3,055	3,024	3,086	2,994	3,303	4,418	5,109	3,305
Min.	92	20	59	9	28	57	24	9
Max.	6,605	7,602	6,203	5,648	6,776	7,475	6,051	7,602
5%-ile	288	291	222	263	212	245	320	256
95%-ile	5,749	5,884	5,796	5,482	5,770	6,063	5,694	5,814

Note: all units m^3, ^Apart of season.

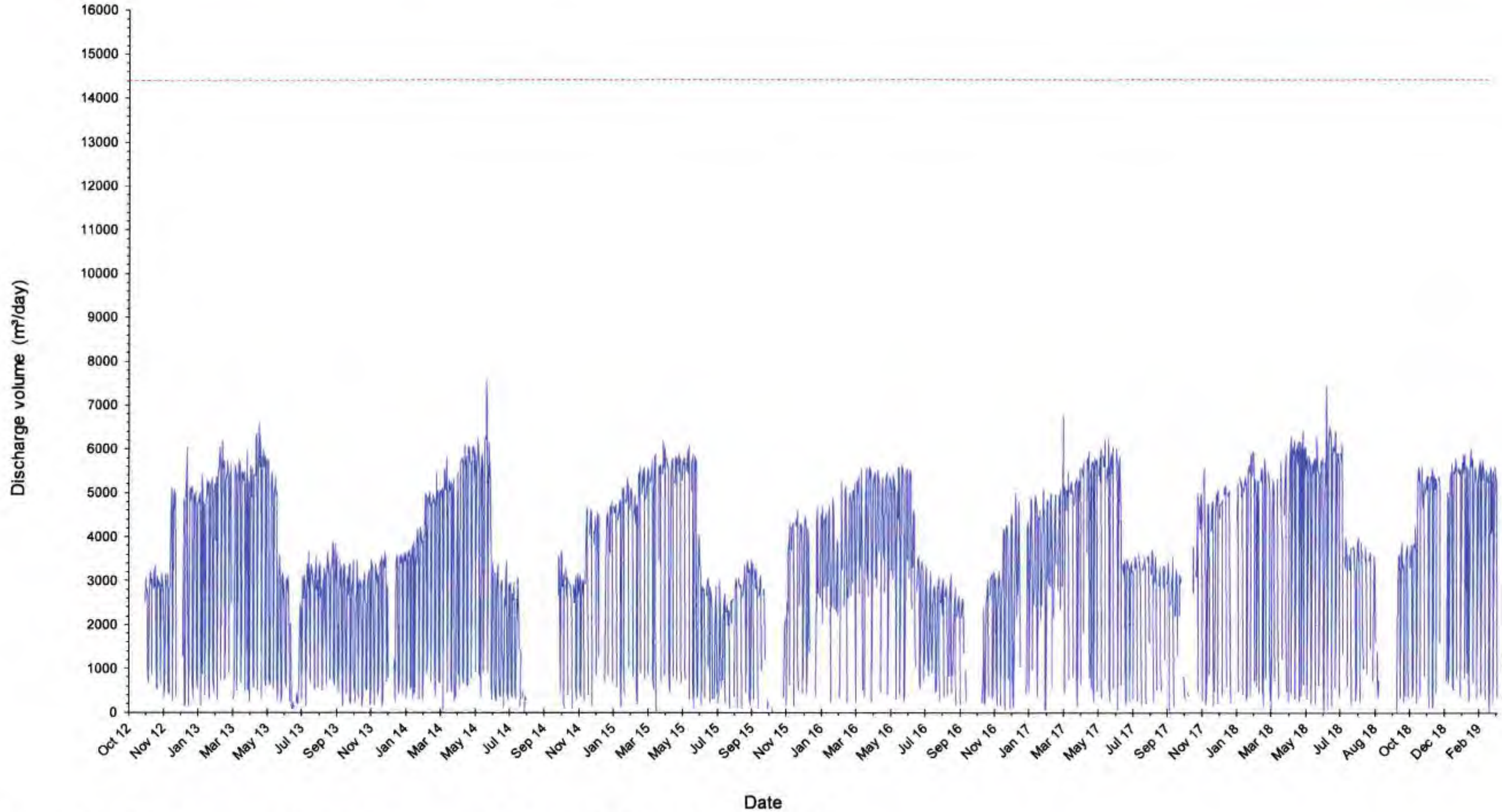


Figure 3: Discharge volumes between October 2012 and March 2019.

2.4 Discharge Quality

This section presents discharge quality for physico-chemical parameters, nutrients and microbial characteristics, most of which were monitored during the discharge season on an approximately weekly basis from 1 November 2012 to 12 March 2019.

pH

The overall median pH of the discharge was 8.5 (5%-ile - 95%-ile: 6.8–9.3). The minimum seasonal median occurred in 2012/13 (pH = 7.2), which was notably lower than in subsequent seasons and the highest seasonal median was in 2014/2015 (pH = 8.8) (Table 3 and Figure 4).

Table 3: Summary of discharge pH between November 2012 and March 2019.

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2012/18
N	44	43	48	45	47	43	18	288
Med.	7.2	8.6	8.8	8.6	8.5	8.2	8.6	8.5
Min.	5.5	6.1	6.7	7.2	6.9	6.2	7.7	5.5
Max.	9.6	9.6	9.3	9.6	9.5	9.2	8.9	9.6
5%-ile	6.5	7.0	7.1	7.8	7.5	7.0	8.2	6.8
95%-ile	9.2	9.3	9.2	9.3	9.1	8.7	8.8	9.3

Note: pH units.

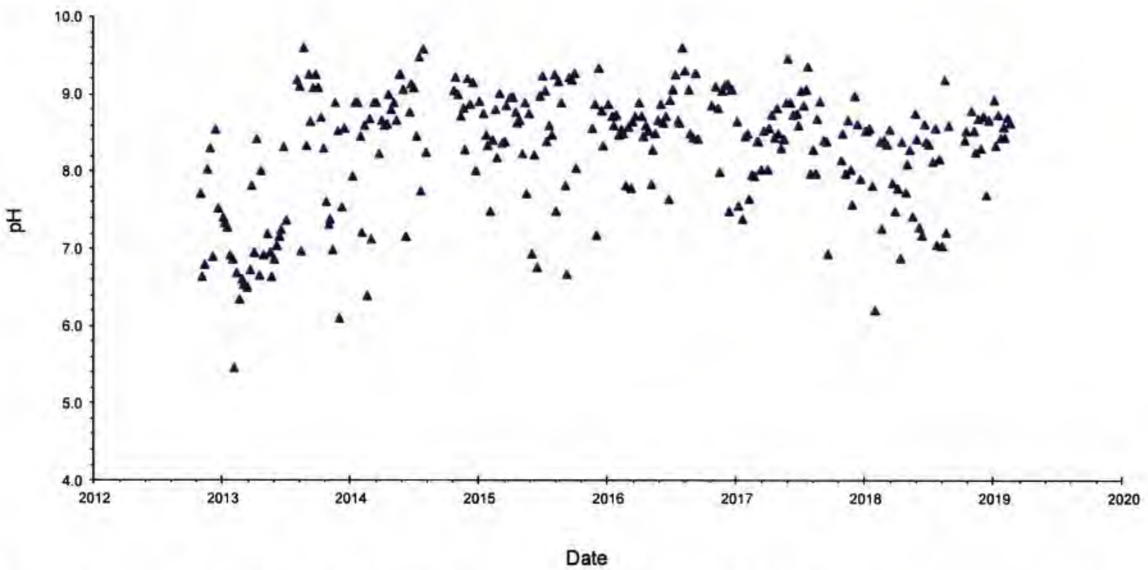


Figure 4: Discharge pH between November 2012 and March 2019.

Conductivity

Conductivity testing was conducted on the wastewater between 1 November 2012 and 2 November 2016 (Figure 5). Only two measurements were made in the 2016–17 season, hence for seasonal comparisons this data is excluded. The overall median conductivity of the discharge was 130 mS/m (5%-ile-95%-ile: 58–390 mS/m) (Table 4); the minimum seasonal median was in 2013/14 (110 mS/m) and the highest in 2015/16 (150 mS/m).

Table 4: Summary of discharge conductivity between November 2012 and September 2016.

	2012/13	2013/14	2014/15	2015/16	2016/17	2012/17
N	44	43	48	45	2	182
Med.	140	110	140	150	94	130
Min.	54	46	55	60	78	46
Max.	470	420	410	390	110	470
5%-ile	57	49	66	77	80	58
95%-ile	383	321	380	298	108	360

Note: Units = mS/m;

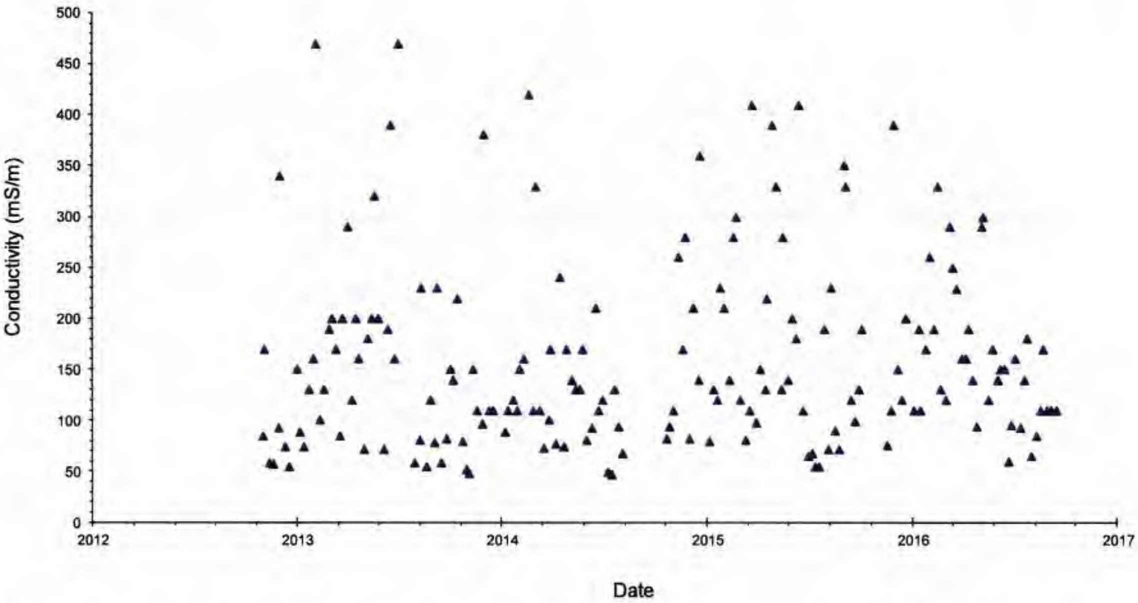


Figure 5: Discharge conductivity between November 2012 and September 2016.

Total Suspended Solids

The median Total Suspended Solids (TSS) concentration in the discharge was 67 g/m^3 (Table 5). The consent requires the TSS concentration in the discharge not exceed 200 g/m^3, with an additional condition that TSS concentrations 'consistently maintained' at less than 100 g/m^3; 'consistently maintained' being defined as 80% of any five consecutive samples.

The TSS concentration in the discharge exceeded the 200 g/m^3 limit on one occasion, with a concentration of 220 g/m^3 recorded on 24 May 2018. There were three occasions when TSS concentrations were not 'consistently maintained' at less than 100 g/m^3 and included once in 2012/13 (100 g/m^3 and 110 g/m^3 in the space of three days), once in 2013/14 (170 g/m^3 and 132 g/m^3 in the space of two days), and once in 2017/18 (180 g/m^3, 220 g/m^3 and 110 g/m^3 in the space of four days); it is noted the 95%-ile TSS concentration in the discharge was 100 g/m^3. The maximum seasonal median TSS concentration occurred in 2014/15 and 2017/18 (76 g/m3) and the lowest occurring in the 2016/2017 season (57 g/m^3) (Figure 6). The median TSS load in the discharge for the entire monitoring period was 293 kg/day (5%-ile-95%-ile: 114–565 kg/day).

Table 5: Summary of discharge TSS between November 2012 and March 2019.

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2012/18
N	44	43	48	45	47	44	18	289
Med.	60	65	76	68	57	76	75	67
Min.	32	40	42	30	35	50	52	30
Max.	110	170	140	130	110	220	180	220
5%-ile	38	42	49	40	40	52	52	42
95%-ile	85	97	99	93	99	119	129	100

Note: Units = g/m^3.

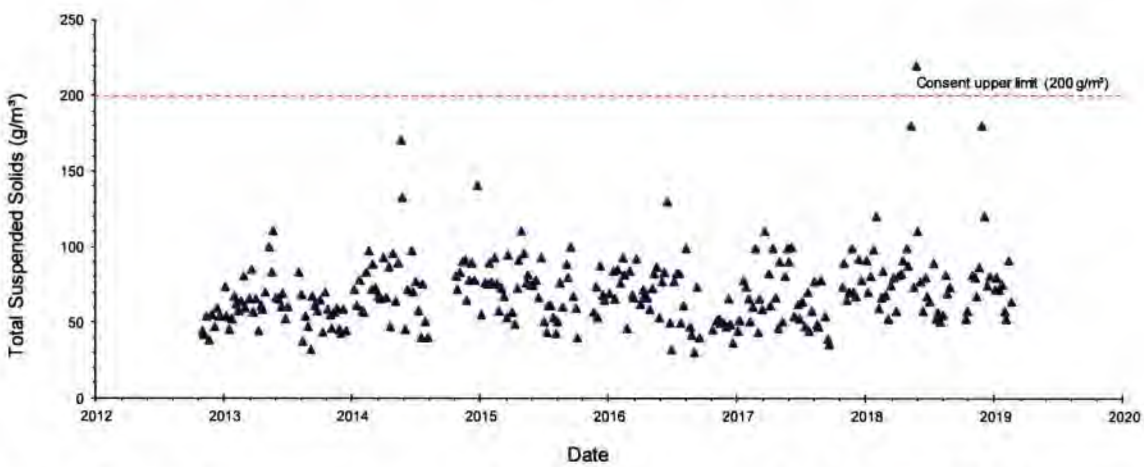


Figure 6: Discharge TSS concentrations between November 2012 and March 2019.

Oil and Grease

Oil and grease analysis testing was conducted between 1 November 2012 and 2 November 2016. Only two data were measured in the 2016-17 season, hence for seasonal comparisons this data is excluded. The overall median oil and grease concentration of the discharge was 13 g/m^3 (5%-ile-95%-ile: 5–26 g/m^3) (Table 6); there is no seasonal trend apparent in oil and grease data.

Table 6: Summary of discharge oil and grease concentrations between November 2012 and November 2016.

	2012/13	2013/14	2014/15	2015/16	2016/17	2012/17
N	44	43	48	45	2	182
Med.	13	15	14	11	13	13
Min.	<4	<4	<4	<4	11	<4
Max.	28	39	67	21	14	67
5%-ile	7	5	6	4	11	5
95%-ile	24	27	29	19	14	26

Sulfide

The median total sulfide concentration of the discharge was 0.48 g/m^3 (5%-ile-95%-ile: <0.4–1.1 g/m^3) (Table 7). The consent requires the total sulfide concentration not exceed 5 g/m^3 and also be 'consistently maintained' at less than 2 g/m^3. Both elements of this condition were fully met throughout the 2012–2019 discharge record throughout which, it is noted, total sulfide marginally exceeded 2 g/m^3 on only one occasion (Figure 7).

Table 7: Summary of sulfide concentrations between November 2012 and March 2019.

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2012/19
N	44	43	48	45	47	43	17	287
Med.	0.57	0.49	0.47	<0.4	<0.4	0.54	0.46	0.48
Min.	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
Max.	1.3	1.5	0.86	2.1	0.73	1.4	0.86	2.1
5%-ile	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
95%-ile	1.2	1.1	0.79	0.98	0.66	1.0	0.76	1.1

Note: Units = g/m^3.

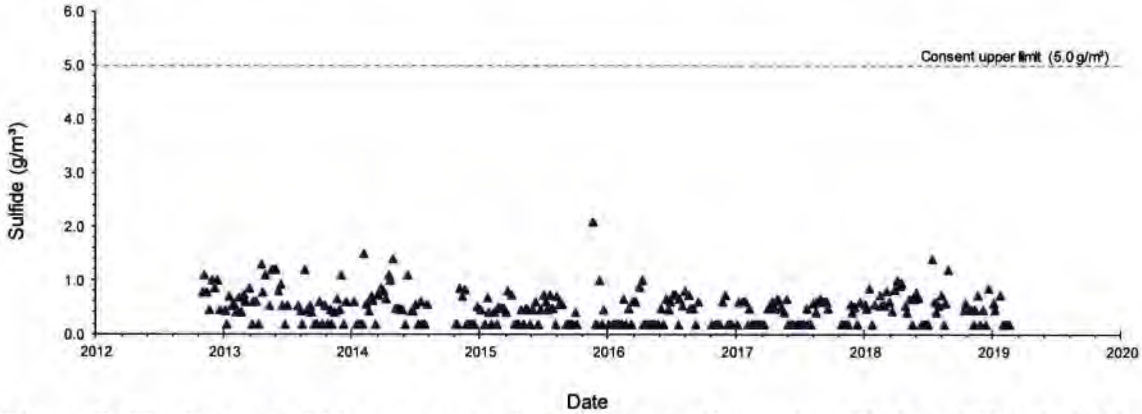


Figure 7: Discharge sulfide concentrations between November 2012 and March 2019.

Nutrients

Chemical Oxygen Demand

The median chemical oxygen demand (COD) concentration in the discharge was 340 g/m^3 (5%-ile-95%-ile: 180 –520 g/m^3) (Table 8 and Figure 8); no inter-seasonal trend in COD concentrations is apparent.

Table 8: Summary of COD concentrations between November 2012 and March 2019.

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2012/19
N	44	43	48	45	47	43	18	288
Med.	335	310	375	370	310	390	300	340
Min.	160	150	160	100	140	50	180	50
Max.	550	630	610	550	1600	780	490	1600
5%-ile	210	182	194	130	180	182	206	180
95%-ile	527	428	557	506	475	547	473	520

Note: Units = g/m^3.

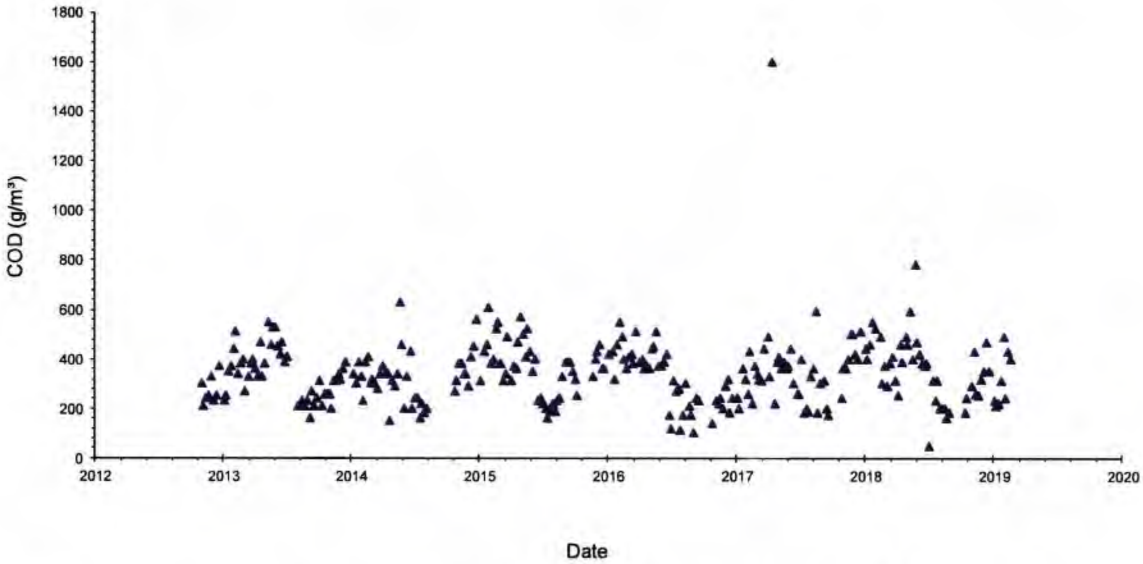


Figure 8: Discharge COD concentrations between November 2012 and March 2019.

Biological Oxygen Demand

The median biological oxygen demand (BOD) concentration in the discharge was 190 g/m^3 (5%-ile-95%-ile: 83 –290 g/m^3) (Table 9 and Figure 9); on average BOD concentrations are 54% of COD. The consent condition for BOD states concentrations in the discharge should not exceed 300 g/m^3. In total there were nine occasions when this consent requirement was not met: twice in 2012/13, once in 2013/14, once in 2015/16, once in 2016/17 and four times in 2017/18. The median BOD load in the discharge for the entire monitoring period was 809 kg/day (5%-ile-95%-ile: 227–1,589 kg/day).

Apart from the cluster of elevated BOD concentrations between January and June 2018 there is no apparent inter-seasonal trend in BOD concentrations.

Table 9: Summary of BOD concentrations between November 2012 and March 2019.

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2012/19
N	44	42	48	44	48	44	22	292
Med.	200	180	200	200	150	220	180	190
Min.	94	42	75	30	61	98	92	30
Max.	310	360	290	310	320	430	290	430
5%-ile	102	72	100	71	66	110	111	83
95%-ile	290	250	280	290	257	330	279	290

Note: Units = g/m^3.

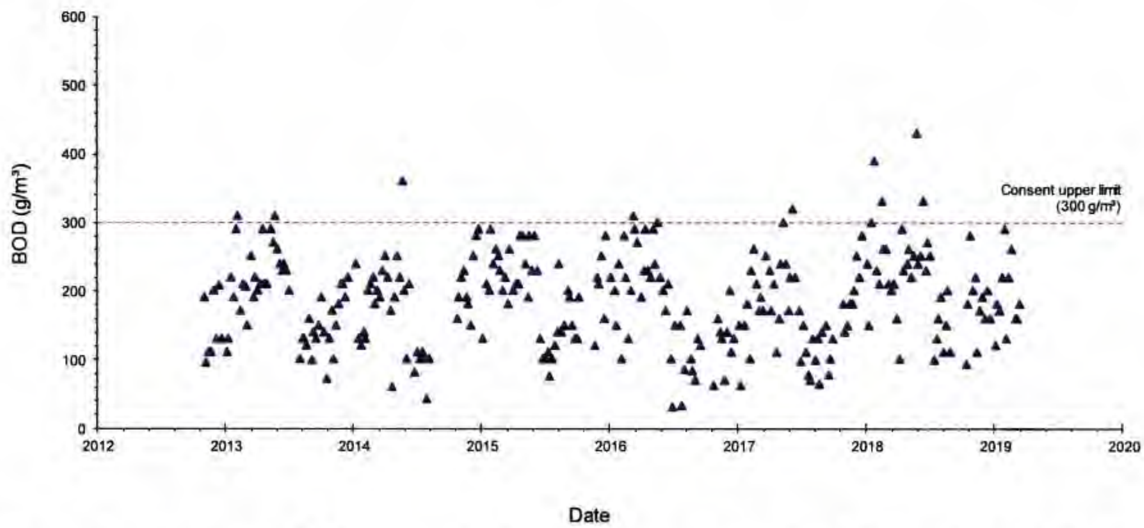


Figure 9: Discharge BOD concentrations between November 2012 and March 2019.

Low Molecular Weight Biological Oxygen Demand

In addition to COD and BOD, low molecular weight (LMW)-BOD was determined on the discharge between 1 November 2012 and 2 November 2016. LMW BOD was measured to assess the risk of heterotrophic slimes occurring.

The median LMW-BOD concentration in the discharge was 80 g/m^3 (5%-ile-95%-ile: 37–189 g/m^3) (Table 10 and Figure 10), and on average, LMW-BOD concentrations were 49% that of BOD. The median LMW-BOD load in the discharge for the monitoring period was 283 kg/day (5%-ile-95%-ile: 95–870 kg/day). Elevations in LMW-BOD were evident for the 2015/16 season compared with other seasons.

Table 10: Summary of low molecular weight BOD concentrations between November 2012 and March 2019.

	2012/13	2013/14	2014/15	2015/16	2016/17	2012/18
N	44	43	48	45	2	182
Med.	61	70	92	89	60	80
Min.	29	18	17	19	38	17
Max.	150	250	490	190	82	490
5%-ile	39	20	31	40	40	37
95%-ile	137	110	227	148	80	189

Note: Units = g/m^3.

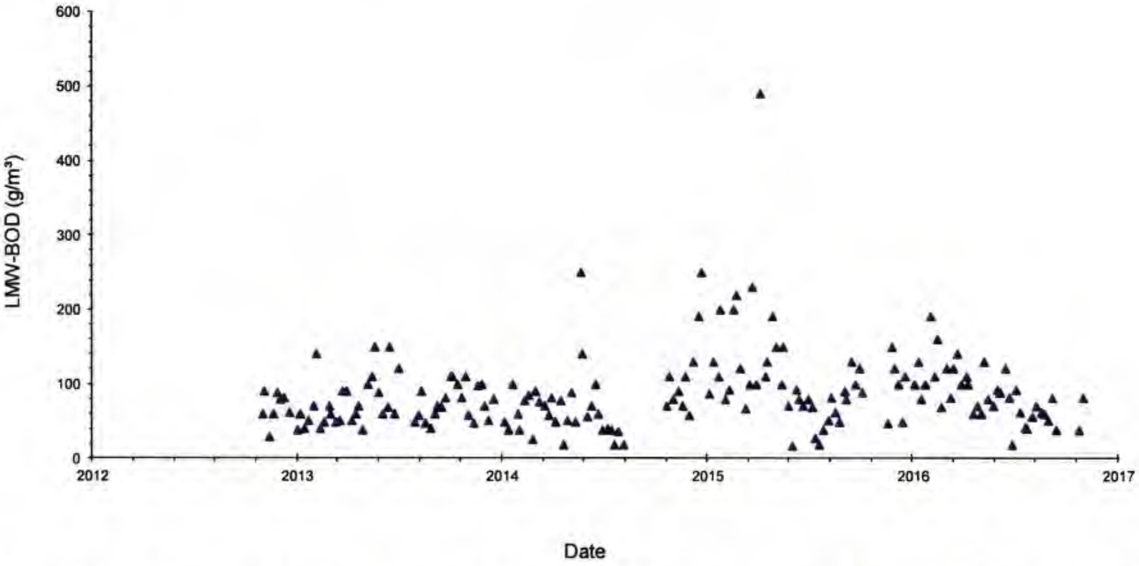


Figure 10: Discharge low molecular weight BOD concentrations between November 2012 and November 2016.

Total Kjeldahl Nitrogen

The median total kjeldahl nitrogen (TKN) (Amm-n + organic N) concentration in the discharge was 40 g/m^3 (5%-ile-95%-ile: 19–59 g/m^3) (Table 11 and Figure 11). Elevation in discharge TKN concentrations are evident for the 2017/18 season compared with other seasons. Median TKN load in the discharge for the entire monitoring period was 168 kg/day.

Table 11: Summary of TKN concentrations between November 2012 and March 2019.

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2012/19
N	44	43	48	45	47	43	18	288
Med.	40	38	43	42	40	49	39	40
Min.	16	14	16	10	16	20	29	10
Max.	65	68	140	63	59	90	54	140
5%-ile	19	20	21	15	20	24	31	19
95%-ile	58	47	61	57	58	70	50	59

Note: Units = g/m^3.

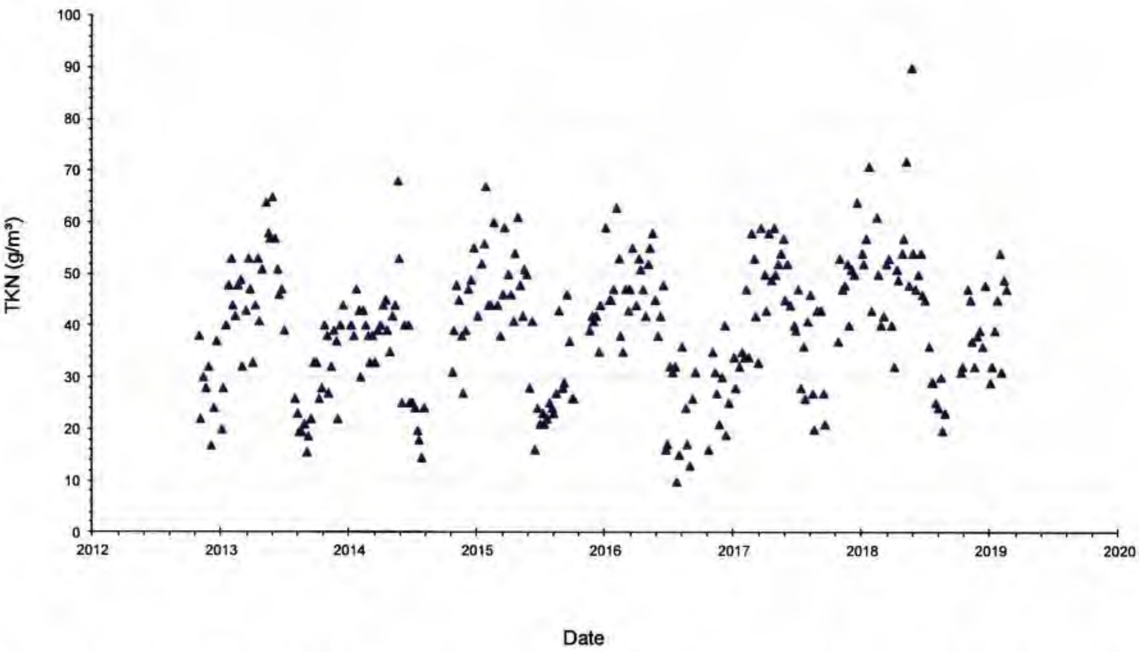


Figure 11: Discharge TKN concentrations between November 2012 and March 2019.

Ammoniacal Nitrogen

The overall median Amm-N concentration was 15 g/m^3; 5%-ile-95%-ile: 5.9–29 g/m^3 (Table 12 and Figure 12). On average the Amm-N concentration comprised approximately 42% of TKN; hence the average organic-N concentration comprised 58%.

The consent requires Amm-N concentrations not to exceed 50 g/m^3 and also be 'consistently maintained' at less than 30 g/m^3. The upper limit was met 100% of the time, whereas the 'consistently maintained' requirement was not met on three occasions between 19 February 2015 and 23 March 2015. It is noted the 95%-ile Amm-N concentration over the entire period was 29 g/m^3.

Table 12: Summary of Amm-N concentrations between November 2012 and March 2019.

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2012/19
N	44	43	48	45	48	44	22	294
Med.	13	13	19	21	13	15	16	15
Min.	5.0	3.9	8.5	5.5	2.1	2.3	9.4	2.1
Max.	25	34	36	31	37	40	30	40
5%-ile	5.3	6.4	9.0	10	4.3	4.5	10	5.9
95%-ile	23	23	35	29	25	29	27	29

Note: Units = g/m^3.

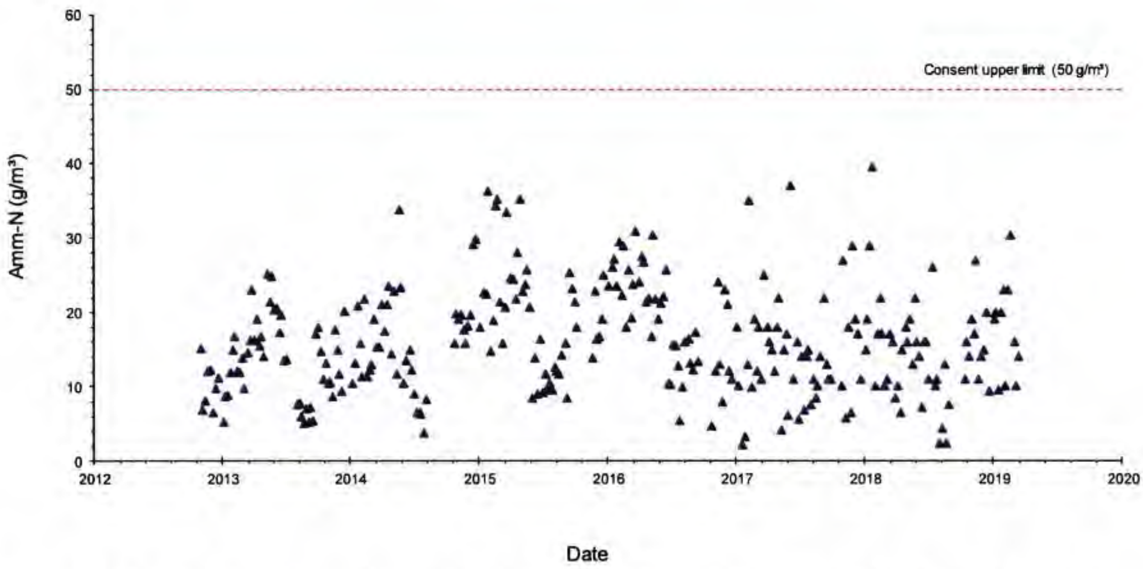


Figure 12: Discharge Amm-N concentrations between November 2012 and March 2019.

Total Phosphorus

The median TP concentration in the discharge was 3.5 g/m^3 (5%-ile-95%-ile: 1.5–5.9 g/m^3). The median TP load in the discharge for the entire monitoring period was 16 kg/day (Table 13 and Figure 13). A gradual upward trend in discharge TP concentrations is evident and a trend analysis (Kendall Trend Test) indicated a 'virtually certain' (probability = 99.6%) increasing trend in TP concentrations of 7.5% per year. The upward trending discharge concentrations of TP are associated with particulates in the size range 0.45 µm – 1.2. The median TP concentration in the current season was 4.4 g/m^3 compared to 3.5 g/m^3 for the complete dataset.

Table 13: Summary of TP concentrations between November 2012 and March 2019.

TP	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2012/19
N	44	43	48	45	48	43	18	289
Med.	2.3	3.2	3.6	3.9	3.2	4.1	4.4	3.5
Min.	1.0	1.2	1.3	1.4	1.1	1.3	2.5	1.0
Max.	4.9	8.0	6.5	5.7	7.9	7.2	6.1	8.0
5%-ile	1.2	1.5	1.9	2.0	1.8	1.9	2.9	1.5
95%-ile	4.2	5.7	5.5	5.4	6.7	6.4	5.7	5.9

Note: Units = g/m^3.

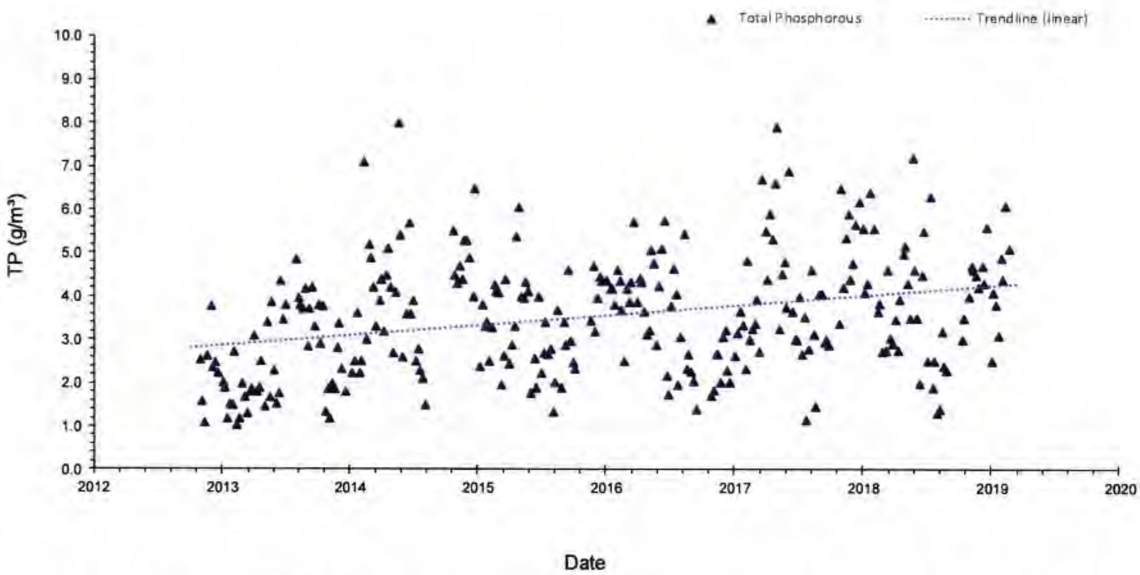


Figure 13: Discharge TP concentrations between November 2012 and March 2019.

Dissolved Reactive Phosphorus

The median DRP concentration in the discharge was 0.20 g/m³ (5%-ile-95%-ile: 0.06 - 0.88 g/m³) (Table 14, Figure 14). DRP typically comprised 9.8% of TP. Unlike TP, no statistically significant trend was evident in discharge DRP concentrations (which are determined on the <0.45 µm fraction). The median DRP concentration in the current season was 0.30 g/m³ compared to 0.20 g/m³ for the complete dataset.

Table 14: Summary of DRP concentrations between November 2012 and March 2019.

DRP	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2012/19
N	44	43	48	44	47	44	21	291
Med.	0.18	0.18	0.17	0.23	0.21	0.23	0.30	0.20
Min.	0.036	0.013	0.018	<0.09	0.089	0.060	0.17	0.013
Max.	1.70	2.2	0.90	1.0	1.5	1.2	1.04	2.2
5%-ile	0.056	0.024	0.056	0.057	0.093	0.11	0.19	0.06
95%-ile	1.2	0.65	0.62	0.89	0.70	0.85	0.98	0.88

Note: Units = g/m³.

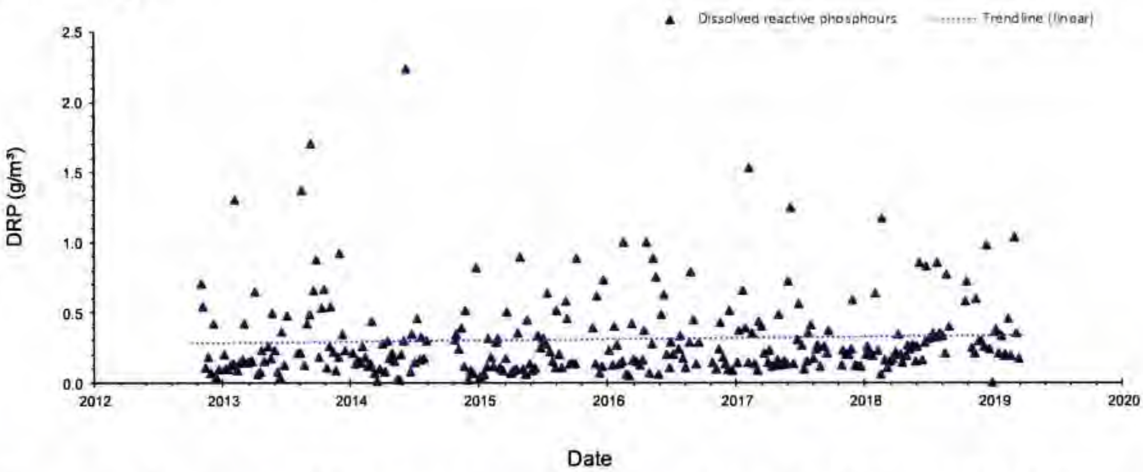


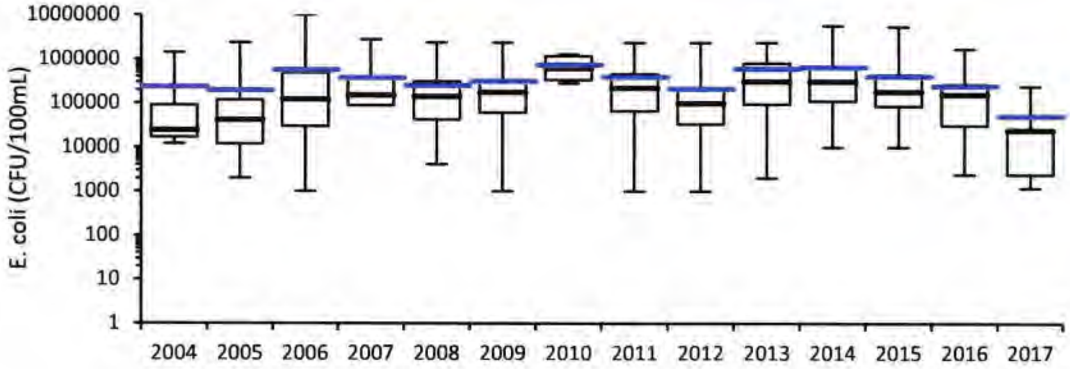
Figure 14: Discharge DRP concentrations between November 2012 and March 2019.

2.5 Microbial Characteristics

The microbial assessment has been undertaken by Streamlined Ltd (Dada 2019a) and the results are summarised below. Dada (2019a) full report is presented in Appendix 1 and summarised below.

The microbiological characteristics and microbial treatment performance of the meat works plant discharge are summarised in this section in terms of *E.coli* concentrations of the discharge water since 2004. Additional sampling was conducted over the last two summers specifically for the zoonotic pathogens (pathogens that can be transmitted from animals to humans).

Box plots of treated wastewater monitoring data for *E. coli* in the treated final effluent were supplied by Alliance Plant, Mataura for the period 10 November 2004 to 14 March 2018 (Figure 15). Historical *E. coli* concentrations in the discharge generally ranged between 1 x 10^3 CFU/100mL and 1 x 10^7 CFU/100mL.



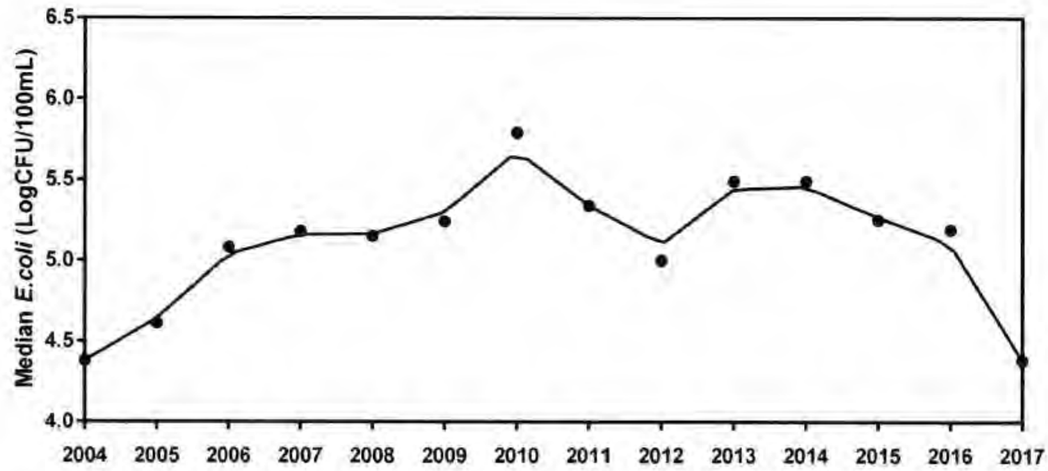


Figure 15: (a) Box plot analysis and (b) Lowess-fitted trend analysis of historical *E. coli* concentrations in the Alliance Mataura WWTP discharge. Blue lines are the means.

Whilst *E. coli* are the key faecal indicator bacteria (FIB) used for regulatory purposes in NZ freshwaters, it is pathogens for which they are intended to indicate that are of most concern for human health risk assessment. The two key groups of pathogens of most concern in animal wastewater are bacteria and protozoans, and literature indicates there are no substantial human health risks established for transmission of fungi and viruses through animal wastewater discharge.

Because there had been no pathogen data collected during the routine monitoring for *E. coli* Alliance initiated monitoring for specific pathogens in autumn 2018 and again during the summer of 2018/19 (3 successive monthly samples) with a view to comparing these pathogen concentrations with FIB levels. Salmonella, Campylobacter and *E. coli* 0157:H7 were selected as representative bacterial pathogen species whilst parasites of the genus Cryptosporidium and Giardia were the representative protozoans. Treated wastewater samples were subjected to molecular source tracking (MST) by analysing for the presence of molecular markers specific to five host sources (humans, cattle, sheep, dogs, birds).

Results showed a very high level of *E.coli*, up to 10^6 CFU/100mL, was being discharged into the Mataura River from the Alliance Plant, but that the levels of the representative pathogens was much lower and more variable (Table 15). For example, in autumn 2018 the discharge contained a reasonable number of *Salmonella* species (120 cells per 100mL), *Campylobacter jejuni* (22 cells per 100mL, Table 15) but few *E. coli* 015: H7 (0.3 cells per 100mL) but zero cysts of either *Cryptosporidium* or *Giardia*. In contrast over the summer of 2018/19, Salmonella species and *Campylobacter jejuni* were lower in concentration (<30 cells per 100mL) while *Cryptosporidium* and *Giardia* were detected at comparatively higher levels (up to 310 oocysts per litre, Table 15). This variability is not unexpected because pathogens in meat works wastewater will depend on the resident population of pathogens in the animals before slaughter, which will vary. The maximum and minimum pathogen levels measured were used as input into a QMRA. As expected, MST analysis showed that ruminant markers predominated the faecal signature in the treated wastewater (Dada, 2019a).

Table 15: Pathogen monitoring data for treated Alliance Mataura wastewater

A. May 2018

Description	*E.coli* MPN/100mL	*Salmonella* MPN/100 mL	Campylobacter species MPN/100 mL	*C. jejuni* MPN/100 mL	*E. coli* 0157 MPN/100 mL	*Giardia (oocysts /1000ml)*	*Cryptosporidium (oocysts /1000ml)*
Treated wastewater day 1	2,400,000	240	4	1.5	0.3	<1	<1
Treated wastewater day 2	520,000	0.6	43	43	0.3	N.D	N.D
Average	1,460,000	120	24	22	0.3	<1	<1

Note: * N.D. = non detect.

B. December 2018-February 2019

Pathogen	Dec-18	Jan-19	Feb-19
Salmonella (CFU/100ml)	21	4	<3
Campylobacter (CFU/100ml)	<3	9	4
E.coli 0157: H7 (CFU/100ml)	<3	<3	*
Giardia (oocysts /1,000ml)	32	150	2
Cryptosporidium (oocysts /1,000ml)	310	250	1
E.coli (CFU/100ml)	300,000	4,500,000	90,000

Note: * *E. coli* O157 was detected in this sample, however quantification was not possible due to the presence of inhibitory substances in the matrix.

2.6 Discharge Loads

Discharge loads of key parameters (TSS, BOD, TKN and TP) were calculated on a daily basis from the product of the daily discharge volume and the discharge concentration. The latter is measured approximately weekly and an estimate of discharge concentrations on non-sampling days was derived from the average of the measured concentrations at either end of the sampling cycle.

On days when discharge occurred the average daily discharge loads between October 2012 and March 2019 were: TSS = 236 kg/d; BOD = 641 kg/d; TKN = 137 kg/d; and, TP = 11.7 kg/d. Despite not being able to calculate TN loads due to the absence of total oxidised nitrogen (nitrate and nitrite nitrogen) data, TKN is a useful surrogate for TN because discharge total oxidised nitrogen concentrations are typically less than the analytical detection limit. Apart from BOD there is no limit on nutrient discharge loads; the 3,500 kg/day limit on the discharge load of BOD, which achieved 100% compliance over the monitoring period.

Discharge loads of TSS, BOD, TKN and TP for each completed processing season are presented in Table 16. TSS loads ranged from 62-91 t/yr, BOD 158-241 t/yr, TKN 33-52 t/yr and TP 2.4-4.4 t/yr. Results in Table 16 show a 47% increase in TSS load, 48% increase in BOD load, 33% increase in TKN load and 22% increase in TP load in the 2017/18 season compared to the 2016/17 season. Further discussion of the potential effects of TSS, BOD, TN and TP loads are discussed later in this report.

Table 16: Processing season discharge loads of TSS, BOD, TKN and TP.

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
TSS	62	64	74	62	62	91
BOD	198	158	202	173	163	241
TKN	41	33	43	36	39	52
TP	2.4	3.1	3.5	3.4	3.6	4.4

Note: Units = tonnes.

Summary

The processing season typically starts in October and ends in September with a short 'off season' between late September and mid-late October. Prior to 26 September 2012 the Mataura Plant processed 10,000 sheep and lambs per day along with cattle and calves. Extensive work was undertaken in the mid 2000's to separate high phosphorus wastewater streams, and apply targeted dissolved reactive phosphorus treatment to those streams. However, some cross-contamination issues remained, meaning not all high phosphorus streams were treated as intended. Removal of sheep and lamb processing resulted in a significant reduction in water use and potential contaminant loads in the treated wastewater including reducing low molecular weight BOD and DRP. *Micoplasma bovis* increased the number of cattle being processed in the 2017/8 and current seasons (Doyle Richardson pers. com.). This increase in processing has resulted in an increase in the total volume and total load, TSS, BOD, TKN and TP loads and TP and DRP concentrations in the current season compared previous seasons. Changes to wastewater solids processing may have also contributed to changes.

Alliance's consent requires that the total discharge volume does not exceed 14,400 m^3/day. On no occasion was the consent limit for total discharge volume exceeded with the median discharge for the period between the 2012/13 and current seasons being 3,305 m^3/day.

Overall Alliance achieved a very high (near 100% compliance) with its treated wastewater discharge consent limits. One or two BOD non compliances were recorded each year and the Amm-N limit of 'consistently maintain' < 30 g/m^3 was not met on 3 occasions between February 2015 and March 2015.

Results reported by Dada (2019a) showed a very high level of *E.coli*, in the discharge, up to 10^7 CFU/100mL, but that the levels of the representative pathogens which are known to cause illness were much lower and more variable.

3.0 Water Quality Effects

3.1 Introduction

The following assessment draws on a comparison of monitoring data at the upstream site (Hydro-race) and downstream site (Bridge) between 1 November 2012 and 12 March 2019, continuous dissolved oxygen and temperature surveys upstream and downstream of the discharge, site specific monitoring at Sites U1, U2, D1 and D2, continuous temperature monitoring upstream and downstream of the take and longitudinal water quality survey results.

The water quality parameters are compared with the relevant water quality standards and guidelines in the SWLP for the Mataura River, NPS-FM (2017) limits, various MfE guidelines and ANZECC (2000) guidelines for fresh and marine water (Table 17). The Plant lies within the Mataura 3 classification in the SWLP which are *the Protected Waters other than those parts classified as Mataura 1 (NZMS 260 F45:967-503 to F45:963-508) and Mataura 2 (between map references NZMS 260 F45:894-581 to F45:885-584 and NZMS 260 F46:917-391 to F46:924-396).*

A healthy river is a river that meets the NPS-FM, SWLP, MfE and ANZECC guidelines.

The potential and in some cases actual effects of the discharge on the receiving water quality that are assessed in this report are presented in Table 18 and include:

- Ammoniacal-N (Amm-N) toxicity.
- Increased nutrient concentrations.
- Increased bacteria concentrations.
- Reduced dissolved oxygen (DO) concentrations.
- Altered colour and clarity.
- Generation of foams and scums.

The potential effects assessed in this report and summarised in Table 18 were identified through analysis of the available discharge and receiving environment data. A brief summary of the nature and extent of these potential effects is set out below and is followed by a detailed assessment.

Table 17: Current River Monitoring and Water Quality Guidelines and Standards.

Parameter	Discharge Currently Monitored by Alliance	River Currently Monitored by Alliance	Discharge Consent Limit	River Consent Limit	SWLP (Mataura 3 Classification)	ANZECC (2000)** and MfE Guidelines	NPS (2017)			
							Attribute A	Attribute B	Attribute C	National Bottom Line
Temperature (°C)	No	Yes - weekly	-	< 3 °C change	< 3°C change when ambient is ≤ 16°C and < 1°C change when ambient is > 16°C	-	-			
Electrical Conductivity (μS/cm)	No	Yes - weekly	-	-	-	-	-			
Dissolved oxygen (g/m^3 and % saturation)	N/A	Yes – annually at Chalmers Rd*. Weekly since Jan 2018. One off longitudinal study.	-	> 5 mg/L	5 mg/L	98 – 105%	≥8.0 (7-day mean min*) ≥7.5 (1-day mean min*)	≥7.0 and <8.0 (7-day mean min*) ≥5.0 and <7.5 (1-day mean min*)	≥5.0 and <7.0 (7-day mean min*) ≥4.0 and <5.0 (1-day mean min*)	5.0 (7-day mean min*) 4.0 (1-day mean min*)
Clarity (m) black disc.	N/A	Yes** – annually	No conspicuous change	-	No conspicuous change	> 0.8	-			
Colour	N/A	Yes***	No conspicuous change	-	No conspicuous change	-	-			
Films, scums and foams	N/A	Yes***	-	-	Discharge to be substantially free from suspended solids, grease and oil	-	-			
pH	Yes - weekly	Yes - weekly	-	-	6–9 except when due to natural causes.	7.2 – 7.8	-			

*Summer = 1 November – 30 April. **Monitored during Summer-Autumn Low River Flows. *** added to monitoring in December 2017.

Parameter	Discharge Currently Monitored by Alliance	River Currently Monitored by Alliance	Discharge Consent Limit	River Consent Limit	SWLP (Mataura 3 Classification)	ANZECC (2000)** and MfE Guidelines	NPS (2017)			
							Attribute A	Attribute B	Attribute C	National Bottom Line
Total sulphide (g/m³)	Yes - weekly	No	< 5 Consistently <2	-	-	-	-			
Carbonaceous Biochemical oxygen demand (g/m³)	Yes - weekly	Yes ***	< 300 Total loading < 3,500 Kg/day	-	-	< 5	-			
Soluble Biochemical oxygen demand (g/m³)	No	No	-	-	-	< 2	-			
Nitrate-nitrite nitrogen (g/m³) (Toxicity)	No	Yes - weekly	-	-	No destruction of natural aquatic life, cause unpalatable or unsafe for humans and farm animals	< 0.444 (lowland site median)	≤1.0 (annual median) ≤1.5 (annual 95%)	>1.0 and ≤2.4 (annual median) >1.5 and ≤3.5 (annual 95%)	>2.4 and ≤6.9 (annual median) >3.5 and ≤9.8 (annual 95%)	6.9 (annual median) 9.8 (annual 95%)
Ammoniacal nitrogen (g/m³)	Yes – weekly	Yes - weekly	< 50 Consistently < 30	-		< 0.021	≤0.03 (annual median) ≤0.05 (annual maximum)	>0.03 and ≤0.24 (annual median) >0.05 and ≤0.40 (annual maximum)	>0.24 and ≤1.30 (annual median) >0.40 and ≤2.20 (annual maximum)	1.30 (annual median) 2.20 (annual maximum)
Total Kjeldahl nitrogen	Yes - weekly	No								
Total nitrogen (g/m³)	Yes***	Yes ***	-	-	-	< 0.614	-			

Parameter	Discharge Currently Monitored by Alliance	River Currently Monitored by Alliance	Discharge Consent Limit	River Consent Limit	SWLP (Mataura 3 Classification)	ANZECC (2000)** and MfE Guidelines	NPS (2017)			
							Attribute A	Attribute B	Attribute C	National Bottom Line
Total oxidised nitrogen	No	Yes - weekly	-	-	-	< 0.444 (lowland site median)				
Dissolved reactive phosphorus (g/m^3)	Yes - weekly	Yes - weekly	Total load < 14.4 kg/day	-	-	< 0.010	-			
Total phosphorus	Yes - weekly	Yes - weekly	-	-	-	< 0.033	-			
Turbidity (NTU)	No	Yes ***	-	-	-	< 5.6	-			
Total suspended solids	Yes - weekly	Yes - weekly	< 200 g/m^3 Consistently < 100 g/m^3	-	Discharges to be substantially free from suspended solids	-	-			
Faecal coliforms (CFU/100 ml)	No	No	-	-	< 1,000/100 mL	-	-			
E. coli (CFU/100 ml)	Yes - weekly	Yes – weekly during summer	-	-	< 130/100 mL at popular bathing sites	261 – 550/100mL (Microbiological Assessment Category C)	≤ 130 (annual median) ≤540 (95%) >540 (exceed <5%) >260 (exceed <20%)	≤ 130 (annual median) ≤1000 (95%) >540 (exceed 5-10%) >260 (exceed 20-30%)	≤ 130 (annual median) ≤1200 (95%) >540 (exceed 10-20%) >260 (exceed 20-34%)	

Parameter	Discharge Currently Monitored by Alliance	River Currently Monitored by Alliance	Discharge Consent Limit	River Consent Limit	SWLP (Mataura 3 Classification)	ANZECC (2000)** and MfE Guidelines	NPS (2017)			
							Attribute A	Attribute B	Attribute C	National Bottom Line
Heavy metals	Yes***	No	-	-	No destruction of natural aquatic life, cause unpalatable or unsafe for humans and farm animals	Refer to guidelines	-			
Organo nitrogen and phosphorus pesticides	Yes***	No	-	-	No destruction of natural aquatic life, cause unpalatable or unsafe for humans and farm animals	Refer to guidelines	-			
Surfactants (Mbas)	Yes***	N	-	-	No destruction of natural aquatic life, cause unpalatable or unsafe for humans and farm animals	Refer to guidelines	-			
Organics (SVOC and VOC)	Yes***	No****	-	-	No destruction of natural aquatic life, cause unpalatable or unsafe for humans and farm animals	Refer to guidelines	-			
Periphyton - Trophic State (mg chl-a/m²)	NA	Yes					≤50 (no more than 8% of samples)[1]	>50 and ≤120 (no more than 8% of samples)	>120 and ≤200 (< 8% of samples	200
Invertebrates	NA	Yes								
Fish	NA	No****			Shall not be rendered unsuitable for human consumption by presence of contaminants					

Note: * NPS (2017) criteria need to be developed to control periphyton growths by controlling DRP and DIN. ** lowland river guidelines presented. *** one sample collected in February 2018. **** one off sampling scheduled. [1]Mataura River defined as Default class. Minimum record length for grading a site based on periphyton (chl-a) is monthly for 3 years.

Amm-N

Elevated Amm-N has the potential to be toxic to a range of aquatic organisms and can contribute significantly to nitrogen enrichment (Richardson 1997). Table 19 provides a summary of acute toxicity mortality data for short-term experiments for a number of New Zealand species (Richardson 1997; Hickey and Vickers, 1994), including eels and other native fish, and a range of macroinvertebrates. The most sensitive species are invertebrates including the mayflies *Deleatidium* and *Zephlebia dentata*, the amphipod *Paracalliope fluviatilis*, the stonefly *Zelandobius furcillatus* and the clam *Sphaerium novaezelandiae*, and the caddisfly *Pycnocentria evecta*.

In a recent paper, Clearwater et al. (2013) also provided results of acute toxicity tests with glochidia (early larval stage that is parasitic on a host fish) of the New Zealand freshwater mussel *Echyridella menziesii*, which showed they were relatively sensitive with a 48-hr NOEC (No Observed Effect Concentration) of 8–10 mg total Amm-N-1 (pH 7.8).

Freshwater Solutions (2014) provides chronic Amm-N levels for various species from a number of studies. Data has also been reported for *Deleatidium*, which is a ubiquitous mayfly throughout the Mataura River, where the No Observed Effects Concentration (NOEC) levels over a 29-day period were 1.3 mg/L at pH=8/20ºC (Hickey et al. 1999) and the clam *Sphaerium novaezelandiae*, which was more sensitive with a chronic level over 60 days of 0.57 mg/L (Hickey and Martin 1999).

Hence, depending on concentrations the Amm-N concentration in the discharge has the potential to cause adverse effects in the mixing zone through chronic and acute toxicity, as well as result in non-toxic effects such as adversely affecting fish migration in the mixing zone. In addition, discharge Amm-N contributes to nitrogen loadings in the lower Mataura River and Toetoes Estuary.

Nutrients

Dissolved nitrogen and phosphorus can cause nuisance algal growths in some rivers (MFE 2000) while total phosphorus (TP) and total nitrogen (TN) can result in eutrophication effects such as nuisance macrophyte and macroalgal growths in the lower reaches of rivers and in estuaries (NIWA 2007, NIWA 2012).

The nitrogen and phosphorus load in the discharge has the potential to contribute to adverse cumulative effects as a result of elevated background nutrient concentrations in the Mataura River and the Toetoes Estuary. These effects are a result of point source as well as the input of nutrients from the wider catchment which will impact on the lower Mataura River (e.g., cyanobacteria blooms) and the Toetoes Estuary (e.g., macroalgae proliferations).

Microbial

Bacteria have the potential to cause human health issues (MFE/MoH 2003) directly through contact recreation and indirectly through contamination of fish and shellfish. MfE (2017) set out the following *E. coli* levels across various swimming categories:

- Excellent: < 5% exceedance of > 540 *E. coli*/100 mL.
- Good: 5 – 10 % exceedance of > 540 *E. coli*/100 mL.
- Fair: 10 – 20 % exceedance of > 540 *E. coli*/100 mL.
- Intermittent: 20 – 30 % exceedance of > 540 *E. coli*/100 mL.
- Poor: > 30 % exceedance of > 540 *E. coli*/100 mL.

Table 18: Summary of potential adverse effects associated with the discharge.

Potential effect	Mixing zone	Mataura River	Toetoes Estuary	Time
Amm-N toxicity	Y	Y	N	Discharge period
Increase nitrogen	Y	Y	Y	Discharge period for DIN. Year round for TN
Increase faecal bacteria	Y	Y	Y	Discharge period
Reduce dissolved oxygen	N	Y	N	Discharge period
Alter colour and clarity	Y	Y	N	Discharge period
Cause conspicuous foams and scums	Y	N	N	Discharge period
Nuisance algae	Y	Y	Y	Year round
Reduce benthic invertebrate community health	Y	Y	Y	Year round
Reduce fish abundance and diversity	Y	Y	Y	Year round
Reduce recreational use	Y	Y	Y	Year round

Table 19: Selected Amm-N toxicity data for New Zealand resident species.

Species	LC50 (mg/L)	LC10 (mg/L)	Reference
Anguilla australis (shortfin eel)	108	64	Richardson (1997)
Galaxias fasciatus (banded kokopu)	37, 27	22, 21	Richardson (1997)
Galaxias maculatus (inanga)	67	52	Richardson (1997)
Gobiomorphus cotidianus (common bully)	39	28	Richardson (1997)
Gobiomorphus huttoni (redfin bully)	50	33	Richardson (1997)
Retropinna (common smelt)	57, 27	28, 20	Richardson (1997)
Sphaerium novaezelandiae (clam)	21	12	Hickey and Vickers (1994)
Deleatidium spp. (mayfly)	21	4.3	Hickey and Vickers (1994)
Paracalliope fluviatilis (amphipod)	8.2[a]	2.2[b]	Hickey and Vickers (1994)
Paratya curvirostris (shrimp)	-	29	Hickey and Vickers (1994)
	35, 27	21, 20	Richardson (1997)
Potamopyrgus antipodarum (snail)	14, 16	8.7, 11	Hickey and Vickers (1994)
Pycnocentria evecta (caddis)	18	5.5	Hickey and Vickers (1994)
Zephlebia dentate (mayfly)	-	1.8	Hickey and Vickers (1994)
Zelandobius furcillatus (stonefly)	-	5.1[b]	Hickey and Vickers (1994)

Notes: Data are 96-hr LC50 or LC10 unless stated. Data adjusted to pH 8 and 20°C. [a]48-hr LC50, [b]48-hr LC10.

The background faecal indicator bacteria concentrations in the Mataura River and the Toetoes Estuary are elevated. There are a number of designated bathing areas in the lower Mataura River and contact recreation in the form of trout fishing, salmon fishing, white baiting, eel fishing and game bird hunting is common. The Toetoes Estuary is an important area for fishing and contact recreation and as a consequence the faecal indicator bacteria load in the discharge has the potential to adversely affect humans. Refer to Section 3 and Appendix 1 for the assessment of microbial related effects of the discharge.

Dissolved Oxygen

Dissolved oxygen is critical to supporting healthy aquatic ecosystems with concentrations needing to be above 5 g/m^3 as a minimum over 7 days and above 4 g/m^3 as a one day minimum to avoid adverse effects (NPS-FM 2017). The discharge has the potential to contribute to low summertime DO concentrations in the lower Mataura River that has the potential to have an adverse effect on aquatic biota.

Colour, Clarity, Foams and Scums

Wastewater discharges have the potential to have aesthetic effects by altering colour and clarity and generating foams and scums (MFE 1994). The Mataura River is heavily used by fishermen and for other recreational purposes including the section of river between the Mataura Bridge and Mataura Falls. The amount of recreational use increases the potential for the discharge to receive more attention due to potential adverse effects through altering colour and clarity and causing the generation of foams and scums.

3.2 Discharge Mixing

The full mixing zone assessment report by Streamlined Ltd (Dada 2019b) is presented in Appendix 2 and summarised below. To define the mixing zone extent, a hydrodynamic mixing model of the Alliance Plant discharge into the Mataura River was constructed and used to simulate river mixing of *E.* coli, which had previously (Dada, 2019) been shown to be present at elevated concentrations below the Alliance discharge. Over the 200 m–1 km distance below the discharge point it was assumed *E coli* was conservative (i.e. no die-off).

The EFDC model dilution maps for the Alliance Plant discharge show, as expected, that when the treated effluent is discharged into the river, it does not instantaneously mix with the receiving water. Instead, what forms is an effluent plume starting at the outfall as effluent begins to mix with the Mataura River water. The mixing zone is thus a transitional area within the Mataura River in which the treated effluent discharge is gradually assimilated into the Mataura River.

Because of the high receiving water to Alliance Plant wastewater ratio, the hydrodynamics of the river and the bank-side discharge mechanism, the discharged water is well mixed in the receiving environment. The plume does not travel along the river bank or accumulate along the river bank regardless of the hydrological and wind conditions.

The effect of the discharge is felt at the opposite stream bank within a longitudinal distance of approximately 50 m from the discharge point, where concentrations gradually begin to increase as a result of the plume extension.

At a longitudinal distance of approximately 100 m from the discharge point, no further analyte dilution takes place. At sites beyond this 100 m distance, analyte concentrations downstream of the discharge remain the same (i.e. more or less the same concentrations downstream). This is the point of full mixing.

These results were verified using TP analyte concentrations and similar results were obtained for the mixing zone - no further analyte dilution takes place at a longitudinal distance of approximately 100 m from the discharge point.

Based on this mixing model, the mixing zone could be affirmed to be approximately 100 m from the Alliance Plant discharge. Designating the site 100 m downstream of the discharge as the mixing zone for compliance monitoring, is, however, impractical. This is because it is not possible to safely access the river at this point at all times. The existing consent conditions set the mixing zone at a more accessible site, Mataura Bridge, approximately 330 m downstream of the outfall. If this site is maintained as a compliance monitoring site, the results of this modelling indicate that contaminants from the discharge will be fully mixed with river water at this point.

3.3 Physico-Chemical Parameters Immediately Upstream and Downstream

Temperature

River water temperature ranged between 2.3–23.2°C (median 11.2°C) upstream and 2.3–23.2°C (median 11.2°C) downstream. There is no apparent effect of the discharge on river temperature. The SWLP (2018) upper temperature guideline for lowland streams that receive discharges (< 23°C) was exceeded once in January 2018 (23.2°C); on that occasion the upstream temperature was also 23.2°C and it is evident the discharge did not result in the downstream increase in river temperature (Table 20 and Figure 16). The maximum river temperature recorded upstream and downstream has at times been close to exceeded the thermal tolerance for sensitive benthic invertebrates such as *Deleatidium* sp. (< 23 °C) (Tables 20 and 41 and Figures 16, 27, 30 and 31).

Table 20: Summary of temperature upstream (Hydro-race site) and downstream (Bridge site) of the Plant - November 2012 to March 2019.

	Temperature (°C)	
	Upstream	**Downstream**
Minimum	2.3	2.3
Maximum	23.2	23.2
Median	11.2	11.2
N	299	299

Note: N = number of samples.

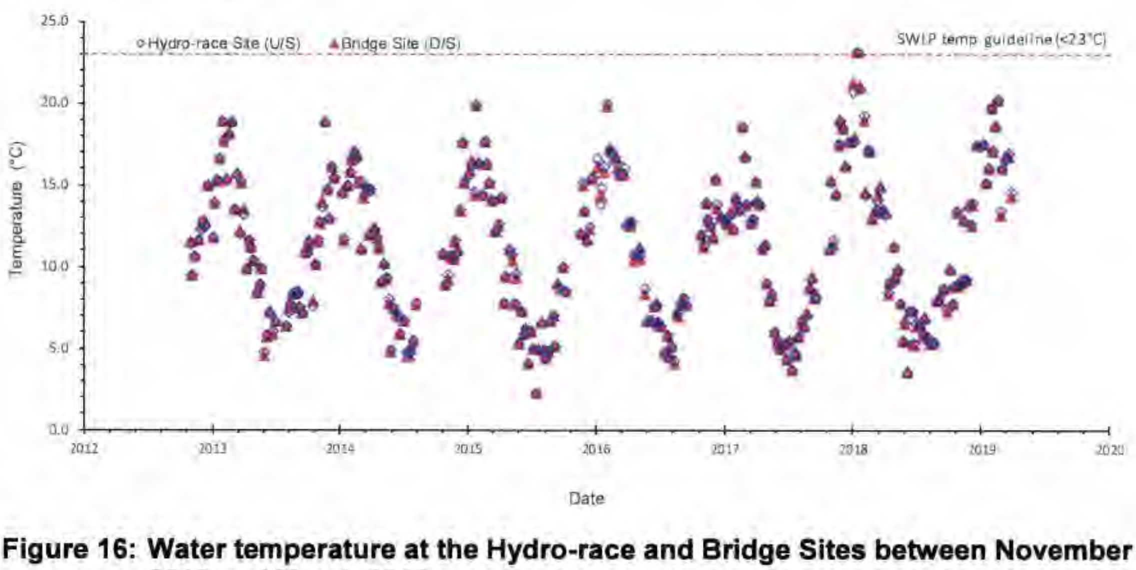


Figure 16: Water temperature at the Hydro-race and Bridge Sites between November 2012 and March 2019.

Dissolved Oxygen

Upstream and downstream DO concentrations monitored weekly between January 2018 and March 2019 remained above the SWLP (2018) standard (5 g/m^3) on all sampling occasions (median 10.5 g/m^3, range 8.3–12.5 g/m^3 and median 10.9 g/m^3, range 8.0–12.8 g/m^3, respectively) (Table 21). The NPS-FM (2017) numeric attribute state A for DO is > 8.0 g/m^3 (7-day mean, Summer Period: 1 November – 30 April) and > 7.5 g/m^3 (1-day minimum, Summer Period: 1 November – 30 April) was also met at upstream and downstream sites. Hence, weekly monitoring data indicates the discharge does not result in any effect on dissolved oxygen immediately downstream. The effects of the discharge on DO levels further downstream are discussed later in this report.

Table 21: Summary of DO upstream of the Plant (Hydro-race site) - November 2012 to March 2019.

	Dissolved Oxygen (g/m^3)	
	Upstream	**Downstream**
Minimum	8.3	8.0
Maximum	12.5	12.8
Median	10.5	10.9
N	55	55

Note: N = number of samples.

Turbidity

The discharge does not result in any marked effect on turbidity. Median turbidity at the upstream site was 5.6 NTU (range 0.6–310 NTU) and compares with 5.1 NTU at the downstream site (range 0.8–300 NTU) (Table 22).

Table 22: Summary of turbidity upstream (Hydro-race site) and downstream (Bridge site) of the plant – December 2017 to February 2019.

	Turbidity (NTU)	
	Upstream	**Downstream**
Minimum	0.6	0.8
Maximum	310	300
Median	5.6	5.1
N	51	51

Note: N = number of samples.

Total Suspended Solids

TSS concentrations exhibited a similar pattern upstream and downstream; the slight difference in median TSS concentrations upstream (5 g/m^3) compared with downstream (6 g/m^3) is attributed slightly higher downstream concentrations on the occasions when river TSS was high at both sites, rather than any consistent increase downstream (Table 23 and Figure 17).

Table 23: Summary of total suspended solids upstream (Hydro-race site) and downstream (Bridge sites) of the Plant - November 2012 to March 2019.

	TSS (g/m³)	
	Upstream	Downstream
Minimum	< 3	< 3
Maximum	480	490
Median	5	6
N	290	289

Note: N = number of samples.

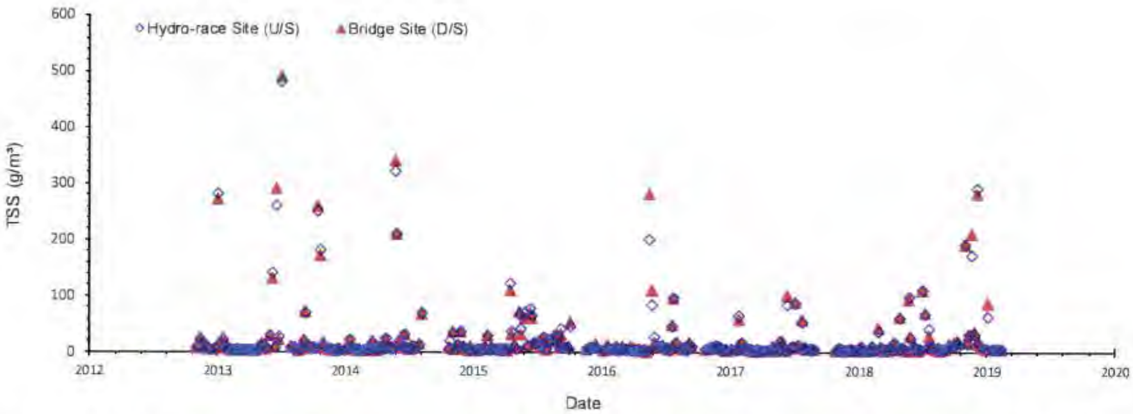


Figure 17: River TSS at the Hydro-race and Bridge Sites between November 2012 and March 2019.

pH

Median pH values over the monitoring period were identical upstream and downstream (pH=7.4) and exhibited little variance (standard deviation at both sites = 0.2); pH values at both sites rarely deviated beyond 0.3 pH units either side of the median. Upstream and downstream pH values were within the range stipulated in the SWLP (2018), i.e., 6.5-9.0, on all occasions bar one at the upstream site in May 2015 (Table 24 and Figure 18).

Table 24: Summary of pH upstream (Hydro-race site) and downstream (Bridge site) of the plant - November 2012 to March 2019.

	pH	
	Upstream	Downstream
Minimum	6.4	6.5
Maximum	8.6	8.2
Median	7.4	7.4
N	290	290

Note: N = number of samples.

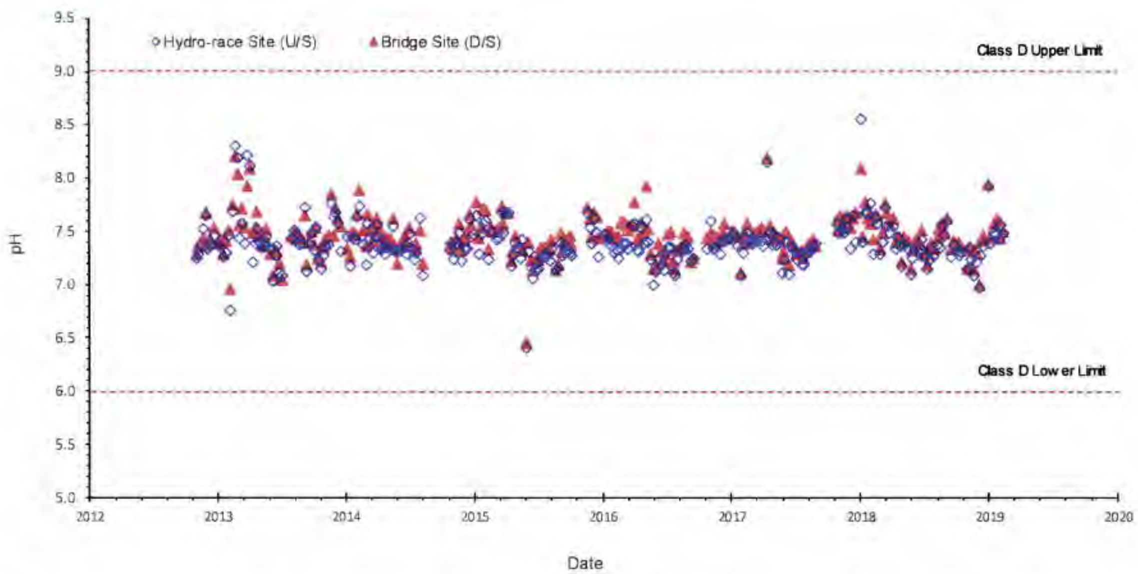


Figure 18: River pH at the Hydro-race and Bridge Sites between November 2012 and March 2019.

3.4 Nutrients

Biological Oxygen Demand

A small amount of BOD data at upstream and downstream sites is available from December 2017 to March 2019. This indicates BOD concentrations were similar at both sites where the upstream median BOD was <2 g/m³ and the downstream medium BOD was also <2 g/m³, thus both are well below the guideline of <2 g/m³ for avoiding nuisance algal growths. Hence, effects on aquatic biota, or the formation of sewage fungus, immediately downstream of the discharge due to BOD are not anticipated. This conclusion is supported by the regular visual observations during summer low flow conditions between the discharge point and Mataura Bridge by Alliance staff with no sewage fungus observed between 2012 and 2018. What appeared to be a very small amount of sewage fungus was recorded at Site D1 in March 2019 with the aid of an underwater viewer (Table 25).

Table 25: BOD concentrations at the Hydro-race and Bridge Sites between December 2017 and March 2019.

	BOD (g/m³)	
	Upstream	**Downstream**
Minimum	< 2	< 2
Maximum	4.6	3.5
Median	< 2	< 2
N	58	52

Note: N = number of samples.

Nitrate+Nitrite Nitrogen

The discharge contains low concentrations of nitrate-nitrogen and this is consistent with the observation that there is little difference in nitrate-nitrogen concentrations upstream and downstream of the discharge (Table 26 and Figure 19). At both sites annual median nitrate-nitrogen concentrations met the NPS (2017) numeric attribute state A for toxicity (≤1.0 g/m^3) for all years of sampling. It is noted nitrate nitrogen concentrations at both sites exceeded the ANZECC (2000) 'physical and chemical stressor' trigger value, which relates to nuisance plant growths, for lowland rivers (0.444 g/m^3). This is discussed further later in this report.

Table 26: NO_3-N + NO_2-N concentrations at the Hydro-race and Bridge Sites between November 2012 and March 2019.

	NO_3-N + NO2-N (g/m^3)	
	Upstream	Downstream
Minimum	0.3	0.1
Maximum	2.1	2.2
Median	0.8	0.9
N	290	290

Note: N = number of samples.

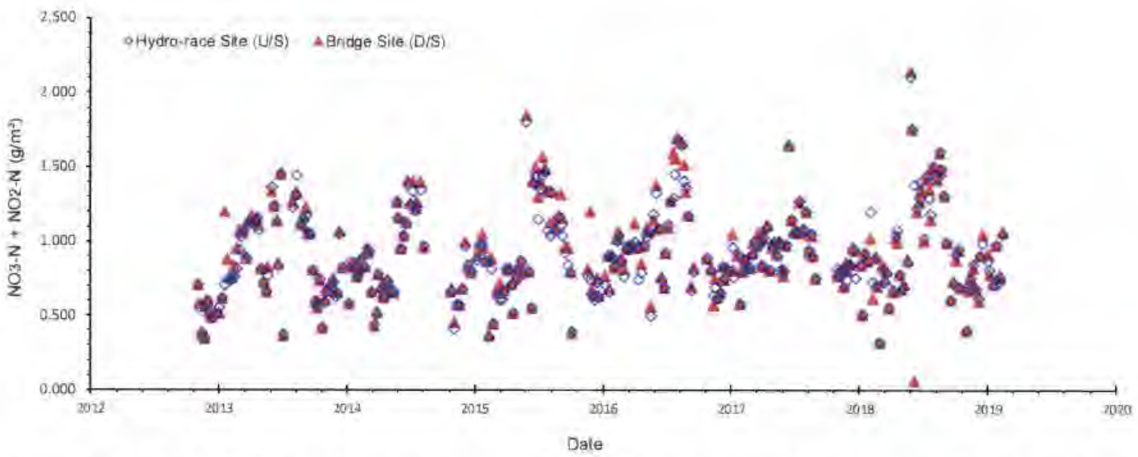


Figure 19: NO_3-N + NO_2-N concentrations at the Hydro-race and Bridge Sites between November 2012 and March 2019.

Ammoniacal-Nitrogen

The median discharge concentrations of ammoniacal-nitrogen for the monitoring period was 15 g/m^3 (5%-ile-95%-ile: 5.9–29 g/m^3), therefore there is potential for a measurable increase in ammoniacal-nitrogen to be found downstream of the discharge. Indeed, whereas the numeric attribute state A for ammoniacal nitrogen for toxicity (≤ 0.03 g/m^3) was always met at the upstream site (annual medians 0.02–0.03 g/m^3), ammoniacal nitrogen concentrations were consistently slightly higher downstream, refer Table 27 and Figure 20. Downstream ammoniacal nitrogen concentrations fall just into NPS attribute state B for toxicity (0.03–0.24 g/m^3) on all occasions (annual medians 0.05-0.06 g/m^3).

The change from attribute state A upstream, to B downstream, is a change from a 99% species protection level to a 95% species protection level, i.e., 5% of the most ammoniacal nitrogen sensitive species may be occasionally affected. Such species are exclusively freshwater mussels, which do not occur in the Mataura River immediately upstream or downstream. Ammoniacal nitrogen sensitive species that do occur in the Mataura River in the vicinity of the discharge are *Deleatidium sp.* and *Potamopyrgus antipodarum*, but these fall within the top 20% of sensitive species that are protected by the Attribute B state.

In addition, it has been noted that the NPS ammoniacal nitrogen numeric attribute states for toxicity are considered unreliable and overly conservative due to the manner in which they were derived and included estimates of toxicity data rather than that which had been obtained empirically (Freshwater Solutions, 2016). Raw toxicity data for those species relevant to the Mataura River include those referenced in Table 18, which includes *Deleatidium sp*, which is typically abundant on the Mataura river in the vicinity of the discharge. The chronic NOEC for *Deleatidium* is 1.3 g/m^3 at pH=8/20°C (Hickey *et al.* 1999), hence effects are not anticipated for this species or other aquatic biota at the downstream site due to the discharge of ammoniacal nitrogen.

Median ammoniacal nitrogen concentrations exceeded ANZECC (2000) 'physical and chemical stressor' trigger values, which relate general water quality and an increased risk of nuisance plant growths, for lowland rivers (0.021 g/m^3) at both sites.

Table 27: Amm-N concentrations at the Hydro-race and Bridge Sites between November 2012 and March 2019.

	Amm-N (g/m^3)	
	Upstream	**Downstream**
Minimum	< 0.001	< 0.001
Maximum	0.240	0.240
Median	0.030	0.050
N	290	290

Note: N = number of samples.

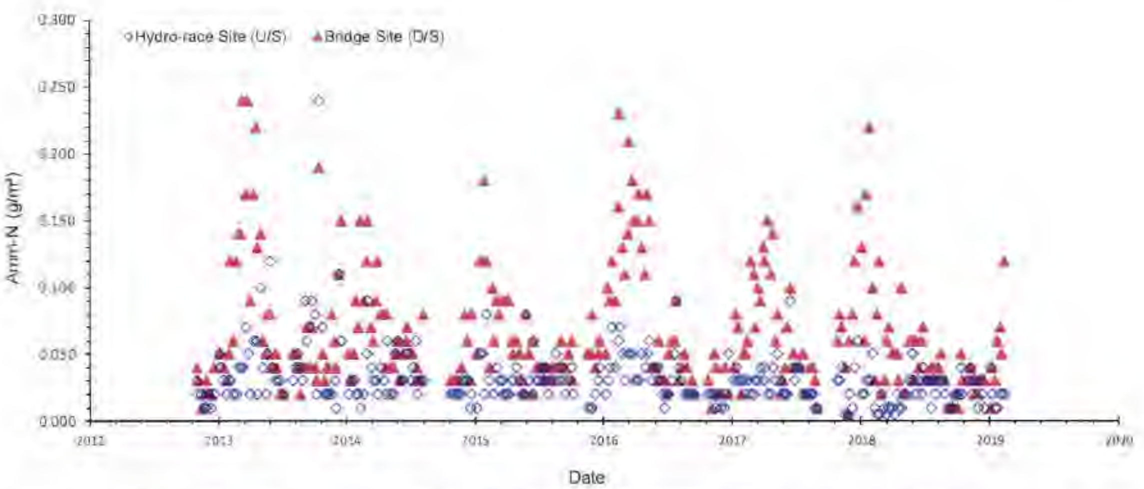


Figure 20: Amm-N concentrations at the Hydro-race and Bridge Sites between November 2012 and March 2019.

Total Nitrogen

Limited upstream and downstream TN data is available from December 2017 to March 2019 (Table 28). However, this indicates TN concentrations were slightly higher downstream; upstream the median TN was 1.1 g/m³ (range 0.56–3.4 g/m³) and downstream the medium TN was 1.2 g/m³ (range 0.62–3.5 g/m³).

Table 28: TN concentrations at the Hydro-race and Bridge Sites between December 2017 and March 2019.

	TN (g/m³)	
	Upstream	**Downstream**
Minimum	0.56	0.62
Maximum	3.4	3.5
Median	1.1	1.2
N	58	54

Note: N = number of samples.

Dissolved Inorganic Nitrogen

DIN results for Sites U1, U2, D1 and D2 are only available for the period between July 2018 and February 2019 and is presented in Table 29. DIN concentrations were very similar between sites. Mean monthly DIN concentrations at all sites exceeded the MfE periphyton guideline for protecting benthic biodiversity across all growth periods (Table 30). Note, nutrient concentration guidelines are based on mean monthly concentrations over a year however the mean monthly data shown in Table 29 is based on 8 samples collected between July 2018 and February 2019.

Table 29: Dissolved inorganic nitrogen results between July 2018 and February 2019.

	Upstream		Downstream	
	Site U1	**Site U2**	**Site D1**	**Site D2**
Minimum	0.40	0.40	0.40	0.40
Maximum	1.5	1.6	1.5	1.5
Mean	0.90	0.90	0.90	0.91
N	8	8	8	8

Note: N = number of samples. All results in g/m³.

Algal growths in rivers are strongly influenced by a range of chemical (e.g. nutrient concentrations), biological (e.g. grazing pressure from macroinvertebrates) and physical factors (e.g. frequency of flow disturbance events). It is therefore not appropriate to compare nutrient concentrations to fixed values such as in ANZECC (2000). For this assessment the MfE (2000) periphyton guidelines which relate nutrient concentrations to accrual periods and flow disturbance events have been used to assess the potential effects of the nutrients from the discharge on algal growths (Table 30). The DIN concentrations upstream and downstream of the Plant far exceeded the recommended DIN (also referred to as Soluble Inorganic Nitrogen or SIN) guideline for preventing excessive periphyton growths across the range of accrual periods over the 8 months of sampling between July 2018 and February 2019.

Table 30: The MfE (2000) guideline maximum mean monthly SIN and DRP concentrations for preventing excessive periphyton growth.

Days of accrual	SIN (g/m³)	DRP (g/m³)
20+	<0.295	<0.026
30+	<0.075	<0.006
40+	<0.034	<0.0028
50+	<0.019	<0.0017
75+	<0.010	<0.001
100+	<0.010	<0.001

Note: Taken from MfE (2000).

Total Phosphorus

Annual median total phosphorous concentrations at both sites did not exceed the ANZECC (2000) guideline of <0.33 g/m³; on an individual sampling basis the guideline was rarely exceeded (three times out of 290 or 1.0% of samples at upstream and downstream sites) (Table 31 and Figure 21).

Table 31: TP concentrations at the Hydro-race and Bridge Sites between November 2012 and March 2019.

	TP (g/m³)	
	Upstream	Downstream
Minimum	< 0.02	< 0.02
Maximum	0.42	0.42
Median	0.02	0.03
N	290	290

Note: N = number of samples.

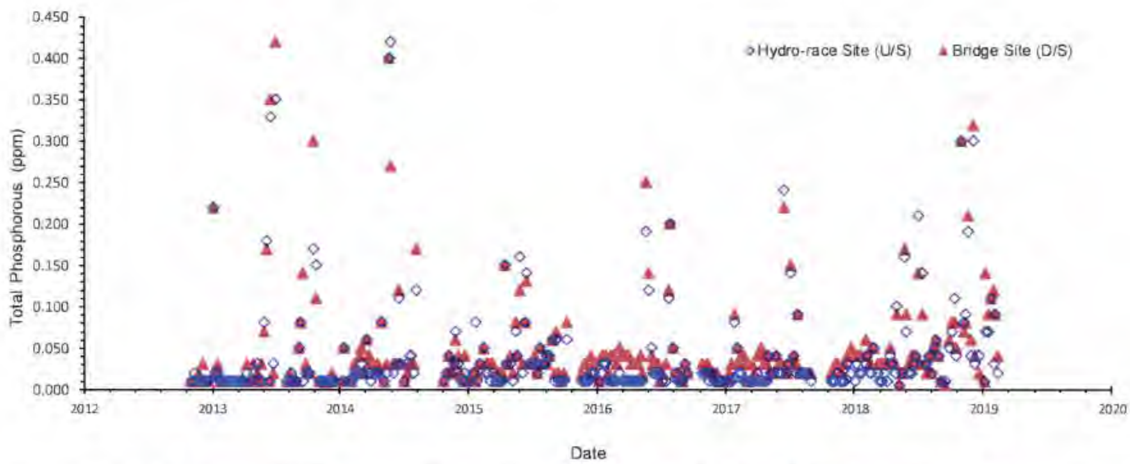


Figure 21: TP concentrations at the Hydro-race and Bridge Sites between November 2012 and March 2019.

Dissolved Reactive Phosphorus

At the Hydro-race Site upstream the ANZECC (2000) DRP nuisance growth trigger value of 0.01 g/m³ was exceeded on 39% of sampling occasions (median 0.009 g/m³, range <0.006–0.050 g/m³) and were consistently slightly higher at the Bridge Site where the trigger value was exceeded on 69% of sampling occasions (median 0.013 g/m³, range <0.004–0.050 g/m³). The median 0.04 g/m³ increase in DRP concentrations at the Bridge Site is not consistent with the low concentrations of DRP in the discharge (median = 0.20 g/m³) (Figure 22), which would typically report as a downstream increase of DRP of approximately 0.0002 g/m³. Hence, it is likely the increase in DRP at the Bridge Site is due to release of phosphorus from sediment, suspended and/or on the river bed.

DRP results for Sites U1, U2, D1 and D2 are available for the period between July 2018 and February 2019 and are presented in Table 32. DRP concentrations were slightly higher at upstream sites compared to downstream sites which appears to be counter to the long-term results that showed an increase in DRP at the Bridge Site. Possible explanations for the apparent difference between the short and long term DRP monitoring results is the very small number of data points (n = 8) and the difference in the site locations.

Mean monthly DRP concentrations at all sites exceeded the MfE periphyton mean monthly guideline (based on 12 months) for protecting benthic biodiversity across all growth periods (Tables 30 and 32). The periphyton cover and biomass results since 2012 (refer to periphyton section in report) indicate that DRP is higher than the MfE guidelines but the observations for periphyton suggest DRP is not stimulating periphyton growths upstream and downstream except following very long late summer – early autumn accrual periods.

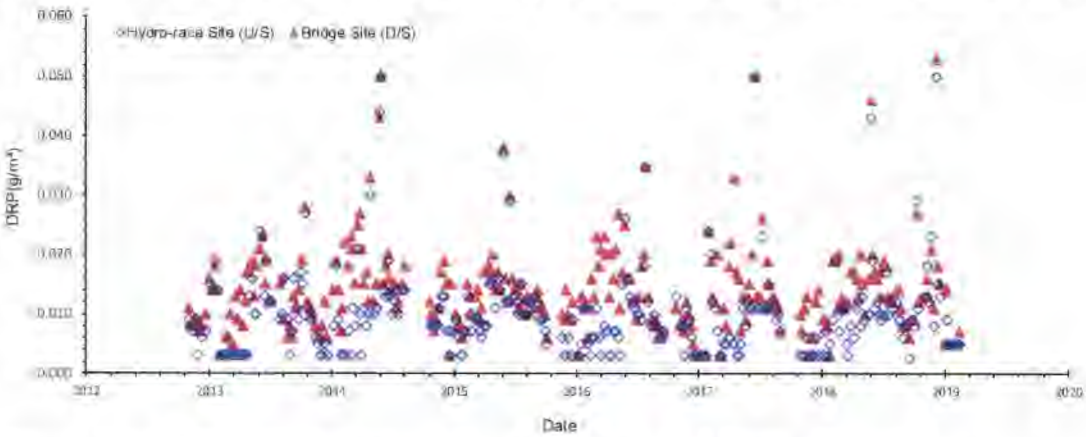


Figure 22: DRP concentrations at the Hydro-race and Bridge Sites between November 2012 and March 2019.

Table 32: Dissolved reactive phosphorous between July 2018 and February 2019.

	Upstream		Downstream	
	Site U1	Site U2	Site D1	Site D2
Minimum	0.002	0.002	0.002	0.002
Maximum	0.029	0.022	0.017	0.015
Mean	0.011	0.011	0.010	0.010
N	8	8	8	8

Note: N = number of samples. All results in g/m³.

3.5 Longitudinal Survey Results

A longitudinal survey of nutrients in the Mataura River was undertaken on 12 January 2018 (Table 33), and then again on 23 January 2019 (Table 34). The locations of the sampling sites is shown in Figure 23 and 24 respectively. Tributaries (Sites C, C and D) were also sampled on 12 January 2018 as shown on Figure 23. At sites immediately upstream (i.e., 1 and 2, and UP3 and PDP1) and immediately downstream (i.e., 3 and 4, and PDP2 and PDP3) of the discharge there is little evidence of changes in water quality due to the discharge other than an approximately 0.2 g/m^3 increase in TN (attributable to TKN) at Site 4 and Site PDP3. Total nitrogen concentrations returned to close to upstream concentrations at Sites 5 and Site 6. This suggests that TN will only potentially affect the river for approximately 2.5 km downstream of the discharge Below that point concentrations trend upward and then downwards; such variability is expected given there are other opportunities for nitrogen input downstream of the discharge (e.g., tributaries, sediment release) as well as consumptive processes occurring in the river. TN concentrations exceeded the ANZECC (2000) 'stressors' trigger for lowland rivers (0.641 g/m^3) at all sites indicating the potential for stimulating algal growths. The results of periphyton surveys have shown that the periphyton community can approach or exceed periphyton cover and biomass guidelines upstream and downstream of the discharge following extended accrual periods (refer to Section 4) (Tables 33, 34 and Figures 23, 24).

With respect to other parameters: BOD concentrations were < 2 g O_2/m^3, TP concentrations showed little variability over the reach surveyed and did not exceed the ANZECC (2000) trigger of < 0.33 g/m^3 at any site, although DRP showed an increase at Site 8, reducing further downstream; downstream chloride increases reflect input from tributaries; and, turbidity was low and variable both upstream and downstream.

Table 33: 12 January 2018 longitudinal survey nutrient results.

		BOD (g/m^3)	Chloride (g/m^3)	DRP (g/m^3)	TP (g/m^3)	TKN (g/m^3)	TON (g/m^3)	TN (g/m^3)
Site 1	▲	<2.0	<5.0	0.009	0.02	0.21	0.63	0.84
Site 2	▲	<2.0	<5.0	0.011	0.02	0.20	0.65	0.84
Site 3	▼	<2.0	<5.0	0.008	0.02	0.23	0.54	0.77
Site 4	▼	<2.0	<5.0	0.010	0.03	0.45	0.50	0.95
Site 5	▼	<2.0	<5.0	0.010	0.02	0.22	0.58	0.80
Site 6	▼	<2.0	<5.0	0.011	0.03	0.24	0.60	0.84
Site 7	▼	<2.0	<5.0	0.012	0.03	0.27	0.61	0.88
Site 8	▼	<2.0	5.6	0.019	0.04	0.35	0.69	1.00
Site 9	▼	<2.0	5.1	0.016	0.03	0.28	0.71	0.99
Site 10	▼	<2.0	5.6	0.017	0.03	0.31	0.39	0.70
Site 11	▼	<2.0	5.7	0.013	0.03	0.26	0.48	0.75
Site 12	▼	<2.0	5.8	0.012	0.02	0.28	0.51	0.79
Site 13	▼	<2.0	6.5	0.016	0.03	0.25	0.47	0.72
Site B	▼	<2.0	16	0.014	0.04	0.50	0.15	0.65
Site C	▼	<2.0	21	0.014	0.03	0.50	0.05	0.55
Site D	▼	<2.0	29	0.014	0.02	0.71	0.70	1.40

Note: ▲ upstream from discharge and ▼ downstream from discharge.

Table 34: 23 January 2019 longitudinal survey nutrient results.

	BOD (g/m^3)	Chloride (g/m^3)	TKN (g/m^3)	TN (g/m^3)	TON (g/m^3)	TP (g/m^3)	Turbidity (NTU)
UP1 (U/S)	< 2	6	0.17	1.1	1	0.02	1.4
UP2 (U/S)	< 2	5.2	0.12	1.2	1	0.02	2
UP3 (U/S)	< 2	< 5	0.16	1.2	1	0.02	1.2
PDP1 (U/S)	< 2	6	< 1	1.1	1	0.02	1.7
PDP2 (D/S)	< 2	6.3	0.11	1.2	1	0.01	1
PDP3 (D/S)	< 2	8.8	0.31	1.3	1	0.03	1.7
BRIDGE (D/S)	< 2	7.3	0.23	1.4	1	0.03	2
PDP4 (D/S)	< 2	7.6	0.22	1.3	1	0.03	1.3
PDP5 (D/S)	< 2	7.4	0.28	1.3	1	0.02	1.4

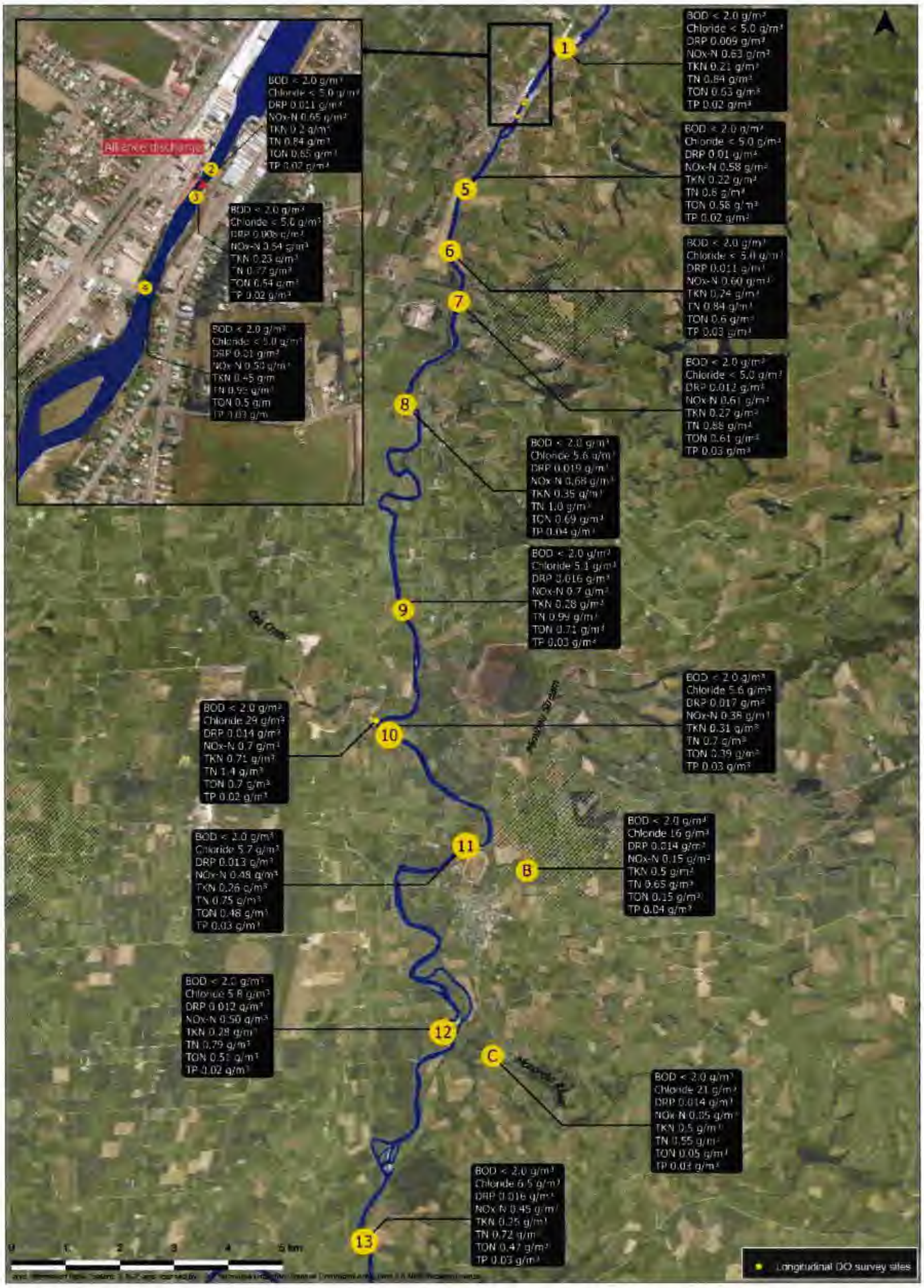


Figure 23: 12 January 2018 longitudinal survey sampling locations and results.

Figure 24: 23 January 2019 longitudinal survey sampling locations and results.

3.6 Nutrient Loads to Toetoes Estuary

The current water quality and ecological health of Toetoes Estuary was described in Freshwater Solutions (2019). Freshwater Solutions (2019) reported:

Stevens and Robertson (2012 and 2017) reported that the extensive subtidal growth present in the estuary is driven by the very high nutrient loads entering the estuary (estimated N load based on NIWA's CLUES model with 2002 land cover is 2,450 tonnes N year, therefore based on current land use is likely to be >4,000 tonnes N year). Because the estuary is relatively small in comparison to the very large freshwater inflow (mean flow 76m³/s), most of the N inflow is rapidly flushed out to sea. However, the high N inputs support excessive growths of nuisance macroalgae in areas exposed to elevated nutrient concentrations and low salinity conditions.

Stevens (2018) reported the results of the 2018 broad scale intertidal habitat mapping of Toetoes Estuary describing the estuary a medium-sized, short residence, tidal river type estuary with a lagoon that discharges to Toetoes Beach at the mouth of the Mataura River and Titiroa Stream. Toetoes Estuary drains a large and primarily high productivity agricultural catchment and has a large freshwater influence because the estuary is small in relation to the freshwater input. Stevens (2018) concluded that the results indicate that although large sections of the lower estuary remain in good condition, sheltered upper estuary embayments, have developed stable nuisance macroalgal growths with poorly oxygenated sediments since 2013. Stevens (2018) went on to state:

These gross eutrophic zones are displacing high value seagrass beds and stressing saltmarsh and benthic habitat. Elsewhere, extensive subtidal growths of macroalgae, and low sediment oxygenation within unvegetated intertidal sediments highlights degradation that is likely to be causing significant ecological stress to the macroinvertebrate communities. Such conditions limit food availability for fish and birdlife, and show the estuary is in a "MODERATE" but declining condition in relation to eutrophication. The ongoing drainage and loss of saltmarsh and densely vegetated terrestrial margins is also placing the estuary under pressure. Excessive nutrient inputs are the primary driver of the eutrophication symptoms being expressed, the estimated ~1700 mgN/m²/d close to where nuisance growths are expected (> 2,000 mgN/m²/d), and well above the thresholds for SIDE estuaries (>100mgN/m2 /d). These high loads are well above natural inputs and highlight there are sufficient nutrients to fuel algal growths in the estuary.

Stevens (2018) reports NIWA's Coastal Explorer database and CLUES model outputs from October 2018, which estimates a catchment load of 3,110 tonnes N per Year - significantly lower than the previous estimate of >4,000 tonnes N per year. The estimated catchment load of phosphorus is 345 tonnes per year.

Based on data from the five seasons from 2012/13 to 2017/18, the Plant discharge loads of TN (estimated from TKN) have ranged from 33-52 tonnes N per year. Hence the TN discharge contribution to the Toetoes Estuary load is 1.1-1.7% (based on 3,110 tonnes). Likewise, the seasonal TP loads have ranged from 2.4–4.4 tonnes P per year and, therefore, the estimated TP discharge contribution to the Toetoes Estuary load is 0.7–1.3%.

There is limited TN and TP data for the Mataura River, however based on data collected weekly from 1 January 2018 to 31 December 2018 the annual river load estimates of TN are 4,400 tonnes at both the downstream and upstream site. This load is more aligned with previous estimates of TN to Toetoes Estuary (>4,000 tonnes per year) than that estimated by the 2018 CLUES model, although it is acknowledged by Stevens (2018) that point source estimates of TN in the 2018 CLUES model are likely underestimated. Regardless, it is evident the vast majority of TN to Toetoes Estuary is derived from inputs upstream of the Plant's discharge.

Likewise, the annual river load estimates of TP at the downstream and upstream sites are 390 tonnes and 360 tonnes, respectively. This compares reasonably well with the CLUES estimate of 345 tonnes from the Toetoes Estuary and infers the vast bulk of the TP load to the Toetoes estuary is from the Mataura River upstream of the discharge.

BOD loads to Toetoes Estuary have not been subject to CLUES modelling. Based on the BOD data presented in this report, seasonal discharge loads ranged from 158–241 tonnes per year (as O_2). Mataura River BOD concentrations in the monitoring period were usually less than the analytical detection limit (< 2/g/m^3) at the upstream and downstream sites. On that basis BOD loads are best estimated as 'less than' limits of <510 tonnes per year and <470 tonnes per year, respectively for upstream and downstream sites. On first sight there is a disconnect between the upstream and downstream BOD load estimates and the discharge loads but, analytical factors aside (i.e., loads being inaccurate because many BOD results are less than the detection limit), this difference is most likely due to BOD consumption occurring between upstream and downstream sites.

The discharge load is high compared with the downstream load (34–48%), but without detailed BOD fate investigations continual consumptive processes make it impossible to accurately assess the effects of discharge BOD loads. It is likely that BOD loads reporting to Toetoes Estuary are significantly less than those estimated at the downstream site. The results of DO monitoring using sondes at Chalmers Road (13 Km downstream) indicate that the BOD load does not cause DO depletion.

In summary, it is considered the far-field effects, i.e., to lower Mataura River and Toetoes Estuary, of TN and TP in the discharge, are no more than minor. Even a marked reduction of the discharge loads of TN and TP would have little, if any, effect on the nutrient status of Toetoes Estuary.

3.7 Effects on Colour

Hue and brightness are the main attributes used to describe water colour (MfE 1994), which is well characterized by the Munsell system (Davies-Colley and Nagels 1999). Alliance conducted a series of Munsell colour measurements at the Hydro-race and Bridge Site between 13 December 2017 and 27 March 2018. The results are presented in Table 35. The water colour at both sites was predominantly 2.5GY (32.5) 8/2 (pale greenish yellow) and only differed marginally between upstream and downstream sites on two occasions. The results indicate that the discharges from the Plant do not adversely affect colour.

Table 35: Munsell colour results between 13 December 2017 and 27 March 2018.

Date	Upstream Hydro-race Site	Downstream Bridge Site
13/12/2017	10Y (30) 8/2	10Y (30) 8/2
2/01/2018*	5Y (25) 8/2	5Y (25) 8/2
8/01/2018	10Y (30) 4/2	5Y (25) 4/2
16/01/2018	5GY (35) 7/6	7.5Y (27.5) 7/6
7/02/2018	2.5GY (32.5) 8/2	2.5GY (32.5) 8/2
15/02/2018	2.5GY (32.5) 8/2	2.5GY (32.5) 8/2
19/02/2018	2.5GY (32.5) 8/2	2.5GY (32.5) 8/2
27/02/2018	5Y (25) 7/6	5Y (25) 7/6
2/03/2018*	2.5 GY (32.5) 8/2	2.5 GY (32.5) 8/2
7/03/2018	2.5 GY (32.5) 8/2	2.5 GY (32.5) 8/2
14/03/2018	2.5 GY (32.5) 8/2	2.5 GY (32.5) 8/2
19/03/2018	2.5 GY (42.5) 8/2	2.5 GY (42.5) 8/2
27/03/2018	2.5 GY (42.5) 8/2	2.5 GY (42.5) 8/2

Note: *No processing onsite.

3.8 Effects on Clarity

Water clarity affects aesthetic values and aquatic biological communities (MFE 1994). Rowe and Dean (1998) reported that banded kokopu avoided waters with >20–25 NTU. Inanga and smelt are less sensitive to turbidity and can tolerate levels less than 160 NTU (Rowe et al. 2002). Total suspended solids (TSS), turbidity and visual clarity measured by black disc sighting distance are not always well correlated as they measure different aspects of light penetration and water characteristics.

The Mataura River upstream and downstream of the discharge does meet the black disc visual sighting distance of >1.6 m for waterways that are managed for contact recreation (MFE 1994). The current consent does not set clarity limit of change between upstream and downstream and instead the 20% guideline appears to have been selected from the MFE guidelines (MFE 1994), which states that 'for class A waters (where visual clarity is an important characteristic of the water body): the visual clarity should not be changed by more than 20%'. MFE (1994) states that 'for other waters: the visual clarity should not be changed by more than 33–50% depending on the site conditions'. The RMA Section 107 also states that a discharge permit should not be granted if there is 'any conspicuous change in the colour or visual clarity'.

River water clarity has been monitored at Sites U1, U2, D1 and D2 during biological surveys since 2012 (Table 36). The clarity has been lower at the downstream sites compared to upstream on most sampling occasions with the difference in the mean upstream and the mean of the mean downstream clarity ranging from -20% to +1%. All black disc readings have been above the MfE guideline of >1.6 m for swimming at all sites on all sampling occasions.

Median TSS and turbidity results from the upstream and downstream monitoring sites, presented in Table 22 and Table 23, are similar with just a slight increase in both at the downstream sites. It is possible that the decline in clarity observed at Sites D1 and D2 is the combined effect of the energy from the Mataura Falls resuspending fine material and the discharge. Overall, the discharge is not likely to result in a conspicuous change in clarity.

Table 36: Black disc readings at sites during surveys between 2012 and 2017.

Survey	Upstream Black Disc distance (m)		Downstream Black Disc distance (m)		% Difference between Upstream and Downstream
	U1	U2	D1	D2	
Jan 2012	3.2 (3.1–3.4)	3.4 (3.3–3.4)	2.5 (2.4–2.6)	2.9 (2.8–2.9)	-18%
Mar 2013	3.4 (3.3–3.5)	3.7 (3.7– 3.7)	2.6 (2.4–2.7)	3.1 (2.9–3.2)	-20%
Apr 2013	3.2 (3.1–3.2)	3.1 (2.9–3.3)	2.8 (2.6–2.9)	3.2 (3.1–3.2)	-5%
Mar 2014	2.70 (2.60–2.90)	2.40 (2.20–2.60)	1.95 (1.85–2.00)	2.50 (2.40–2.60)	-13%
Jan 2015	2.71 (2.69–2.73)	3.12 (3.10–3.14)	2.51 (2.50–2.52)	2.63 (2.60–2.65)	-12%
Feb 2016	3.10 (3.09–3.10)	3.52 (3.50–3.55)	3.01 (2.99–3.03)	3.05 (3.04–3.06)	-8%
Jan 2017	3.12 (3.07–3.15)	2.85 (2.80–2.90)	3.17 (3.10–3.20)	2.87 (2.65–3.00)	+1%
Dec 2017	3.02 (2.98–3.05)	3.00 (3.00–3.01)	2.96 (2.93-3.00)	2.90 (2.88-2.93)	-3%

Notes: Results presented as mean values with ranges in parentheses; and n=3.

3.9 Effects from Foams and Scums

Conspicuous foams and scums can reduce the aesthetic values and human enjoyment of waterways (MFE 1994). The RMA Section 107 requires that a discharge cannot be permitted, if after reasonable mixing, there is 'production of any conspicuous oil, or grease films, scums or foams of floatable or suspended materials'.

Alliance maintained a register of any foam or scum observed during the 2017/18 processing season (Table 37). Foam was observed on 14 occasions with the foam originating below the falls upstream of the Alliance discharge on all occasions with the exception of 2 February 2018 and 28 March 2018. The foam observed on 2 February 2018 was recorded when the discharge was closed. The survey results indicate that foams and scums form below the falls and upstream of the Plant discharge. This conclusion is consistent with the assessment made for the previous assessment of effects (Alliance Group 2003). Overall, the discharge does not appear to result in the generation of conspicuous foams or scums.

Table 37: Timings and location of foam recorded during the 2018 processing season.

Date	Origin of foam	Comment
27/11/2017	Upstream	-
4/01/2018	Upstream	Below falls
8/01/2018	Upstream	Below falls
16/01/2018	Upstream	Below falls
2/02/2018	Downstream	Foam forming in flood waters. No processing on 2/2/18 or 3/2/18
7/02/2018	Upstream	Foam developing at base of small waterfall
15/02/2018	Upstream	Foam developing at base of small waterfall
19/02/2018	Upstream	Foam developing at base of small waterfall
28/02/2018	Upstream	Foam developing at base of small waterfall
2/03/2018	Downstream	Foam observed downstream of discharge
7/03/2018	Upstream	Foam developing at base of small waterfall and flowing downstream
14/03/2018	Upstream	Foam developing at base of small waterfall
4/04/2018	Upstream	Foam originating upstream of discharge and flowing over discharge to downstream
13/12/2018	Upstream	Below falls

3.10 Microbial Effects

The following section has been prepared by Streamlined Ltd (refer to Dada 2019b).

The Receiving Environment

Current risk assessment is based on a monitoring system that assesses the levels of *Escherichia coli* in *the* Mataura River. Since 2007, *E. coli* data has been collected for a number of sites in the Mataura River and associated tributaries (Figure 25).

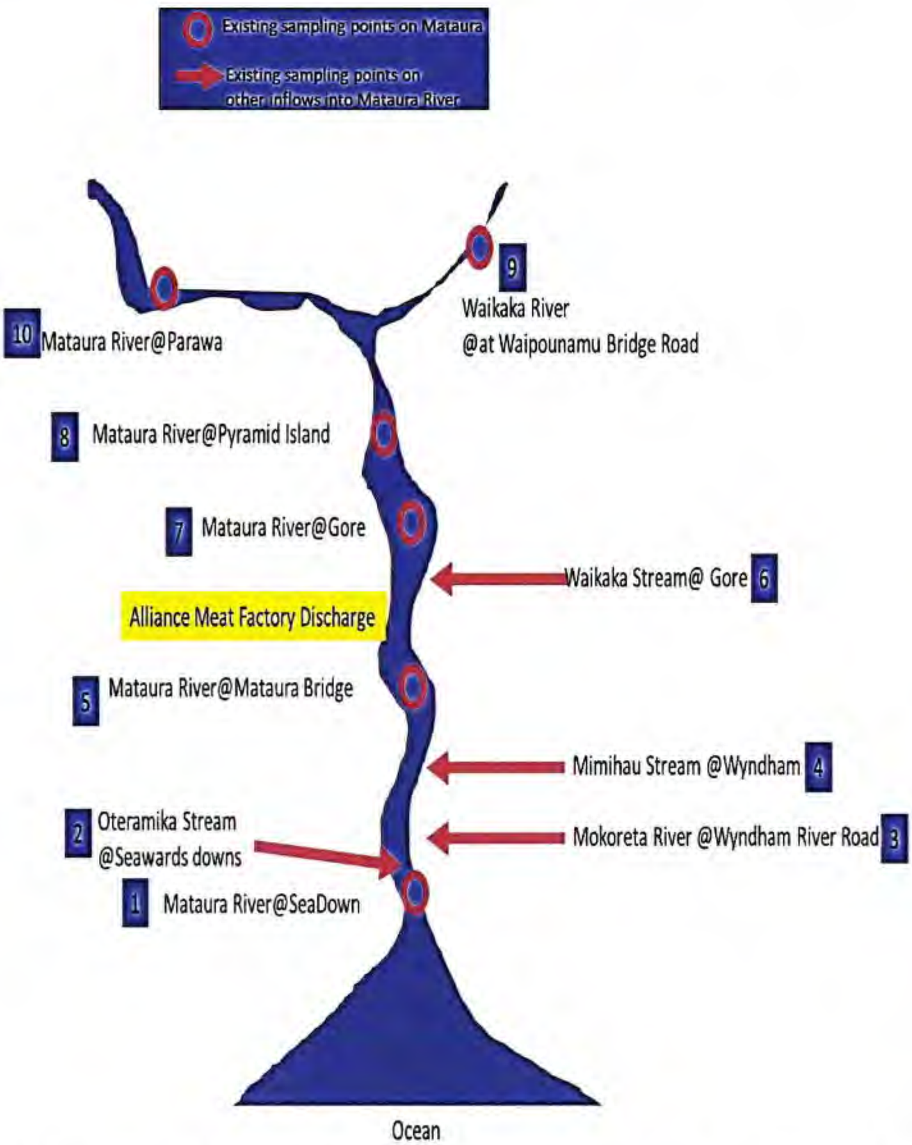


Figure 25: A conceptual model of existing monitoring sites on the Mataura River and tributaries

Analysis of historical monitoring data for Mataura River and its tributaries from 2007 to 2017 indicate that exceedances of the New Zealand single sample bathing water standards of 260 CFU/100mL and 540 CFU/100mL (i.e. 2.42 and 2.73 LogCFU/100mL, in NPS-FM 2017) were common among all the Mataura River sites (sites upstream and downstream of the Alliance Plant) and its tributaries (see Dada, 2019, Figure 6).

However, the NPS-FM (2017) defines River Attribute States for *E. coli* (see Dada, 2019, Table 1) using metrics that go beyond single sample bathing water standards, and include %exceedances over the single value standards, the median concentration and the 95th percentile.

Attribute state classification based on the historical *E. coli* data for the Mataura River and tributaries (2011-2015) indicate that the river is classified as E (Red) for most monitored sites, regardless of whether the site is an upstream or downstream of the Alliance discharge (Table 38). The poor baseline microbiological state of the Mataura River is not surprising. The 190 Km long Mataura River flows through several towns whose industries and sewage treatment plants input wastewater to the river. The river also supports a rapidly growing dairy industry and many other large commercial interests including milk processing plants and a fibreboard factory. These discharges also influence the microbiological quality of the river.

Table 38: Attribute state of the Mataura River based on historical E. coli data. The amended 2017 NPS was used for the Attribute State Classification.

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mataura River at Parawa	17	30	156	1066	D (Orange)
Waikaia River at Waipounamu Bridge Rd	20	31	161	[illegible]	E (Red)
Mataura River at Gore	[illegible]	[illegible]	361	6401	E (Red)
Waikaka Stream at Gore	42	61	231	[illegible]	E (Red)
Mataura River 200m d/s Mataura Bridge	77	[illegible]	1551	[illegible]	E (Red)
Mimihau Stream at Wyndham	[illegible]	65	[illegible]	[illegible]	E (Red)
Mokoreta River at Wyndham River Rd	[illegible]	[illegible]	[illegible]	[illegible]	E (Red)
Oteramika Stream at Seaward Downs	[illegible]	92	601	[illegible]	E (Red)

However, the proportion of samples exceeding the NPS-FM (2017) bathing water standards increased between the upstream and downstream sites. For instance, at the site immediately downstream of the discharge (Mataura River 200m d/s Mataura Bridge), exceedance of the 540 CFU/100mL single sample standard increased from 35% to 77%. This suggests that the discharge is having an effect on the levels of *E. coli* in the receiving water.

Analysis of historical data indicate that there is a strong connection between discharge, clarity conditions of the Mataura River and the observed *E. coli* concentrations (Figure 26) For example, *E. coli* concentrations in the Mataura River water column tend to exceed the bathing water standards of 260 CFU/100mL and 540 CFU/100mL (i.e. 2.42 and 2.73 LogCFU/100mL) more frequently when water clarity is below 2.0m. Similarly, *E. coli* concentrations in the Mataura River water column tends to exceed the bathing water standards more frequently when river discharge (flow rate) is high.

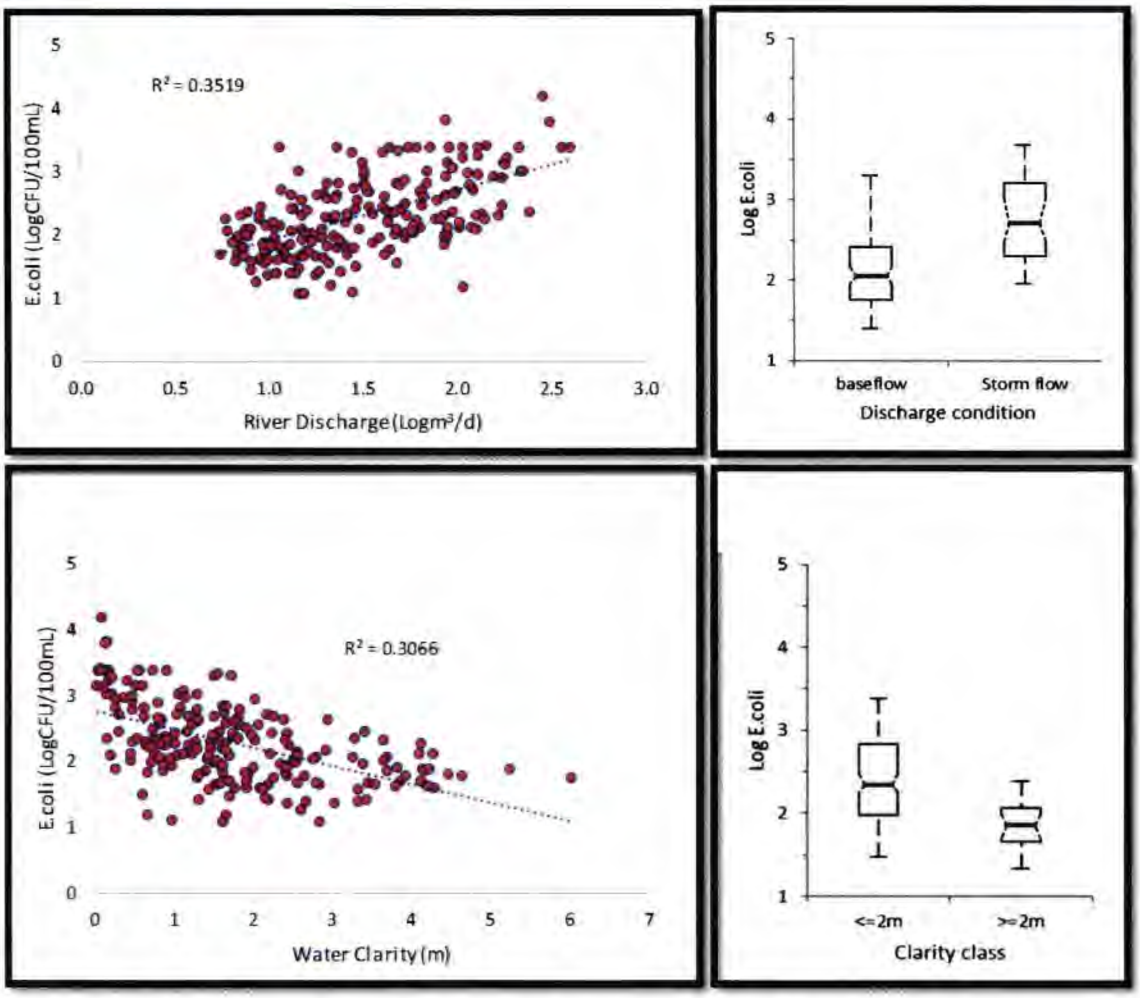


Figure 26: Linear correlation between water column *E. coli* concentrations versus clarity and discharge conditions in the Mataura River.

The correlations shown in Figure 26 between river water *E.coli*, river flow and water clarity give credence to the influence of a combination of high faecal content/faecal bacteria loadings from pastoral catchment overland flows and in-stream processes. Generally, inflows dominated by overland flow will contain elevated loads of suspended particles and bacteria. Once delivered to the river, sediment and bacteria can then accumulate on riverbeds before being re-suspended after an increase in river discharge. Highly erosive stormflow results in the resuspension of particles as a function of flow, which leads to resuspension of bacteria into the water column (often several orders of magnitude higher than baseflow).

The monitoring data of May 2018 (Table 39) showed that high FIB concentrations did not result in high levels of pathogens in the treated wastewater or receiving water. Both *Campylobacter* and *Salmonella* were detected in very low concentrations in the treated wastewater samples despite the high FIB levels in the treated effluent. Similarly, *E.coli* 0157: H7 was also rarely detected despite the high levels of *E.coli* concentrations in the receiving water and treated wastewater. Whilst no Giardia or *Cryptosporidium* analysis was undertaken in receiving waters, their oocysts could not be detected in treated wastewater samples from May 2018 (Dada, 2019 Table 4) and were low in the summer 2018/19 samples (Table 40). The treated wastewater pathogen levels were used as input to a QMRA, which is discussed in the next section.

In the context of the Mataura River risk assessment, the observed lack of correlation between *E. coli* and *Campylobacter* brings into question the applicability of the current New Zealand water standards,[1] which were developed based on the probability of infection with the *Campylobacter* pathogen.

Microbial Effects

The microbial effects of discharging treated wastewater into the Mataura River was assessed from two different perspectives: (i) A policy regulatory perspective in terms of FIB loading and its effect of attribute state as defined in the 2017 update of the NPS-FM, and (ii) from a human health perspective by undertaking a QMRA.

Impact of discharge on FIB loading to the Mataura River

The assessment used a mass balance modelling approach in which *E. coli* data for the Alliance Plant wastewater were combined with *E. coli* data for the receiving waterbody upstream of the discharge to predict how the discharged wastewater will affect the faecal bacteria load in the Mataura River.

Whilst as noted earlier that nearly all sites on the Mataura River would be classified as E (red) in terms of the NPS-FM (2017) the mass balance modelling showed that the Alliance discharge increased the proportion of samples at the downstream site (Mataura River 200m d/s Mataura Bridge), exceeding the NPS-FM (2017) bathing water standards following the discharge (Table 40). The % exceedances more than doubled after the discharge. This suggests that the Alliance Plant discharge is having an effect on the levels of *E. coli* in the receiving water.

Table 39: Observed baseline and modelled Mataura River Attribute State (*E. coli* , human health for recreation) before and after the Alliance Plant discharge.

Standard Criteria (Amended NPS FM 2014)	Upstream E. coli (Mataura River at Gore no WW discharge)	Observed E. coli concentration in Mataura at point discharge site, 200m d/s Mataura Bridge (normal WW flow)	Modelled E. coli concentration in Mataura after dilution (normal WW flow)	Modelled peak E. coli concentration in Mataura after dilution (peak WW flow)
% exceedances over 540 (CFU/100 mL)	35	77	92	99
% exceedances over 260 (CFU/100 mL)	59	83	100	100
Median concentration (CFU/100 mL)	361	1551	1516	2741
95th percentile of *E. coli* (CFU/100 mL)	5401	12551	6108	7356
Attribute State (Band)	E (Red)	E (Red)	E (Red)	E (Red)

[1] The 2014 and 2017 amended NPS Attribute State narratives

Because there is no Attribute State beyond E (red), Table 39 does not show whether the continued discharge of treated wastewater will impact baseline concentrations in downstream sites, to the extent that it would have otherwise caused an attribute state change. Hence, it was identified that there was a need to conduct additional modelling scenarios to determine the extent of improvement the Alliance discharge would need to make, such that it would not cause a NPS-FM attribute state change if the upstream water quality improved from the current "Red" (worst, median *E. coli* >260 CFU/100mL, 95th percentile >1,200 CFU/100mL) attribute state in an NPS-FM context, to:

- Attribute State "Green" (median *E. coli* ≤130 CFU/100mL, 95th percentile ≤ 1,000 CFU/100mL) - **Scenario NPS-FM-1a**.
- Attribute State "Yellow" (median *E. coli* ≤130 CFU/100mL, 95th percentile ≤ 1,200 CFU/100mL) - **Scenario NPS-FM-1b.**
- Attribute State "Orange" (median *E. coli* >130 CFU/100mL, 95th percentile >1,200 CFU/100mL)- **Scenario NPS-FM-1c.**

A range of distributions were used to reliably fit the Mataura River *E. coli* concentrations and the best performing distribution was selected (Dada 2019a, Figure 12). To model the assumed improvement, current median and 95th percentile concentrations were reduced by an improvement factor (in %) until the metrics fell within those specified for each attribute state in the NPS-FM (2017) guideline. To achieve orange, yellow or green band status at Mataura upstream sites (e.g. at Gore), water quality needs to be improved such that *E. coli* concentrations are reduced by at least 63%, 77% or 90%, respectively.

Results of the mass balance modelling is presented in Table 40. From this table it can be determined what the effects of the Alliance Mataura discharge at Matura Bridge (200m d/s) are given improvements in upstream *E coli* levels under average (i.e. annual) conditions, and under summer conditions. For example, If upstream water quality is improved from the current "Red" (worst) attribute state, to "Orange", it is predicted that when Alliance Plant wastewater 95th percentile *E. coli* concentrations are less than 200,000 CFU/100mL, the median or 95th percentile *E. coli* concentrations at the site immediately downstream of the discharge will not increase to the extent that an attribute state change is caused as a result of the discharge. However, during summer (low-flow conditions) when 95th percentile *E. coli* concentrations from the discharge exceed 160,000 CFU/100mL, it is predicted that there will be an attribute state change from "Orange" to "Red".

Table 40: Predicted Annual (A) and Summer (S) downstream Mataura River FIB concentrations as a result of Alliance Plant discharge into an 'improved' upstream Mataura River.

(a) Upstream site improved to 'Green' band (Scenario NPS-FM-1a)

Season		Discharge FIB Concentration in CFU/100mL										
		Baseline	1000-80000	80000-100000	100000-120000	120000-140000	140000-160000	160000-180000	180000-200000	200000-300000	300000-500000	500000-1500000
A	50% Perc	38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	136	163	202	[illegible]
	95% Perc	538	573	639	552	[illegible]	[illegible]	[illegible]	775	897	1082	[illegible]
S	50% Perc	38	70	108	[illegible]	[illegible]	138	146	164	197	[illegible]	[illegible]
	95% Perc	[illegible]	574	[illegible]	[illegible]	[illegible]	773	859	949	1147	[illegible]	[illegible]

(b) Upstream site improved to 'Yellow' band (Scenario NPS-FM-1b)

Season		Discharge FIB Concentration in CFU/100mL										
		Baseline	1000-40000	40000-60000	60000-80000	80000-100000	100000-120000	120000-140000	140000-160000	160000-200000	200000-500000	500000-1500000
A	50% Perc	83	93	109	121	131	139	149	158	169	[illegible]	[illegible]
	95% Perc	1180	1181	1222	1248	1266	1299	1302	1366	1384	[illegible]	[illegible]
S	50% Perc	83	99	119	130	145	159	172	186	202	[illegible]	[illegible]
	95% Perc	1180	1186	1267	1302	1321	1325	1360	1400	1453	[illegible]	[illegible]

(c) Upstream site improved to 'Orange' band (Scenario NPS-FM-1c)

Season		Discharge FIB Concentration in CFU/100mL (Annual)										
		No discharge	1000-40000	40000-60000	60000-80000	80000-100000	100000-120000	120000-140000	140000-160000	160000-200000	200000-500000	500000-1500000
A	50% Perc	132	143	160	170	179	190	200	212	226	[illegible]	[illegible]
	95% Perc	1906	1909	1920	1920	1929	1945	1961	1979	2009	[illegible]	[illegible]
S	50% Perc	132	150	174	188	203	219	232	247	[illegible]	[illegible]	[illegible]
	95% Perc	1906	1909	1921	1968	1989	1992	1995	2002	[illegible]	[illegible]	[illegible]

Note: Upstream water quality is assumed to have improved from the current "Red" (worst) attribute state in an NPS-FM context, to (a) orange, (b) yellow or (c) green before the discharge.

Quantitative Microbial Risk Assessment

QMRA is a framework that applies information and data incorporated into mathematical models that predict the health risk from pathogens through environmental exposures and characterizes the nature of any adverse outcomes.

Although several QMRAs have been documented for human waste discharge into receiving waters in New Zealand, the risks for animal-impacted water may differ from human-impacted water because the mix and densities of pathogens in animal excreta are different from those of humans. Typically, four steps are involved in a QMRA:

- Hazard identification.
- Exposure assessment.
- Dose-response analysis.
- Risk characterisation.

As noted in the section of pathogens in the wastewater, this work identified bacteria and protozoa as being the most critical microbiological groups in meat processing wastewater that may present a hazard to human health. The representative pathogens chosen for this QMRA were:

- *Campylobacter* spp., particularly *C. jejuni*.
- E. coli O157:H7.
- *Salmonella* spp.
- *Cryptosporidium* and *Giardia* spp.

The exposure site chosen was the Mataura River ~330m d/s of the discharge which is a designated recreational site and is routinely monitored by Environment Southland. Exposure pathways are given in Dada (2019a). Treated wastewater pathogen concentrations were derived from minimum and maximum concentrations from the data summarised in Table 40. Similarly, the maximum and minimum wastewater discharge rates are given in Dada (2019a) and derived from 2015-2018 data as were Mataura River flow rates and dilutions.

Methods for predicting exposure doses and dose-response relationships are documented in Dada (2019a) as are the methods used in risk characterization. Risk is reported as the Individual Illness Risk (IIR), calculated as the total number of infection cases divided by the total number of exposures, expressed as a percentage. The IIR are then compared with relevant guidelines, with 1% being the threshold for a significant risk.

Regardless of the QMRA reference pathogen used, some conclusions were the same. The results generally show:

- **No treatment, normal discharge scenario** - Very large dilution of the discharged wastewater occurred in the receiving environment even in instances when there was no treatment or an assumed treatment failure of the entire wastewater plant. Despite the dilutions, the IIR was still above the 1% threshold in winter and summer for children and adults.
- **No treatment, peak discharge scenario** – Risks were higher than in the normal discharge scenario. IIRs were also higher than the 1% threshold in winter and summer for children and adults.
- **Treatment applied, normal discharge scenario** – A combination of wastewater treatment and the effect of dilution of the discharged wastewater in the receiving environment produced significant reductions of risks associated with swimming to low levels. During normal flow discharge conditions, the IIR was below the 1% threshold for both adults and children.
- **Treatment applied, peak discharge scenario** – Risks associated with swimming at the study site was below the 1% threshold for both adults and children. Thus, there is no identifiable microbial health risk associated with swimming at the study site. Therefore, the current wastewater treatment applied at Alliance Plant is sufficient to reduce zoonotic pathogen concentrations and ensure health risks associated with swimming at the study site, are acceptable, even at maximum discharge of 14,400 m^3/d.

While the Plant discharge is having an effect on the levels of *E. coli* in the receiving water, observed increases in *E. coli* concentrations as a result of the treated Plant discharge did not necessarily relate to the abundance of zoonotic pathogens neither did these increases in *E. coli* relate to the individual illness risk.

3.11 Water Take and Cooling Water Temperature Effects

Temperature loggers were deployed in the hydro race upstream and downstream of the water takes and cooling water discharge to measure temperature every 30-minutes over a 9-month period between 1 December 2017 and 31 August 2018 and again from 1 January 2019 and 1 April 2019

For the first deployment of the temperature loggers in 2017–2018 differences between upstream and downstream location each month were analysed using a One-way ANOVA model with data checked for normality using a Shapiro Wilks W-test prior to formal comparisons. All statistical significance was determined at the 0.05 level. Statistical analyses were undertaken using RStudio (RStudio Inc. 2009, vers. 0.98.501).

Upstream and downstream temperature and Mataura River flow data for the first deployment of the temperature loggers in 2017 – 2018 are presented in Table 41 and shown on Figure 27. Median water temperature upstream and downstream of the discharge for the period between 1 December 2017 and 31 August 2018 were 10.10°C and 10.12°C respectively and the downstream site recorded a lower maximum temperature (26.65°C compared with 28.32°C upstream).

There was no significant difference in temperature between upstream and downstream location during any month ($p > 0.05$) during the 2017 – 2018 deployment.

Results from the continuous temperature survey in 2017 – 2018 show there is very little difference in water temperature between upstream and downstream locations and the water take and cooling water discharge was not having a detectable effect on river water temperatures.

The maximum river temperature exceeded the lethal thermal tolerance limit of *Deleatidium* sp. (< 23 °C) upstream and downstream of the discharge for short periods in January 2018 and nearly reached 23 °C upstream and downstream in late January and mid-February 2019 (graph not presented).

Table 41: Summary of continuous water temperature recorded between 1 December 2017 and 31 August 2018.

	Upstream Temperature (°C)	Downstream Temperature (°C)
Minimum	3.25	3.25
Maximum	28.32	26.65
Median	10.10	10.12
Mean	11.93	11.95
Count	13,154	13,154

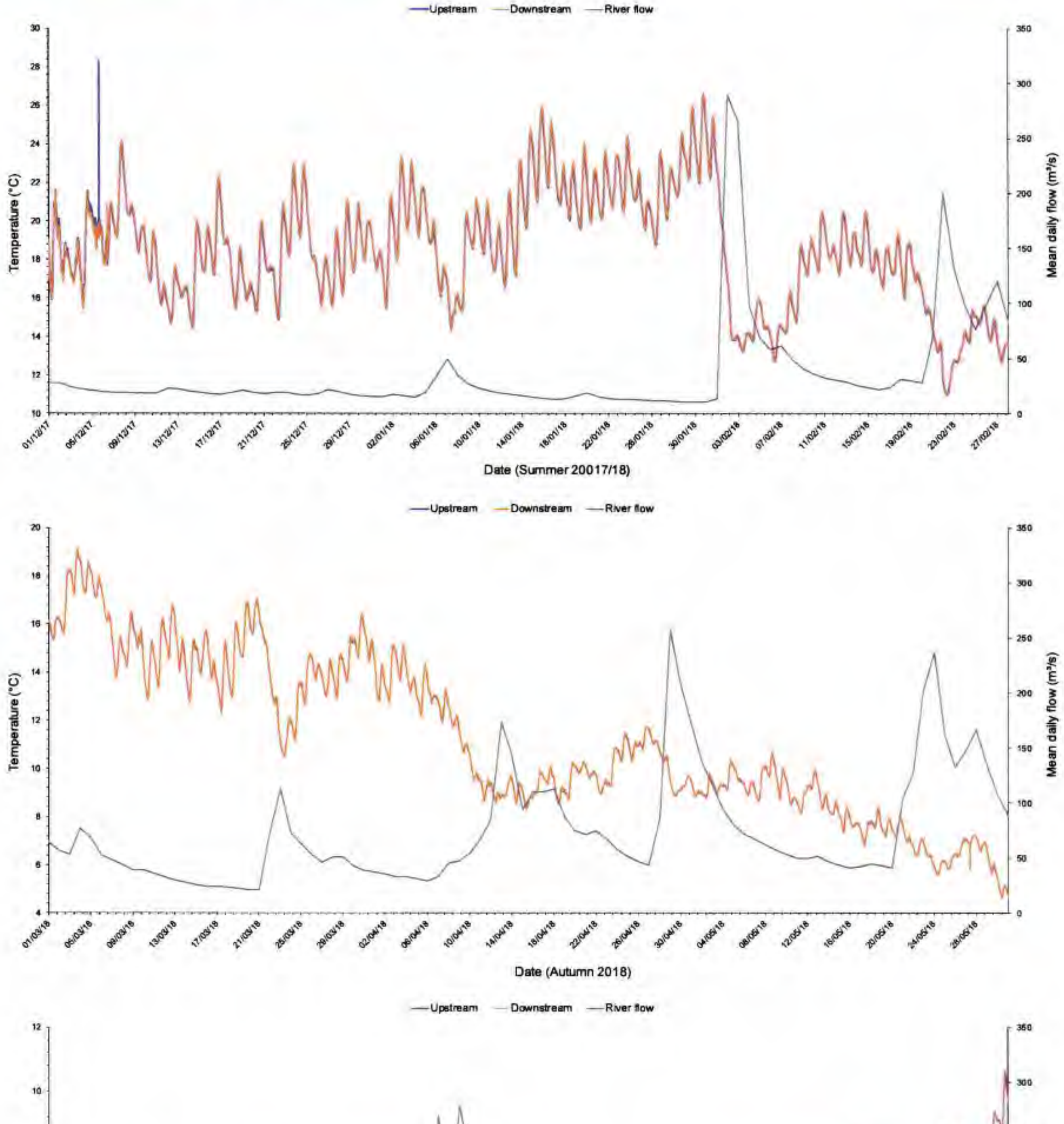


Figure 27: Continuous temperature in the Mataura River upstream and downstream of Plant during summer 2017/18, autumn 2018 and winter 2018.

3.12 Effects on Dissolved Oxygen and Temperature

Longitudinal Survey

A longitudinal survey of river DO concentrations and water temperature was undertaken on 12 January 2018 at 13 sites along the Mataura River with results shown in Figure 28. Refer to Figure 29 for site locations (Freshwater Solutions 2018).

Dissolved oxygen concentration and saturation in the Mataura River ranged between 8.2 g/m³ (86% saturation) at Site 9 (Chalmers Road ~13 km downstream of discharge point) and 9.5 g/m³ (98% saturation) at Site 4 (~318 m downstream of the treated wastewater discharge). Dissolved oxygen levels increased between Site 2 immediately above the discharge point (9.1 g/m³, 95% saturation) and Site 3 immediately below the discharge point (9.4 g/m³, 97% saturation) and remained higher than upstream levels at Site 4 (9.5 g/m³, 98% saturation). A downstream decreasing trend was recorded between Site 5 and Site 9 (2–13 km downstream of discharge point) and DO remained near the lower end of the survey range at Sites 10, 11, 12 and 13 (8.2–8.3 g/m³; 87–88% saturation) (Figure 28).

Hence, at all sites on the survey DO concentrations were above the SWLP standard (5 g/m³). In addition, DO concentrations met the NPS (2017) numeric attribute state A (> 7.5 g/m³; 1-day minimum, Summer Period: 1 November – 30 April).

Results from the January 2018 longitudinal survey show that the discharge was not resulting in an adverse effect on water temperature and DO levels in the Mataura River. The gradual reduction in DO downstream is consistent with the cumulative effects of inputs from the catchment and of the slight increase in river temperature unrelated to the discharge.

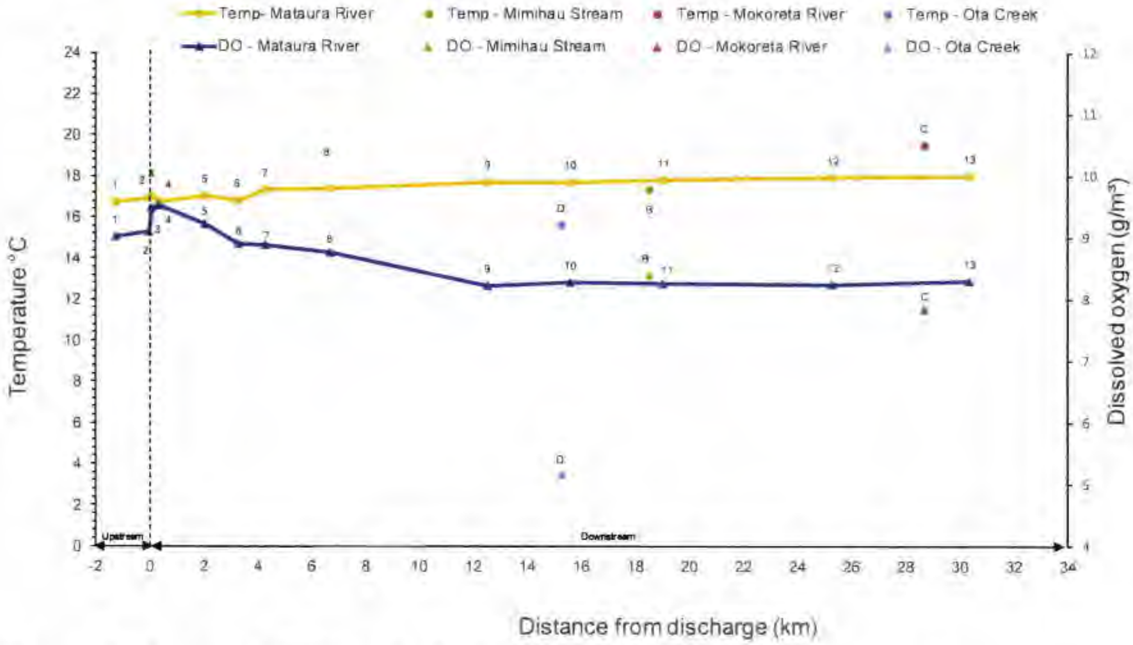


Figure 28: January 2018 longitudinal survey showing dissolved oxygen concentration and temperature.

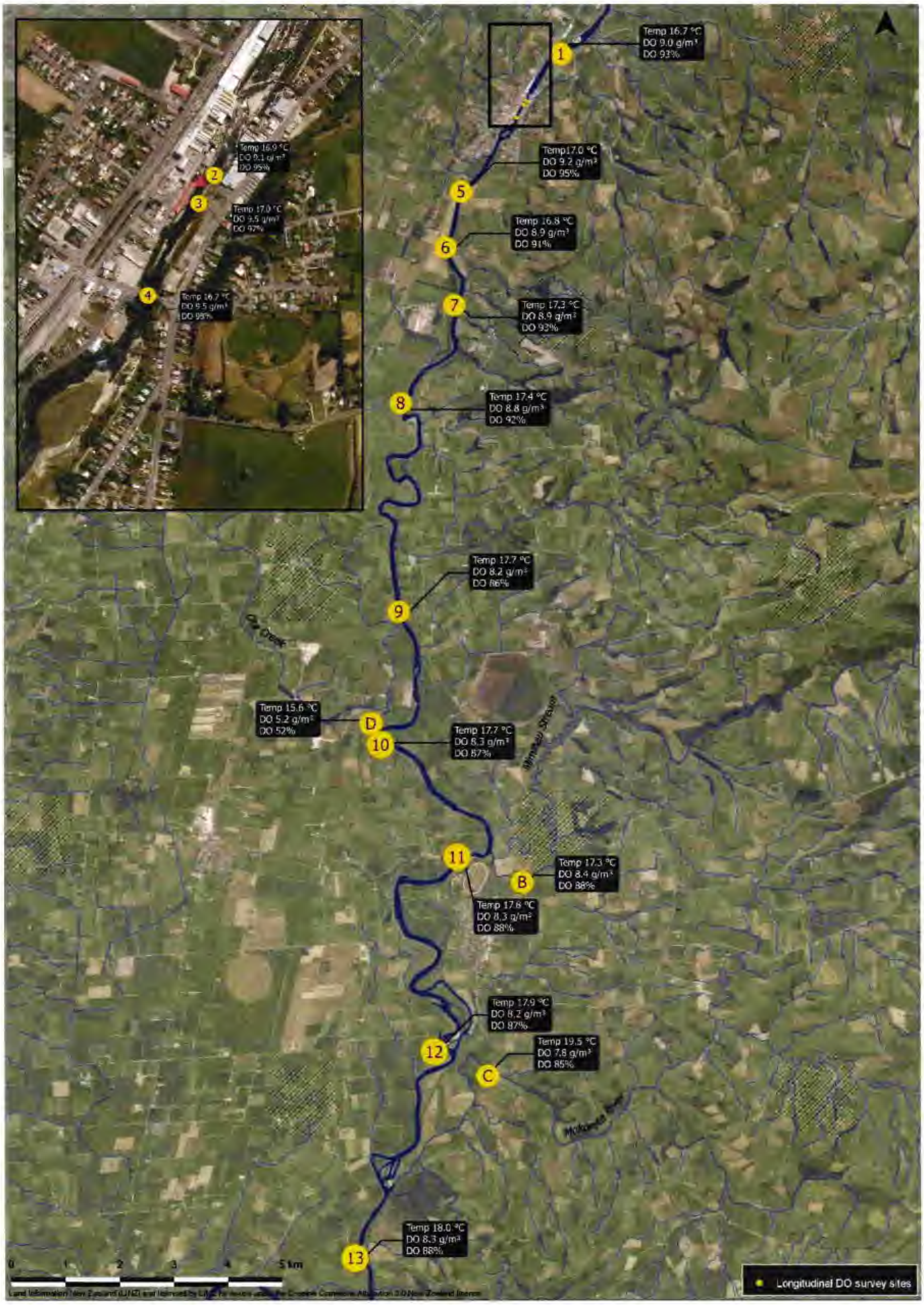


Figure 29: January 2018 longitudinal survey sampling locations showing temperature and dissolved oxygen data.

January 2018 Dissolved Oxygen and Temperature Data Sonde Survey

Dissolved oxygen concentrations upstream ranged between 6.8–10.7 g/m³ (mean 8.8 g/m³; 7-day mean minimum 7.6 g/m³) and saturation ranged from 77.2 – 125% (mean = 100%) with depressed DO saturation (<80%) recorded on 24 January in the early morning.DO concentration downstream at Chalmers Road ranged between 5.9–10.6 g/m³ (mean 8.2 g/m³; 7-day mean minimum 7.1 g/m³) and fell below 80% DO saturation on several days (range 67.1–127%; mean 93.8%) within the monitoring period (Figure 30 and Figure 31).

The NPS (2017) provides guidance on how to interpret continuous DO data versus the various attribute states as follows, "the DO attribute states are defined in the Freshwater NPS by two expressions of DO minima; the lowest 7-day mean of daily minima (the '7-day mean minimum') and the lowest daily minimum (the '1-day minimum')". Hence, the two-classification DO attribute states are B (7.0-8.0 g/m³) and B (5.0-7.5 g/m³) upstream and B downstream (Table 42).

Table 42: DO data sonde survey summary results for January 2018.

Date	Upstream	Downstream
7-day mean minimum	7.6	7.1
NPS	B (7.0-8.0)	B (7.0-8.0)
1-day minimum	6.8	5.9
NPS	B (5.0-7.5)	B (5.0-7.5)

Although there was a noticeable reduction in DO concentrations downstream during the January 2018 survey, there is no change in either the 7-day mean minimum attribute state or the 1-day minimum attribute between upstream and downstream sites. The NPS narrative states that both sites would endure 'occasional minor stress on sensitive organisms caused by short periods (a few hours each day) of lower dissolved oxygen' and potential for 'reduced abundance of sensitive fish and macroinvertebrate species'

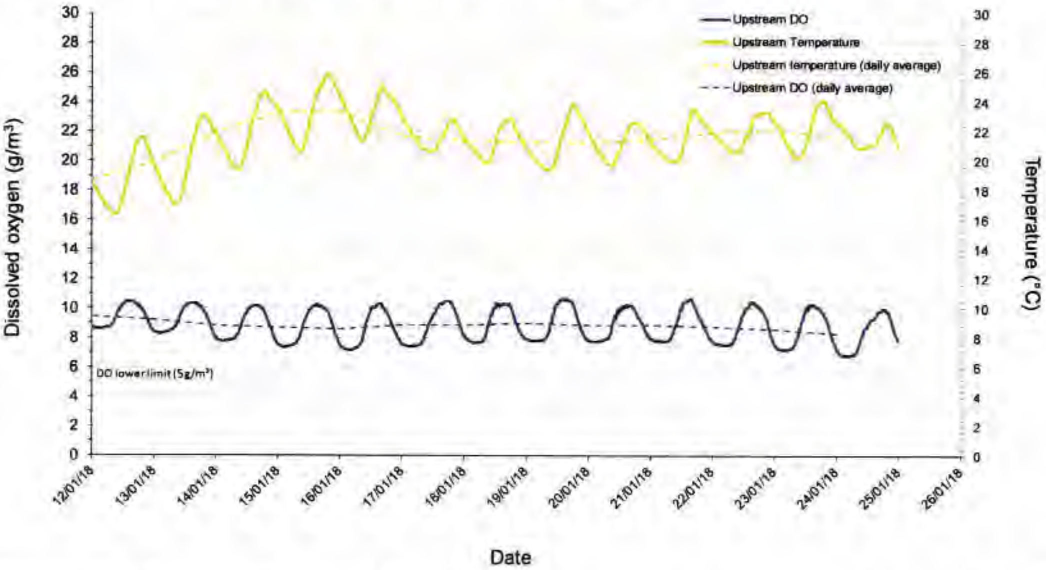


Figure 30: Temperature and dissolved oxygen data recorded upstream of the Plant between 12 and 24 January 2018.

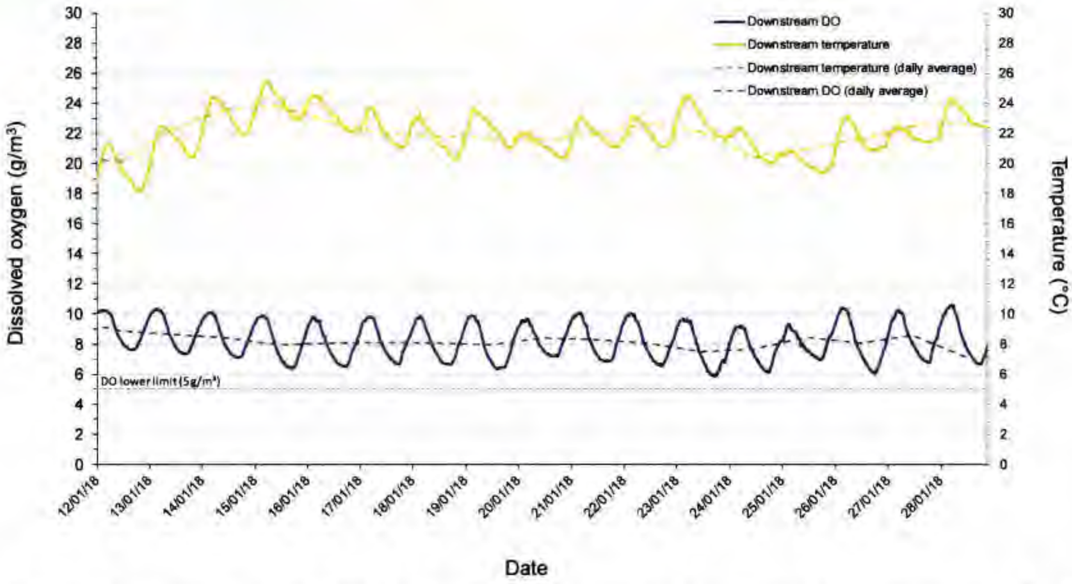


Figure 31: Temperature and dissolved oxygen data recorded downstream of the Plant at Chalmers Road between 12 and 24 January 2018.

February – March 2019 Dissolved Oxygen and Temperature Data Sonde Survey

A data sonde was installed in the Mataura River 1.2 km upstream from the discharge and another at Chalmers Road (13 km downstream from the discharge) February/March 2019; the sonde collected DO data every 15 minutes. The survey results were presented in Figure 32 and Figure 33.

Dissolved oxygen concentrations upstream ranged between 6.8–11.6 g/m^3 (mean 9.2 g/m^3; 7-day mean minimum 8.0 g/m^3). Saturation ranged from 72.9 – 119% (mean = 93.4%) with depressed DO saturation (<80%) recorded on 6-7 March and 13 March in the early morning. Dissolved oxygen concentrations downstream ranged between 8.1–13.9 g/m^3 (mean 10.0 g/m^3; 7-day mean minimum 8.7 g/m^3) and did not fall below 80% DO saturation on any occasion (range 86.5–135%; mean 100%).

The classifications of DO attribute states were B (> 8.0 g/m^3) and B (5.0-7.5 g/m^3) upstream and A (> 8.0 g/m^3) and A downstream (5.0-7.5 g/m^3) (Table 43). Hence, during the February – March 2019 survey despite the conditions that existed in the river following a very long accrual period with extensive algae growths and elevated river water temperatures there was marked improvement in the Mataura River DO status downstream of the discharge between the January 2018 and February – March 2019 surveys.

Table 43: DO data sonde survey summary results for February – March 2019.

Date	Upstream	Downstream
7-day mean minimum	8.0	8.1
NPS	B (7.0-8.0)	A (>8.0)
1-day minimum	6.8	8.7
NPS	B (5.0-7.5)	A (>7.5)

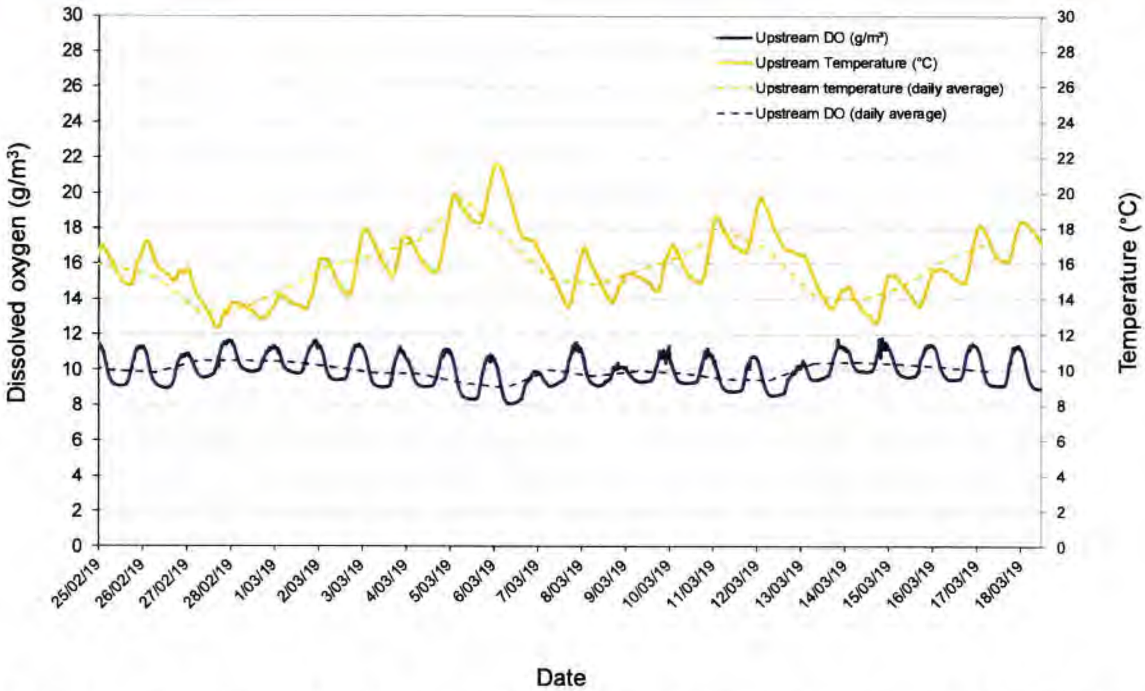


Figure 32: Temperature and dissolved oxygen data recorded upstream of the Plant between 25 February – 19 March 2019.

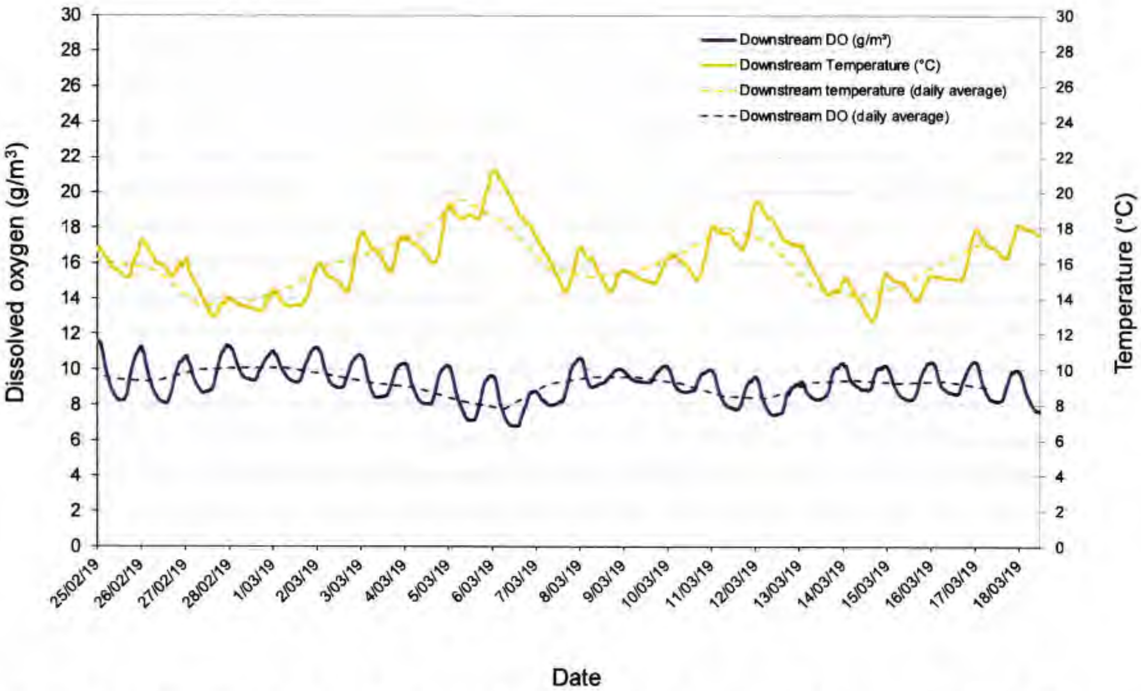


Figure 33: Temperature and dissolved oxygen data recorded downstream of the Plant at Chalmers Road between 25 February – 19 March 2019.

2013 – 2017 Dissolved Oxygen and Temperature Data Sonde Surveys

Results from the continuous DO surveys undertaken at the downstream Chalmers Road site in 2013, 2014, 2016 and 2017 are presented in Table 44. DO survey results were comparable across all years with DO concentrations above the SWLP limit of 5 g/m³ during all surveys. Continuous DO results since 2013 indicate the downstream attribute state is B or greater according to both expressions, i.e., 1-day minimum and 7-day mean minimum.

Table 44: DO survey summary results between 2012 and 2017.

Date	1-day min (g/m³)	7-day mean min (g/m³)	Attribute States
21 Feb - 4 Apr 2013	6.5	7.4	B, B
6 Feb - 12 Mar 2014	6.5	7.6	B, B
16 Feb - 8 Mar 2016	7.1	8.3	B, A
11 Jan - 31 Jan 2017	8.4	8.7	A, A

Summary

The Plant lies within the Mataura 3 classification in the SWLP. The potential effects of the discharge include ammoniacal-N (Amm-N) toxicity, increased nutrient concentrations, increased bacteria concentrations and reduced DO concentrations.

Mixing Zone

A mixing zone assessment determined that the mixing zone is approximately 100m from the discharge. The existing consent conditions set the mixing zone at Mataura Bridge, where full mixing is highly likely to have occurred.

Physico-chemical Parameters, Colour Clarity, Foams and Scums

There is no apparent effect of the discharge on river temperature or DO at the Mataura Bridge Site. There was very little difference in water temperature between upstream and downstream locations in the hydro-race and the water take and thus cooling water discharge was not having a detectable effect on river water temperatures. River water temperature in the hydro-race upstream and downstream of the water takes exceeded the upper lethal temperature for the mayfly *Deleatidium* sp. (< 23 °C) over a period of days in January 2018.

At all sites on the longitudinal survey dissolved oxygen concentrations were above the SWLP standard (5 g/m³) and met the NPS (2017) numeric attribute state A. The January 2018 longitudinal survey showed that the discharge was not resulting in an adverse effect on water temperature and dissolved oxygen levels in the Mataura River. Continuous dissolved oxygen results 1.2 Km upstream and 13 Km downstream of the discharge at Chalmers Road in January 2018 indicated the attribute state was B and B upstream and downstream for the 7-day minimum and 1-day minimum respectively. Continuous dissolved oxygen results 1.2 Km upstream and 13 Km downstream of the discharge at Chalmers Road in February and March 2019 indicated the attribute state was B and B upstream and A and A downstream. Continuous dissolved oxygen results 13 Km downstream of the discharge Chalmers Road between 2013 and 2017 indicated the attribute state was B or greater. Despite the typical decrease in DO that occurs downstream in rivers as a result of cumulative catchment inputs and increased river temperature DO levels at Chalmers Road since 2012 have remained a moderate to high concentrations.

The discharge does not adversely affect pH, turbidity, TSS, colour, clarity the generation of foams or scums or the use of the Mataura River water for stock watering

Nutrients

BOD concentrations were similar at the Hydro-race Site and Mataura Bridge Sites and below the guideline of <2 g/m³ for avoiding nuisance heterotrophic growths. Hence, effects on aquatic biota, or the formation of heterotrophic growths, immediately downstream of the discharge due to BOD are not anticipated. Regular visual observations during summer low flow conditions by Alliance staff between 2013 and 2018 have not recorded sewage fungus. A small amount of sewage fungus was observed at Site D1 during the March 2019 periphyton and benthic invertebrate survey with the aid of a viewer. The sewage fungus or heterotrophic growths were not visible to the naked eye and were not assessed as a conspicuous heterotrophic growth.

Annual median nitrate-nitrogen concentrations met the NPS (2017) numeric attribute state A for toxicity at the Hydro-race Site and Mataura Bridge Sites across the sampling period.

The change from Amm-N attribute state A, upstream, to B, downstream, is a change from a 99% species protection level to a 95% species protection level, i.e., 5% of the most ammoniacal nitrogen sensitive species may be occasionally affected. The only species in the upper 5% most Amm-N sensitive species are freshwater mussels, which do not occur in the Mataura River upstream and downstream the discharge. Those ammoniacal nitrogen sensitive species that do occur in the Mataura River in the vicinity of the discharge are the mayfly *Deleatidium sp.* and the snail *Potamopyrgus antipodarum*, but these fall within the top 20% of sensitive species that are protected by the Attribute B state.

TN concentrations were similar at the Hydro-race Site and Mataura Bridge Site between December 2017 and August 2018.

Mean monthly DIN concentrations at biological monitoring sites upstream and downstream of the discharge exceeded the MfE periphyton guideline for protecting benthic biodiversity (50 mg chlorophyll *a*/m²) across all growth periods (MfE 2000).

DRP concentrations were slightly higher at biological monitoring sites upstream compared to biological monitoring downstream sites with the mean monthly DRP concentrations exceeding the MfE periphyton guideline for protecting benthic biodiversity (50 mg chlorophyll *a*/m²) at all sites. However, the periphyton cover and biomass survey results since 2012 suggest that DIN and DRP are not causing nuisance levels of periphyton.

The TN discharge contribution to the Toetoes Estuary load from the discharge is 1.1-1.7% and the estimated TP discharge contribution is 0.7-1.3% with the vast majority of TN and TP load entering Toetoes Estuary being derived from other catchment inputs particularly diffuse sources. Even a marked reduction of the discharge TN and TP loads would have little, if any, detectable effect on the nutrient status of the lower Mataura River and Toetoes Estuary but it is acknowledged that Alliance will need to reduce its levels over time as part of catchment wide initiatives to improve water quality.

Microbes

While the Plant discharge is having an effect on the levels of *E. coli* in the receiving water, observed increases in *E. coli* concentrations as a result of the treated Plant discharge did not necessarily relate to the abundance of zoonotic pathogens neither did these increases in *E. coli* relate to the individual illness risk. However, Alliance will need to investigate a reduction in bacterial levels to meet the NPS-FM.

4.0 Ecological Effects

4.1 Potential Effects

The potential adverse ecological effects associated with the Plant discharges are:

- Proliferation of nuisance algal growths including thick mats of periphyton (e.g., *Phormidium*) and filamentous green algae.
- Reduced benthic invertebrate community health.
- Reduced fish abundance, diversity and health.
- Recreational effects.

The potential ecological effects assessed in this report and summarised in Table 18. A brief summary of the nature and extent of these potential effects is set out below and is followed by a detailed assessment of each effect.

Nuisance Algal Growths

Nuisance algal growths include sewage fungus (MFE 1992) and periphyton (MFE 2000). The discharge location and elevated nutrient concentrations in the discharge and receiving environment have the potential to elevate nutrient levels leading to the proliferation of periphyton that in turn can alter pH and DO levels and affect a range of aquatic biota (MfE 2000). Algal growths are the most direct indicator of nutrient related effects on rivers and have been monitored at least annually since 2012. The existing periphyton data set therefore provides a sound basis on which to assess the potential effects of the current discharges and take.

Benthic Invertebrate Community

Benthic invertebrates have been monitored at least annually since the early 1990s. The existing benthic invertebrate data set therefore provides a sound basis on which to assess the potential effects of the current discharges and take. The benthic macroinvertebrate community in the Mataura River reflects the location, land use and modification throughout the catchment. The benthic community is dominated by the water and habitat sensitive mayfly *Deleatidium* sp. The invertebrate community is an important component of the ecosystem (e.g. through grazing pressure controlling algal growths and as a food source for native fish and trout). There is potential for the discharge to result in adverse effects indirectly through stimulating algal growths or directly through toxicity (e.g., Amm-N effects).

Fish

The Mataura River supports significant native fish and trout populations and provides seasonal adult habitat and feeding areas for inanga, brown trout and salmon. The discharge has the potential to have direct effects (e.g., through Amm-N toxicity) on fish diversity and abundance within the mixing zone and the lower Mataura River downstream of the discharge and indirect effects through altered habitat (e.g., periphyton growths) and altered food sources (e.g., benthic invertebrate community composition) in the mixing zone, lower Mataura River and Toetoes Estuary.

The lower Mataura River is a migratory pathway for a range of whitebait species, brown trout and salmon. The Amm-N concentrations within the discharge have the potential to affect fish migration and resident fish within the mixing zone.

Fish abundance and health can be influenced by a wide range of factors including proximity to the coast, barriers such as the Mataura Falls, habitat quality and water quality. Fish are therefore not the best indicators of the potential effects associated with the Plant. A fish survey using an electric fishing machine was undertaken at the routine biological monitoring sites (U1, U2, D1 and D2) on 25 and 26 February 2019. A fish survey was also undertaken between the Mataura Bridge and Mataura Falls by setting baited fine mesh fyke nets overnight on 25 February 2019.

Recreational Use and Value

The lower Mataura is used for a range of activities with the main ones being trout fishing, white baiting and game bird hunting. Toetoes Estuary is an important area for non-contact (walking, fishing, bird watching, picnicking etc.) and contact recreation and as a consequence the faecal indicator bacteria load and nitrogen concentrations in the discharge has the potential to adversely affect humans. The discharge has the potential to contribute to the cumulative negative effects of the wider catchment on the recreational values by altering water quality and biological communities.

4.2 Summary of Surveys and Statistical Analysis

Surveys and Data Collection

A summary of the surveys and data collected is presented in Table 45. Refer to compliance monitoring reports for detailed description of sampling methodology. All ecological sampling has been carried out in accordance with standard national guidelines.

Univariate Statistical Analysis

Univariate statistical analysis was carried out on invertebrate and periphyton variables between 2012–2017 and 2012–2018 respectively. Variables from the invertebrate dataset included the number of taxa, total abundance, number of EPT individuals, percent EPT abundance, MCI and QMCI scores and abundance of *Deleatidium*. Periphyton variables included are chlorophyll-*a* (mg/sample and mg/m^2), AFDW (mg/sample and mg/m^2) and Autotrophic Index (AI).

The sampling design for invertebrates and periphyton was such that there were two locations for comparison (i.e., upstream and downstream). Within each location there were two sites nested within each location (i.e., upstream 1, upstream 2, downstream 1 and downstream 2 respectively). Each of the sites had five independent replicate samples.

All variables were checked for normality using a Shapiro Wilks W-test prior to formal comparisons. Where data was determined to depart from expected normality they were checked for lognormal distribution. For invertebrates, taxa and MCI were normally distributed. The remaining data was natural log(x+1) transformed to improve normality. Only EPT and percent EPT failed to improve in normality. For Periphyton, all data across years was deemed non-normally distributed. A log transformation improved chlorophyll-*a* and Autotrophic index; however, the data was not lognormally distributed either (using KSL tests). Only AFDW variables were determined to be lognormally distributed.

For normal, lognormal, and natural log(x+1) transformed data standard two-way crossed ANOVA techniques were used to determine differences between upstream/downstream locations across time. Periphyton data was analysed on the lognormal scale but also correctly analysed using nonparametric methods (e.g., Wilcoxon/Kruskal Wallis tests).

Table 45: Summary of the surveys and data collected since 2012.

Year	Survey Date	Data Collected						
		Continuous DO /Temp	Black disc	Habitat	Periphyton	Invertebrate	Fish	Heterotrophic growths*
2012	12 January			-			-	-
2013	6 March						-	-
2013	3 April						-	-
2014	24 March						-	
2015	15 January						-	
2016	16 February						-	
2017	10 January						-	
2017	15 December						-	
2018	11 January	-	-	-		-	-	
2019	25 January	-	-	-		-	-	
2019	25 February							
2019	19 March	-	-	-			-	

Note: *Observations by Alliance at Site US1 and DS1 during summer low flows.

Differences between sampling locations across time were performed using reverse selection methods with Tukey's HSD mean comparison methods were used to determine differences where appropriate. All statistical significance was determined at the 0.05 level, with marginal differences being reported for p-values falling between 0.10 and 0.05. All analyses were undertaken using JMP statistical software (SAS Institute 2003, vers. 5.0.1.2).

Multivariate Statistical Analysis

Multivariate statistical analysis was performed on periphyton cover and biomass (chlorophyll-*a* and AFDW) data and invertebrate community data available since January 2012. Procedures used included non-metric multidimensional scaling (nMDS), analysis of similarities (ANOSIM) and species contributing to similarity (SIMPER) using PRIMER v7 (PRIMER-E). Multivariate analysis was undertaken on square root transformed data and Bray-Curtis similarity (abundance data) or Euclidean Distance (non-abundance data). The following briefly describes each of the procedures and how results are interpreted:

- *Non-metric multidimensional scaling (nMDS)* – the relative proximity of sites on nMDS ordinations indicates how similar communities are to each other. Points that are closer together represent samples that have a greater similarity in species composition (Clarke and Gorley 2006). Bubble plot nMDS ordinations of selected variables or taxa are included and are a useful way of showing the relative abundance of the selected taxa or size of the variable.
- *Analysis of similarities (ANOSIM)* – is analogous to the univariate ANOVA procedure and tests for significant differences at the community level. The output is a global R-value that tests for overall differences between samples and pairwise comparison R-values that tests for differences between paired sites. R-values range between 0 and

1 and can be interpreted as follows; R>0.75 = community is well separated, R>0.5 = clear differences but some overlap and R<0.25 = communities are barely different (Clarke and Gorley 2006).

4.3 Effects on Algal Growths

Habitat

Habitat characteristics have been measured at monitoring sites located upstream (U1 and U2) and downstream (D1 and D2) of the Plant with typical conditions in summer shown in Figure 34 and Figure 35.

a) Site U1 (upstream)

b) Site U2 (upstream)

Figure 34: Habitat characteristics at upstream compliance biomonitoring sites.

a) Site D1 (downstream)

b) Site D2 (downstream)

Figure 35: Habitat characteristics at downstream compliance biomonitoring sites.

Periphyton forms the base of the food chain and is a primary source of food for aquatic invertebrates, which become food for fish. The amount of periphyton in a river is determined by interactions between flow regime, nutrients, light, temperature, streambed substrate and invertebrate grazing. Excessive periphyton in rivers can cause detrimental impacts on instream values (e.g., ecological, recreation, aesthetics and ecosystem health.

The Plant is located on the Mataura Falls. The Mataura falls is a dominant feature of the river and along with the weir is likely to influence habitat upstream and downstream by acting as a hydraulic and sediment transport control. These influences have the potential to alter habitat characteristics and this is evident between the Mataura Falls and Mataura Bridge where the river bed is bedrock dominated with very little gravel or cobble substrate that is such a dominant feature throughout the river. The influence of the Mataura Falls is also evident at Site D1 where the river bed is dominated by bedrock and large boulders.

The discharges and take appear to have no effect on habitat in the Mataura River. Habitat along the Mataura River in the vicinity of the discharge is characterised by a coarse boulder-cobble-gravel dominated riverbed, variable flow velocities, poor channel shading due to wide channel widths and dominated by run habitat with shallow fast flowing riffle and deep pools being less common. Sites U1 and D1 are most similar and have shallower water depths and a higher proportion of loosely compacted gravel making up the riverbed. Sites U2 and D2 are most similar and have a higher proportion of boulders, have a more stable compacted riverbed and generally has deeper water depths in riffle habitat. Habitat conditions have generally been similar at monitoring sites between 2012 and 2019.

Periphyton Cover

The SWLP (2018) defines thresholds for stream periphyton cover (as a percentage of the stream bed) to support instream values affected by periphyton in the Southland Region. Mataura River is classed as a 'lowland hard bed' river and has the following guideline:

- *For the period 1 November through to 30 April, filamentous algae of greater than 2 cm long shall not cover more than 30% of the visible stream bed. Growths of diatoms and cyanobacteria >0.3 cm thick shall not cover more than 60% of the visible stream bed*

Periphyton cover has been assessed at upstream (U1 and U2) and downstream (D1 and D2) sites using the MfE Rapid Assessment Method 2 (RAM2) outlined in Biggs and Kilroy (2002) since January 2012. With the exception of Site U1 and U2 in April 2013 periphyton cover has been below the MfE guideline of < 60% cover of thick algal mats (>3 mm thick) at all sites during all surveys between January 2012 and March 2019 (Figure 36).

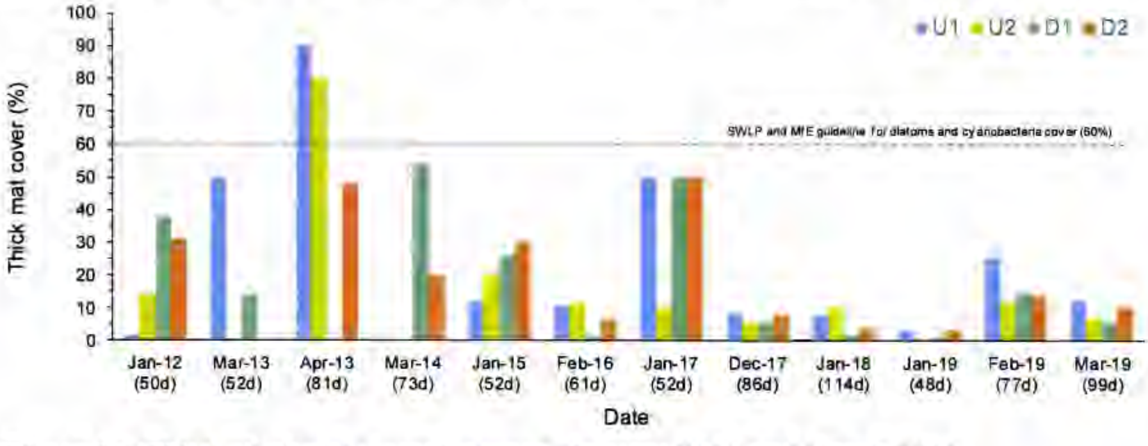
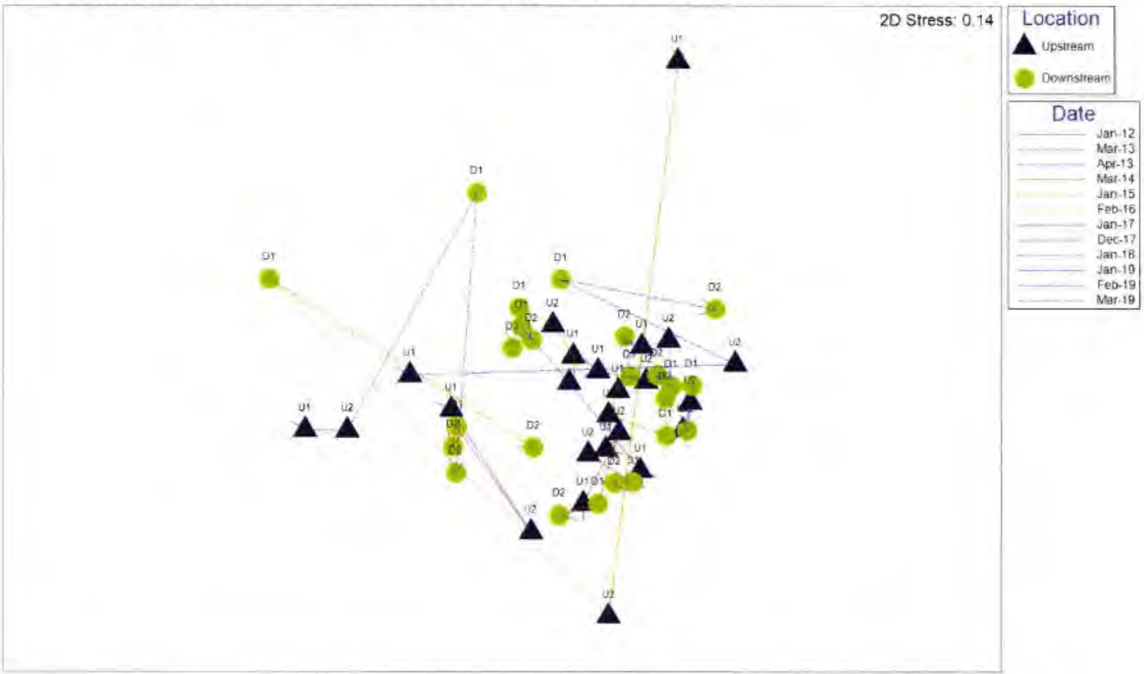


Figure 36: Thick algal mat cover between January 2012 and March 2019.

The pattern in periphyton cover composition for sites between March 2013 and December 2017 are shown on nMDS ordinations differentiated by location (Figure 37a and 37b). The nMDS ordinations in Figure 38 show there is no clear or consistent pattern in periphyton cover between sites or location (upstream vs. downstream) across surveys indicating that the discharge does not exert a strong or consistent effect on stimulating periphyton growths.

a) nMDS of periphyton cover by location (arrows = upstream to downstream)



b) nMDS of periphyton cover by location with correlated cover classes and groups (68% similarity)

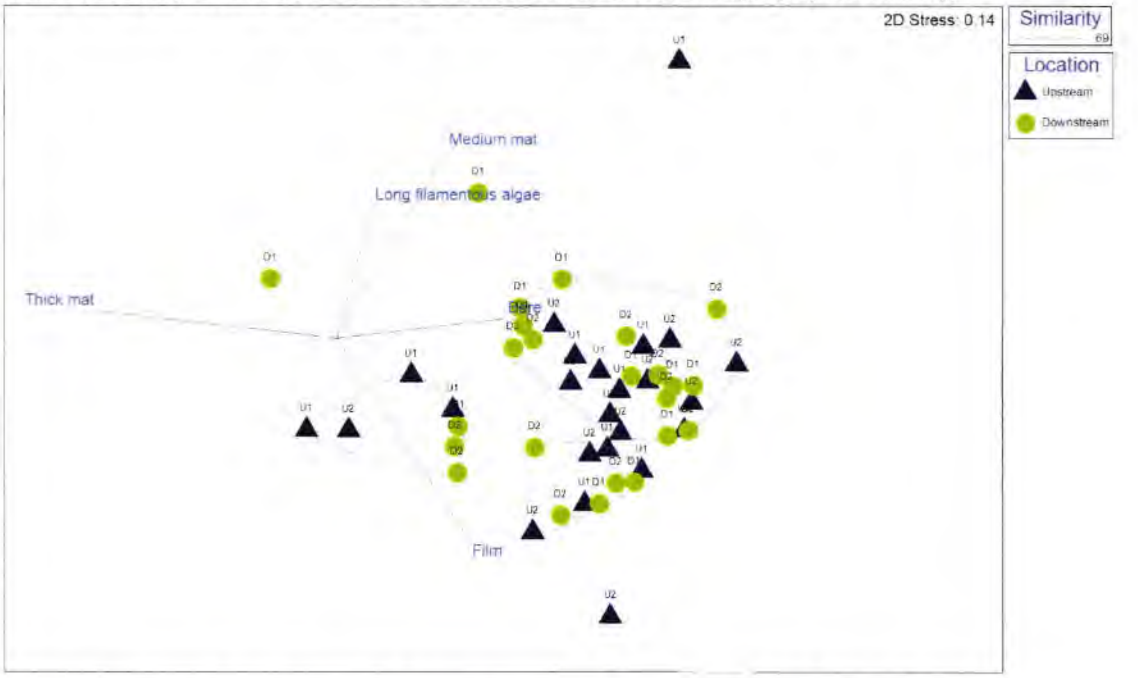


Figure 37: nMDS of periphyton cover between April 2013 and March 2019.

Figure 37b shows three main groups are identified at the 68% level of Bray-Curtis similarity with each group containing upstream and downstream sites. Sites plotted in the lower-right area of the nMDS are most correlated with bare streambed or thin films whilst sites plotted in the upper-left area most correlated with medium-thick mat and long filamentous algae. The ANOSIM procedure detected no significant difference ($p>0.05$) in cover between sites or between location ($R = -0.053$ to -0.055) again supporting the conclusion that the discharge does not have a significant stimulatory effect on periphyton growths. A significant difference in periphyton cover was detected between surveys ($p<0.01$, $R = 0.513$) as would be expected given differences in river conditions and accrual periods between surveys.

Two nMDS ordinations of periphyton cover between March 2013 and February 2019 and showing the relative cover of thick mat and long filamentous algae as bubbles is presented in Figure 38. Sites and sampling occasions with higher cover of thick mat and long filamentous algae (larger bubbles) are plotted in the upper-left area of the nMDS whilst sites and sampling occasions with lower cover (smaller bubbles) are plotted in the lower-right area. Periphyton cover at upstream and downstream sites in February 2016, December 2017, January 2018 and January 2019 are plotted in the lower-right of the nMDS and had lower cover of thick mats and long filamentous algae on these occasions.

Overall the results of annual compliance monitoring since 2012 shows that the discharge has not resulted in a downstream increase in the cover of potentially nuisance thick mats, *Phormidium* and long filamentous algae.

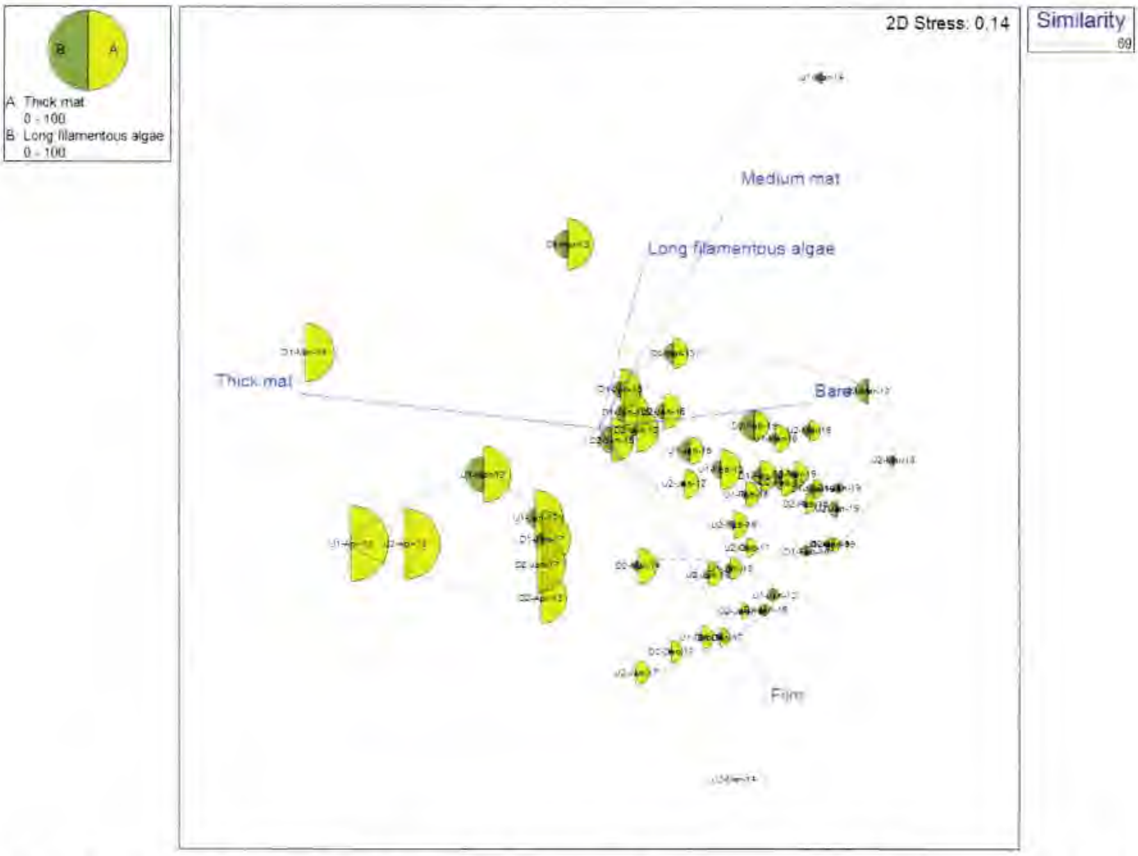


Figure 38: nMDS bubble plot showing pattern in periphyton cover between April 2013 and February 2019.

Periphyton Chlorophyll-*a* and Ash Free Dry Weight

The SWLP (2018) defines thresholds for stream periphyton cover (as a percentage of the stream bed) to support instream values affected by periphyton in the Southland Region. Mataura River is classed as a 'Lowland hard bed' river and has the following guideline:

- *Biomass shall not exceed 35 g/m^2 for either filamentous algae or diatoms and cyanobacteria.*
- *Chlorophyll-a shall not exceed 120 mg/m^2 for filamentous algae and 200 mg/m^2 for diatoms and cyanobacteria.*

There are four bands (A to D) defined in the periphyton attribute of the national objectives framework (NOF) in the NPS-FM. Chlorophyll-*a* (in mg/m^2) is the periphyton attribute unit and targets ecosystem health as the value for protection. The four attribute states (A to D) are outlined in Table 46 where 200 mg/m^2 is the bottom line.

Table 46: Thresholds for the periphyton attribute (trophic state) in the NPS-FM based on chlorophyll-*a* concentrations.

Attribute state	Numeric attribute state[1]	Narrative attribute state
A	≤50	Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat.
B	>50 and ≤120	Occasional blooms reflecting low nutrient enrichment and/ or alteration of the natural flow regime or habitat.
C	>120 and ≤200	Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or alteration of the natural flow regime or habitat.
National bottom line	200	
D	>200	Regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat.

Note: Default class = exceeded no more than 8% of samples.

Alliance Compliance Monitoring Chlorophyll-a Data

Chlorophyll-*a* concentrations measured at Sites U1, U2, D1 and D2 between January 2012 and March 2019 show that following long accrual periods chlorophyll-a levels can become elevated in response to a range of factors including nutrient enrichment upstream and downstream of the discharge (Figure 39). Chlorophyll-*a* concentrations have been the highest at Site D1 compared to the other sites on 1 out of the 10 surveys (January 2012) when levels at both Site D1 and D2 exceeded the Band D limit of > 200 mg/m^2 when sheep and lamb processing was still occurring

Chlorophyll-*a* concentrations have been the highest at Site D2 compared to the other sites on 4 out of the 10 surveys (February 2016, January 2017, February 2019 and March 2019) when levels were within Band A in January 2016, Band B in January 2017 and February 2019 and exceeded the Band D limit of > 200 mg/m^2 in March 2019. Chlorophyll-*a* concentrations have been the highest at either of the upstream sites compared to the other sites on 4 out of the 10 surveys (March 2013, March 2014, January 2018 and January 2019) when levels were within Band A, Band B or Band C (Figure 39).

Chlorophyll-*a* concentrations increased sharply at all sites between the February 2019 and March 2019 surveys reflecting the significant effect that accrual period length has on chlorophyll-*a* levels generally. Between the February 2019 and March 2019 surveys the chlorophyll-a levels at Site D1 went from Band A to the upper end of Band C, Site D2 went from the middle of Band B to Band D, Site U1 went from the lower end of Band B to the upper end of Band B and Site U2 went from Band A to the upper end of Band C. The chlorophyll-a levels at Sites D1 and D2 in January 2012 and at all Sites in March 2019 indicated that periphyton was likely to be having an adverse effect on benthic invertebrate community health. This effect is discussed further in Section 4.4.

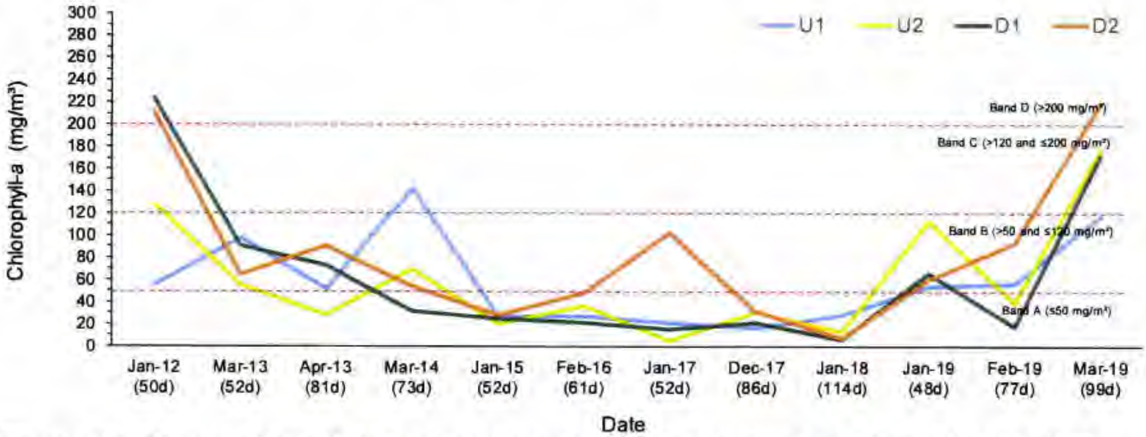


Figure 39: Mean chlorophyll-*a* concentrations for upstream and downstream sites between 2012 and 2019 (numbers in brackets = days in accrual period prior to each survey).

Alliance Compliance Monitoring AFDW Data

AFDW of periphyton recorded at compliance monitoring sites between January 2012 and March 2019 have been below the guideline of 35 g/m² in the SWLP (2018) with the exception of Sites U1 and D2 in April 2013 (Figure 40). AFDW has been variable between sites over this period with no consistent upstream-downstream trend. Highest AFDW has been recorded at upstream Sites U1 or U2 on 6 occasions (March 2013, April 2013, January 2015, February 2016, January 2018 and January 2019) (Figure 40) and at downstream Sites D1 or D2 on 6 occasions (January 2012, March 2014, January 2017, December 2017, February 2019 and March 2019). The monitoring data therefore indicates the discharge was not resulting in a consistent effect on AFDW between 2012 and 2019.

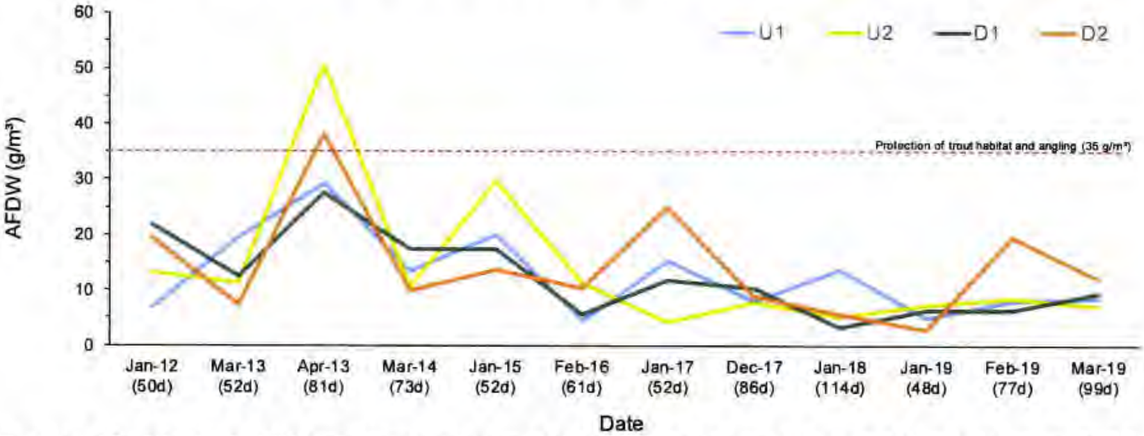


Figure 40: Mean AFDW for upstream and downstream monitoring sites between 2012 and 2019.

Alliance Compliance Monitoring Autotrophic Index Data

Autotrophic Index (AI) is a measure of possible organic enrichment. AI scores in 2012, March 2013, January 2019, February 2019 and March 2019 were below the guideline of 400 at all sites (Figure 41). In other years, AI scores have been variable between sites with no downstream trend. AI scores were higher at the upstream Site U2 than at downstream sites in April 2013, January 2015, February 2016 and January 2017, highest at Site D1 in March 2014, January 2019 and February 2019 and highest at Site D2 in January 2018. Monitoring data indicates the discharge was not having an effect on AI scores.

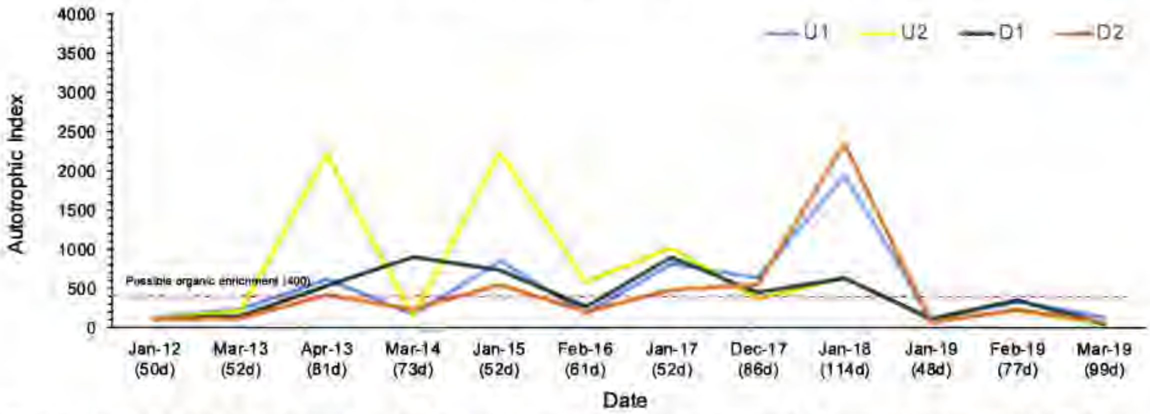


Figure 41: Mean Autotrophic Index values for upstream and downstream monitoring sites between 2012 and 2019.

Alliance Compliance Monitoring Biomass Data

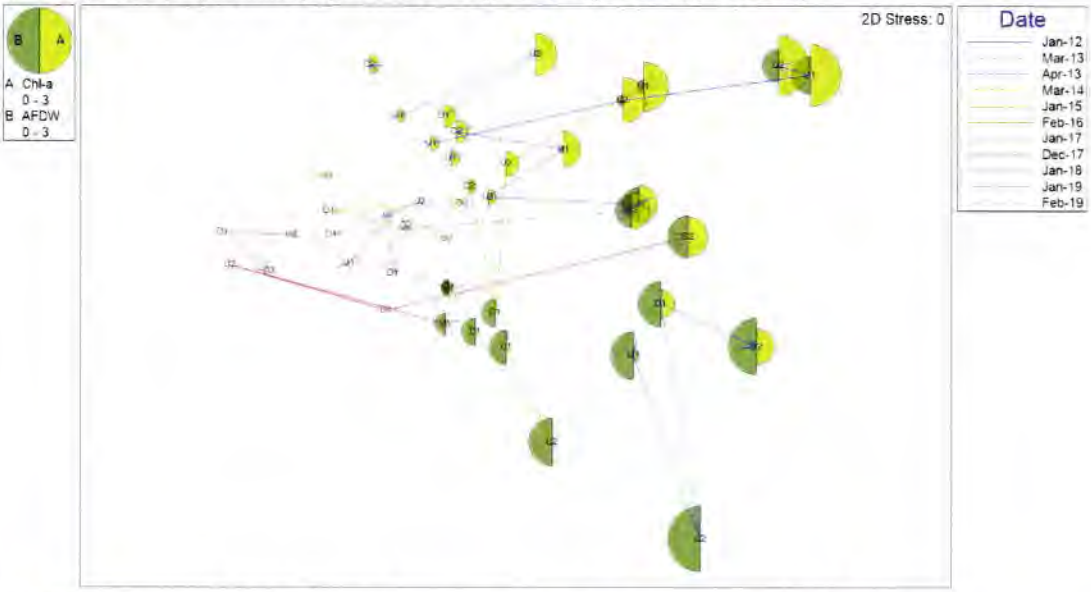
Two nMDS ordinations of periphyton biomass data show a gradient of increasing chlorophyll-*a* and AFDW from left to right along Axis 1 (x axis). There is a secondary gradient along Axis 2 (y axis) from samples with higher chlorophyll-*a* in the upper portion and samples with higher AFDW in the lower portion of the nMDS (Figures 42a and b).

Figure 42a shows the combination of chlorophyll-*a* and AFDW in samples at Sites U1 and D1 are plotted closer together than other sites in April 2013, January 2015, February 2016, January 2017, December 2017 and January 2019. Sites U1 and D1 have the most similar habitat conditions (i.e., cobble/boulder dominated, stable, deeper and swift) and results indicate they supported the most similar periphyton biomass on these occasions and that the discharge was not resulting in a significant increase in chlorophyll-a or AFDW.

The trajectories (arrows) on Figure 42a show 'zig-zagging' between upstream and downstream sites along Axis 1 and that there is not a clear upstream-downstream trend. The exception being in January 2012 when there was an increasing downstream trend in chlorophyll-*a* and AFDW along Axis 1 with values at downstream Sites D1 and D2 being the highest recorded over the 2012–2019 period and indicating a probable discharge related effect. A change to the processing at the Plant that saw the end to sheep and lamb processing in September 2012 resulted in a significant reduction in discharge volume and improvement in discharge quality which explains the results presented in Figures 42a and b.

Figure 42b shows periphyton cover types (cover data) that are correlated (r_s >0.2) with the pattern of chlorophyll-*a* and AFDW data between 2012 and 2019. There is a good match between cover data and chlorophyll-*a* and AFDW data with thick mat (typically *Phormidium*) being most associated with samples with higher AFDW in the lower-right area of the nMDS (Figure 42b). Lower chlorophyll-*a* and AFDW levels occur to the left of the nMDS and are most associated with thin films and bare riverbed (Figure 42b). Short and long filamentous algae is weakly correlated with the pattern of chlorophyll-*a* and AFDW in samples as indicated by the short length of the vectors. ($r < 0.22$).

a) nMDS (bubble plot) of chlorophyll-*a* and AFDW (arrows = upstream-downstream)



b) nMDS of chlorophyll-*a* and AFDW with correlated variable (vectors) and groups (68% similarity)

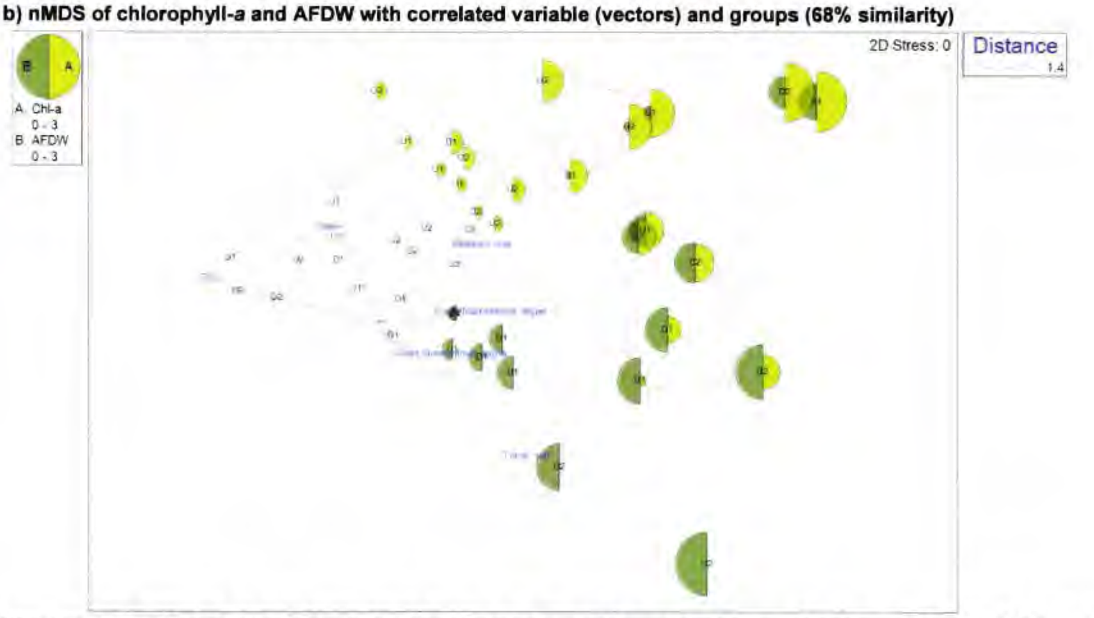


Figure 42: nMDS bubble plot showing the pattern in chlorophyll-*a* and AFDW for sites between 2012 and February 2019.

Figures 43a – d presents separate nMDS ordinations for each site and shows how the combination of chlorophyll-*a* and AFDW changes at each site over time between 2012 and January 2019 and with correlated variables ($r_s > 0.5$). The pattern in chlorophyll-*a* and AFDW at the upstream Site U1 has been variable with no clear pattern over time along Axis 1 or 2 (Figure 43a). The pattern for Site U2 has a cluster of samples in the middle of the nMDS and no clear pattern over time. The combination of chlorophyll-*a* and AFDW at Sites U1 and U2 in January 2012 and February 2019 are plotted close together indicating values on these occasions were most similar (Figure 43a and b). The pattern in chlorophyll-*a* and AFDW at downstream Sites D1 and D2 shows a general shift from right to left and higher to lower chlorophyll-*a* and AFDW along Axis 1 (see vectors) over the period between January 2012 and January 2019 (Figure 43c and d). Unlike upstream sites, the combination of chlorophyll-*a* and AFDW in samples at downstream Sites D1 and D2 in January 2012 prior to the Plant changes being seen in the periphyton community are not plotted close to the samples collected in January 2019 indicating a probable reduction in nutrient related effects over this period (i.e., lower chlorophyll-*a* and AFDW).

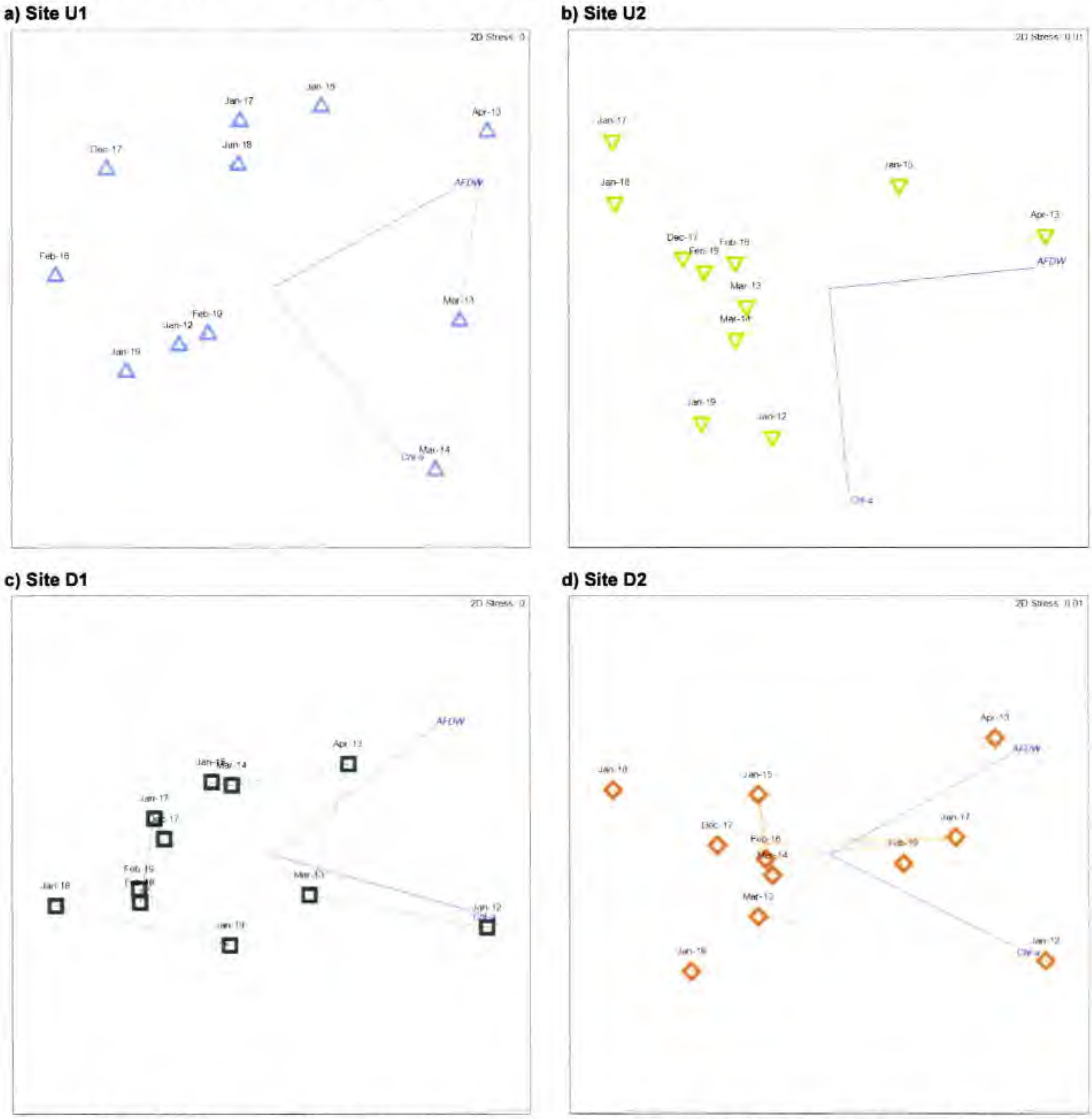


Figure 43: nMDS ordinations showing the time series pattern in chlorophyll-*a* and AFDW for each site separately between 2012 and February 2019. Correlated (r_s >0.5) variables are shown as vectors and vectors (arrows) indicating time series.

4.4 Effects on Benthic Invertebrates

Taxa Number

Taxa number has been variable across sites and between surveys over the 2012–2019 period (range: 8–22 taxa) (Figure 44). Taxa number has typically been lowest at the upstream Site U2 (range: 9–15 taxa) and increases downstream of the discharge at Site D1 (range: 12–22 taxa) and Site D2 (range: 11–18 taxa). The upstream Site U1 has a similar range in taxa number (8–18 taxa) to that at downstream Sites D1 and D2. ANOVA analysis determined sampling location (upstream vs. downstream) and sampling time were both independently statistically significant ($p<0.001$) with Tukey's mean comparison test finding downstream locations have statistically higher taxa number than upstream locations ($p<0.001$). Results indicate the discharge has not resulted in a reduction in taxa number at downstream sites over the period between January 2012 and March 2019.

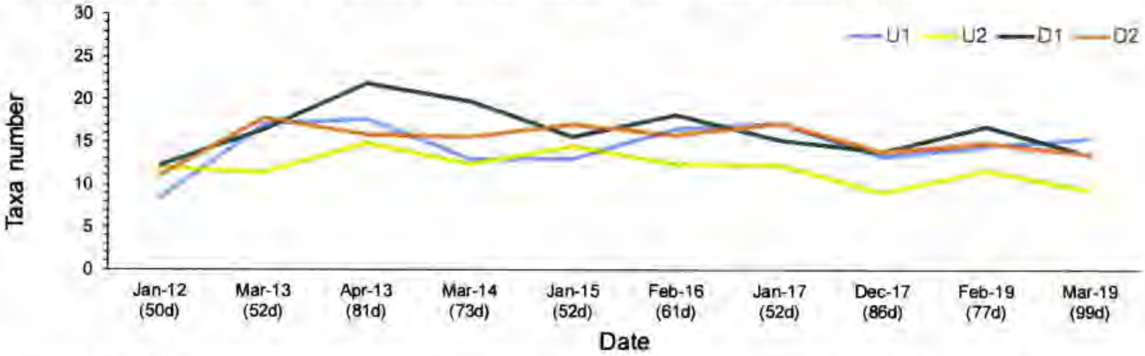


Figure 44: Mean taxa number for upstream and downstream sites between January 2012 and March 2019.

EPT Taxa Number

EPT taxa number recorded at sites across surveys between January 2012 and February 2019 has ranged between 4–8 taxa (**Figure 45**). EPT taxa number increases downstream of the discharge between Sites U2 and D1. EPT taxa number recorded at Sites U1, D1 and D2 are generally within a similar range. EPT taxa followed the same statistical pattern as taxa number with downstream sampling locations having statistically higher EPT taxa number than upstream locations ($p<0.05$). Results indicate the discharge has not resulted in a downstream reduction in the diversity of water quality sensitive EPT taxa. The number of EPT taxa was similar at upstream and downstream sites in February 2019 and March 2019 indicating that even after a very long accrual period (77 days and 99 days respectively) the discharge was not reducing the diversity of water quality sensitive taxa.

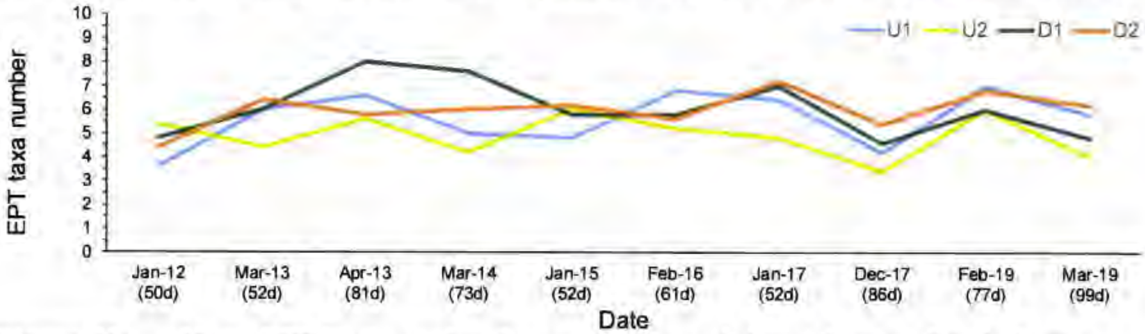


Figure 45: Mean EPT taxa number for upstream and downstream sites between January 2012 and March 2019.

Percent EPT

Percent EPT has been variable between January 2012 and March 2019 (Figure 46) with a general increase at sites between April 2013 and December 2017. There was a decrease in percent EPT at sites with the exception of Site U2 between December 2017 and February 2019 and especially at Site D1. Percent EPT decreased sharply at Site U1, U2 and D2 and increased slightly at Site D1 between the February 2019 and March 2019 indicating a general deterioration in water quality upstream and downstream of the discharge occurred between the February and March 2019 surveys. This effect is consistent with the long accrual period in mid to late summer creating stressful conditions (e.g. elevated temperature, thick algae mats) in the river upstream and downstream of the discharge at the time of the February 2019 and in particular March 2019 surveys. A similarly long mid to late summer accrual period prior to the April 2013 survey (81 days) also saw low %EPT at all sites with the lowest %EPT recorded at Sites U1, U2 and D1 (Figure 46).

Percent EPT has been lowest at Site D1 compared to the other 3 monitoring sites on 6 out of the last 10 surveys between January 2012 and March 2019. Percent EPT has never been the highest at Site D1 compared to the other 3 sites over the 10 surveys.

Percent EPT has never been the lowest at Site D2 compared to the other 3 monitoring sites over the 10 surveys. Percent EPT has been highest Site D2 compared to the other 3 monitoring sites on 6 out of the 10 surveys between January 2012 and March 2019.

Percent EPT at downstream sites and in particular at Site D1 was lower compered to upstream sites in February and March 2019 and reflected the decrease in *Deleatidium* sp abundance at these sites at the time of these surveys. It is probable that the combination of stressful instream conditions (elevated temperature and extensive late successional stage algae growths) throughout the river at the time of the February 2019 and March 2019 surveys resulted in the decrease in %EPT but may not have been as pronounced in February across the survey sites except Site D1.

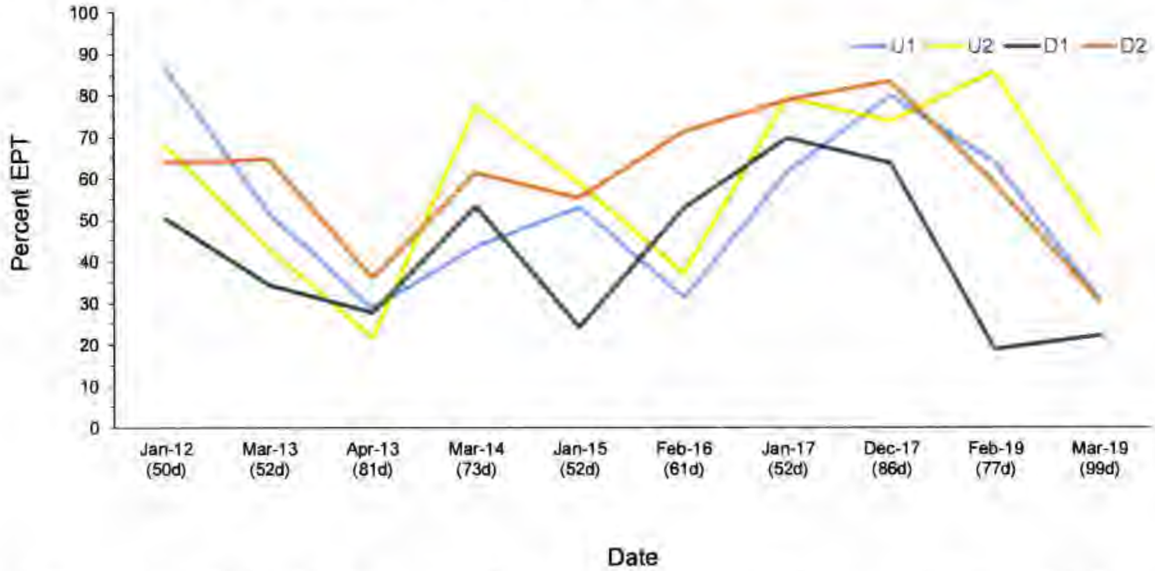


Figure 46: Mean %EPT for upstream and downstream sites between January 2012 and Mach 2019.

Deleatidium sp. Abundance

Deleatidium sp. abundance has been variable between sites and over surveys. *Deleatidium* abundance was determined to be significantly lower at downstream sites ($p<0.05$). Prior to the most recent survey there had been a general increasing trend at Site D1 since April 2013 (Figure 47).

In February 2019 *Deleatidium* sp. abundance at Sites D1 and D2 was approximately 1/3 of the *Deleatidium* sp. abundance at Sites U1 and U2. The last time such a significant decrease in *Deleatidium* sp. abundance was recorded at downstream sites was in January 2012 prior to the transferring of sheep and lamb processing to Lorneville. The decline in *Deleatidium* sp. abundance at downstream sites in February 2019 is not explained by periphyton cover and biomass data which was similar among sites upstream and downstream of the discharge and below levels known to reduce the abundance of sensitive taxa at the time of the survey. *Deleatidium* sp. is sensitive to elevated Amm-N concentrations. The Amm-N concentrations at the time of the February and March 2019 surveys were typical and do not explain the unexpected decline in *Deleatidium* sp. at the time of the survey.

Deleatidium sp. abundance decreased at all sites between the February 2019 and March 2019 surveys mirroring the %EPT decline identified in the previous section. The decline in *Deleatidium* sp abundance between the February 2019 and March 2019 surveys was particularly sharp at the upstream sites indicating that the upstream river water quality and/or periphyton community characteristics had deteriorated significantly between the surveys. The sharp decline in *Deleatidium* sp abundance at upstream sites is most likely to be related to the very long mid to late summer accrual period creating stressful conditions (elevated river temperatures and extensive growths of late successional stage periphyton growths) that were not suited to supporting an abundant *Deleatidium* sp population at the time of the survey.

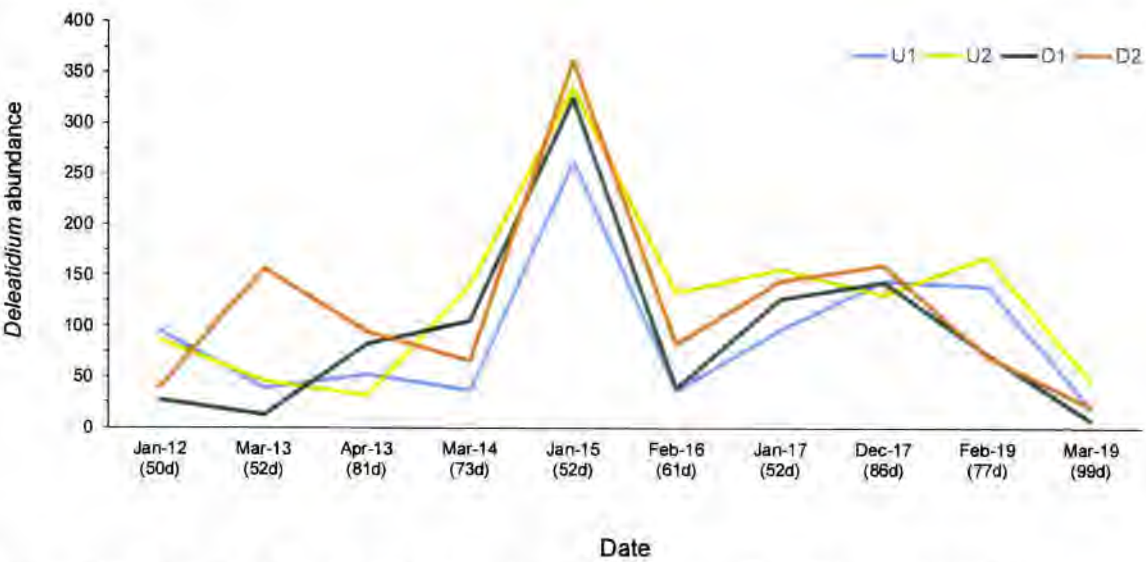


Figure 47: Mean *Deleatidium* sp abundance for upstream and downstream sites between January 2012 and Mach 2019.

MCI

MCI scores have been similar upstream and downstream of the Plant over the period between January 2012 and March 2019 and remained within the 'fair' stream health range for all sites (Stark and Maxted 2007) (Figure 48). No significant difference in MCI scores between location was determined ($p>0.05$).

The SWLP (2018) defines guidelines for macroinvertebrates in 'lowland hard bed' rivers based on the MCI score >90. MCI scores have been above the SWLP (2018) guideline of MCI >90 at Site D1 on all sampling occasions except in the 3 most recent surveys in December 2017, February 2019 and March 2019. The only survey when MCI scores were below 90 at all sites was December 2017. In February 2019 Site D1 was the only site below 90 while in March 2019 all sites except D2 were below 90

MCI scores for Site D2 and the upstream Site U1 and Site U2 have been below 90 on 4, 3 and 6 occasions respectively.

Overall the MCI results among the 10 surveys indicate that the MCI scores hover close to the SWLP guideline of 90 above and below the discharge and reflect the cumulative effect that catchment inputs and in particular nutrients from diffuse sources have on periphyton and benthic invertebrate community health. There is no evidence to indicate that the discharge causes a general decrease in MCI scores.

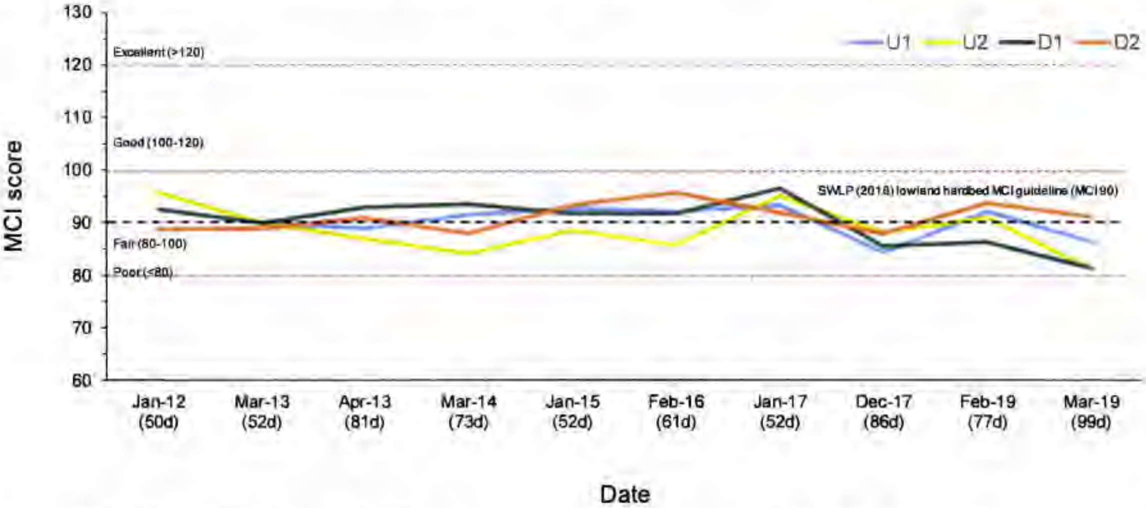


Figure 48: Mean MCI score for upstream and downstream sites between January 2012 and March 2019.

QMCI

Overall the QMCI scores, like MCI scores reflect the cumulative effect that catchment inputs and in particular nutrients from diffuse sources have on periphyton and benthic invertebrate community health. QMCI scores have been variable among years and reflect accrual period length and is largely as a result of differences in the relative abundance of the mayfly *Deleatidium* sp. (Figure 49). Since April 2013 QMCI scores have been higher at the Site U2. QMCI scores at Sites U1, D1 and D2 were generally within a similar range between March 2013 and January 2017. QMCI scores were lower at downstream sites compared to upstream sites in January 2012, December 2017, February 2019 and March 2019.

The greatest decrease in QMCI scores between upstream and downstream sites was recorded in February 2019 when Site U1 and U2 were in the 'good' QMCI score range and Site D1 and D2 were in the 'poor' QMCI score range. The QMCI scores at Sites U1 and U2 decreased by approximately 2 and 1.5 points respectively between the February 2019 and March 2019 surveys. This result mirrors the decreases in %EPT and *Deleatidium* sp abundance presented earlier reflecting the close linkage between these 3 indices and the effect of the high periphyton chlorophyll-*a* levels in the river at the time of the survey (refer to Figure 39.

The only other survey when QMCI scores were 'poor' among all sites was April 2013 after an extended period of low flow in late summer and early autumn. A key difference between the April 2013 survey and the March 2019 survey is that in the April 2013 survey the QMCI scores at Sites D1 and D2 were higher compared to Sites U1 and U2 while the reverse occurred in the March 2019 survey. The low QMCI scores at all sites in April 2013 appear to be linked to the high periphyton biomass (AFDW) at the time of the survey (refer to Figure 40).

The decrease in QMCI score in January 2012 downstream of the discharge is consistent with the effect the pre sheep and lamb processing removal discharge appeared to be having on periphyton growths at the time of that survey.

The decrease in QMCI score at downstream sites observed in February 2019 and March 2019 is reflective of the decrease in *Deleatidium* sp. abundance which as outlined previously appears to have been caused by the particularly stressful conditions at the time of the survey.

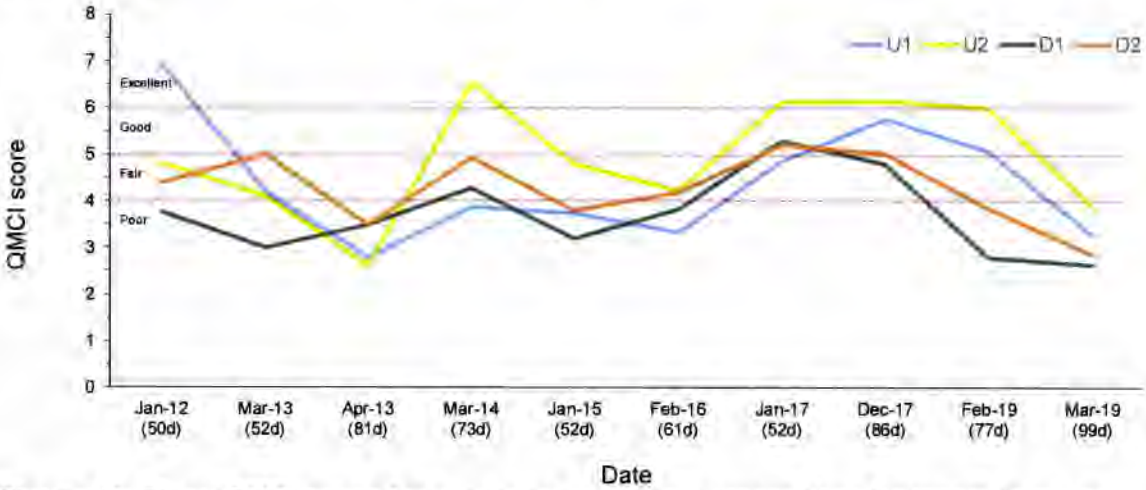


Figure 49: Mean QMCI score for upstream and downstream sites between January 2012 and March 2019.

The SWLP (2018) defines guidelines for macroinvertebrates in 'lowland hard bed' rivers based on Semi-Quantitative Macroinvertebrate Community Index (SQMCI) scores >4.5.

The QMCI is calculated from Alliance Mataura monitoring data as opposed to the SQMCI as quantitative invertebrate data is collected. Nonetheless, a comparison with the SQMCI guideline (>4.5) in the SWLP (2018) is applied as the SQMCI and QMCI both have an abundance component. The only occasion when QMCI scores have been below 4.5 at downstream sites only was in January 2012 and February 2019. On all other occasions when QMCI scores have been below 4.5 at downstream sites they have also been below 4.5 at one or both upstream sites.

As outlined previously the decrease in QMCI identified in February 2019 and March 2019 is driven by a decline in *Deleatidium* sp abundance. The cause of the decline in February 2019 is not able to be explained by periphyton cover and biomass results although it is possible that there were differences in periphyton chlorophyll-a or AFDW at the upstream and downstream sites that were not detected by the survey. The cause of the general decline in QMCI scores at sites upstream and downstream of the discharge in March 2019 appears to be linked to the high periphyton chlorophyll-a levels that existed in the river at the time of the survey and possibly elevated river water temperature.

Results indicate the treated wastewater discharge has not resulted in a consistent decrease in QMCI scores between upstream and downstream locations over the period between April 2013 and March 2019. Taking into account all of the survey results since 2012 the discharge does not appear to have had a significant effect on QMCI scores. In long mid to late summer accrual periods stressful conditions in the river do appear to occur earlier downstream of the discharge compared to upstream and this appears to a result in a decrease in QMCI score at downstream sites 2–3 weeks before a similar decrease occurs upstream of the discharge. There is no clear evidence from the available water quality and periphyton data of a causal link between water quality, periphyton and benthic invertebrate community health associated with the characteristics of the discharge at the time.

4.5 Effects on Fish

The treated wastewater discharge has the potential to directly affect fish through elevated Amm-N concentrations or indirectly through nutrient enrichment altering the benthic invertebrate community (a key food source for native fish and trout). The benthic invertebrate survey results indicate that any effect from the discharge is likely to be limited to infrequent periods when very long accrual periods occur. Survey results also indicate that any effects of the discharge on the benthic invertebrate community, if they occur, are likely to be limited to a short section of river relative to the extent of productive benthic invertebrate habitat available suggesting that any food related effects on fish are likely to be small. The downstream Amm-N concentrations do not reach levels that are likely to affect fish living in or migrating through the mixing zone.

Fish survey results from electric fishing and fyke net surveys on 25–26 February 2019 are presented in Table 47–Table 49. The electric fishing survey results indicate the fish community in run habitat is dominated by a small number of common species – longfin and shortfin eel elvers and upland bully. A single juvenile lamprey was recorded at Site U1. Elvers were more abundant at downstream sites compared to upstream sites and could be the result of differences in habitat suitability or simply the timing of the upstream migration by a particular group of new recruits into the river. The highest total density of run dwelling fish was recorded at Site D1 (0.36 fish/m^2) followed by Site U2 (0.25 fish/m^2).

The electric fishing survey results indicate the fish community in riffle habitat is dominated by elvers with upland bully and unidentified galaxiids recorded in low numbers. The highest total density of riffle dwelling fish was recorded at Site D1 (0.38 fish/m^2) followed by Site U1 (0.23 fish/m^2) (

Table 48).

The fish community in the reach between the Mataura Falls and Mataura Bridge based on fyke net survey results indicates that the Mataura River immediately upstream and downstream of the discharge supports a healthy longfin eel population including several very large fish (+5 kg) (Table 49). Based on an external visual assessment all of the fish captured using nets and by electric fishing appeared to be in a healthy condition.

The contaminants that can make fish unsuitable for consumption are persistent pollutants such as certain metals (e.g. mercury) and persistent organic pollutants (e.g. dioxins, other chlorinated compounds). There are no persistent pollutants in the Mataura discharge and therefore adverse effects from the discharge on fish health or the consumption of fish are not expected.

Table 47: Survey results in run habitat February 2019.

Common name	Scientific name	Diadromous	Upstream		Downstream	
			Site U1	Site U2	Site D1	Site D2
Shortfin eel	*Anguilla australis*	Y	-	-	2 (350-400 mm)	-
Longfin eel	*Anguilla dieffenbachii*	Y	-	-	6 (350-450 mm)	2 (320-400 mm)
Elver	*Anguilla* sp.	Y	1 (120 mm)	1 (140 mm)	30	15 (130-170 mm)
Upland bully	*Gobiomorphus breviceps*	N	50 (15-14 mm)	1 (70 mm)	1	14 (30-70 mm)
Lamprey	*Geotria australis*	Y	1 (120 mm)	-	-	-
Un-ID galaxiid	*Galaxias* sp.	Y	-	-	-	-
Number of fish			**52**	**2**	**39**	**31**
Area fished			**210 m²**	**175 m²**	**120 m²**	**180 m²**
Fish density (fish/m²)			**0.25**	**0.01**	**0.36**	**0.17**

Table 48: Survey results in riffle habitat February 2019.

Common name	Scientific name	Diadromous	Upstream		Downstream	
			Site U1	Site U2	Site D1	Site D2
Longfin eel	*Anguilla dieffenbachii*	Y	-	-	10 (150-420 mm)	-
Elver	*Anguilla* sp.	Y	11	19 (120-160 mm)	35	7
Upland bully	*Gobiomorphus breviceps*	N	-	2 (30 mm)	-	-
Un-ID galaxiid	*Galaxias* sp.	Y	1	2 (80-55 mm)	-	-
Number of fish			**12**	**23**	**45**	**7**
Area fished			**150 m²**	**100 m²**	**120 m²**	**60 m²**
Fish density (fish/m²)			**0.08**	**0.23**	**0.38**	**0.12**

Table 49: Survey results in pool habitat in February 2019.

Site	Location	Longfin eel	Elver	Total
1	TLB 30 m upstream	-	10 (120-160 mm)	10
2	TLB 10 m upstream	-	34	34
3	TLB opposite discharge	1 (430 mm)	11	12
4	TLB 30 m downstream	1 (620 mm)	11	12
5	TLB 80 m downstream	1 (600 mm)	-	1
6	TLB 120 m downstream	3 (600-1200 mm)	1	4
7	TLB 140 m downstream	-	1	1
8	TLB 160 m downstream	6 (700-1200 mm)	1	7
9	TLB 180 m downstream	6 (450-900 mm)	-	6

The Mataura River supports a world-renowned brown trout fishery and the river downstream of the Plant is heavily fished by resident and overseas anglers. There is a large resident population of brown trout and late summer and early autumn run of sea run brown trout and salmon are regularly seen and caught between the Mataura Falls and the Mataura Bridge. The presence of such large numbers of brown trout and seasonal migration of brown trout and salmon indicate that the water quality in this section of the river is suitable for supporting salmonids that are amongst the most water quality sensitive species present in New Zealand.

Results of the water quality assessment, benthic invertebrate community assessment, recent fish survey results, the very large population of brown trout and seasonal use of the river close to the discharge by brown trout and salmon indicate that the treated wastewater discharge and cooling water discharge do not appear to adversely affect fish in the river.

Summary

Habitat

The Mataura Falls and weir are likely to influence habitat immediately upstream and downstream. These influences are most obvious between the Mataura Falls and Mataura Bridge where the river bed is dominated by bedrock. The influence of the Mataura Falls is also evident at Site D1 where the river bed is predominately bedrock and boulders compared to the cobble dominated sites upstream and at Site D2.

Periphyton

Overall the periphyton community upstream and downstream of the discharge reflects the cumulative effect of catchment wide inputs upstream and despite the high background nutrient concentrations remains in a healthy state except during long accrual periods.

There is no clear or consistent pattern in periphyton cover between sites across surveys indicating that the discharge does not exert a strong or consistent effect on stimulating periphyton growths. Overall the results of annual compliance monitoring since 2012 shows that the discharge has not resulted in a downstream increase in the cover of potentially nuisance thick mats, *Phormidium* and long filamentous algae or an increase in chlorophyll-*a* and AFDW.

Benthic Invertebrates

Overall the benthic invertebrate community upstream and downstream of the discharge reflects the cumulative effect of catchment wide inputs upstream and is in fair to poor health across most benthic invertebrate indices. Total taxa number and EPT taxa number have been variable across sites and between surveys over the 2012–2019 period with no clear evidence that the discharge causes a reduction in total diversity or the diversity of water quality sensitive taxa.

Deleatidium abundance which has been variable between sites and among surveys but has tended to be lower at downstream sites. Prior to the most recent surveys there had been a general increasing trend in *Deleatidium* abundance at Site D1 since April 2013. In February 2019 *Deleatidium* sp. abundance at Sites D1 and D2 was approximately 1/3 of the *Deleatidium* sp. abundance at Sites U1 and U2 reflecting the very stressful conditions (elevated river temperature and extensive late successional algal growths) that existed in the river at the time of the survey. The decline in *Deleatidium* sp. abundance at downstream sites in February 2019 is not explained by periphyton cover and biomass or Amm-N concentrations but could reflect elevated river temperatures with overall conditions affecting this site before upstream sites. The March 2019 survey was notable for the sharp decline in *Deleatidium* sp abundance at the upstream sites. This decline that may have been caused by the elevated river temperature and extensive algal growths leading up to the survey.

MCI scores have been similar upstream and downstream of the Plant over the period between January 2012 and March 2019 and remained within the 'fair' stream health range for all sites. MCI scores have been above the SWLP (2018) guideline of MCI >90 at Site D1 on all sampling occasions except in the December 2017 when scores were below 90 at all sites and in February 2019 when Site D1 was the only site with an MCI score of < 90 and most recently in March 2019 when all sites upstream and downstream except Site D2 were < 90.

QMCI scores have been variable across years largely as a result of differences in the relative abundance of *Deleatidium*. QMCI scores have typically been higher at the upstream Site U2 whereas QMCI scores for Site U1 and downstream Sites D1 and D2 have generally been within a similar range. The decrease in QMCI score in January 2012 downstream of the discharge is consistent with the effect the pre sheep and lamb processing removal discharge appeared to be having on periphyton growths at the time of that survey. The decrease in QMCI score at downstream sites observed in February 2019 is reflective of the decrease in *Deleatidium* sp. abundance. The only occasion when QMCI scores have been below SWLP (2018) SQMCI score of 4.5 at downstream sites only was in January 2012 and again in February 2019. The QMCI score was < 4 at all sites during the March 2019 survey and was reflective of the stressful conditions in the river upstream and downstream of the discharge at the time of the survey. As outlined previously the decrease in QMCI is driven by a decline in *Deleatidium* sp abundance. The cause of the decline is not able to be explained by periphyton cover and biomass results or Amm-N concentrations in the river and appears to have been driven by river conditions (e.g. elevated temperature) at the time of the survey.

Overall results indicate the treated wastewater discharge has not resulted in a consistent decrease in MCI and QMCI scores between upstream and downstream locations over a range of accrual periods between April 2013 and December 2017. The February and March 2019 surveys stand out as differing from the pattern of similar results at upstream and downstream sites since 2013 but there is no clear evidence for possible effects of the discharge or how that would reduce MCI and QMCI scores. The lower scores are likely to be due to a mixture of factors and cumulative stress including temperature and algal growths.

Fish

The lower Mataura River supports a diverse fish community. Survey results in February 2019 indicated that the most common native fish in riffle and run habitat were elvers and upland bully. There are no persistent pollutants in the Mataura discharge and therefore adverse effects from the discharge on fish health or the consumption of fish are not expected.

5.0 Water Take Effects

5.1 Receiving Environment

Alliance's existing consent authorises the taking of up to 35,600 m^3/day of water from the race for processing purposes and cooling water. Water is diverted by the weir into the hydro-race (Figure 50).

The Mataura River Conservation Order 1997 protects the river from adverse effects associated with abstraction. However, Clause 6 (3) specifically allows for the weir if the water permits are granted or renewed subject to similar terms and conditions to which the former permits were subject. Freshwater Solutions understands the existing water permit for the weir set a minimum water level of >50 mm that must be maintained over the crest of the weir (Doyle Richardson pers. comm.). Because the weir water level and its associated river flow has been set through another resource consent process and the effects of the established water level and river flow have been assessed as part of that process this report does not assess the effects of the diversion of water from the weir in the section of river between the Mataura Falls and the weir itself. For completeness the section of river between the weir and discharge point is described below.

The Mataura River between the weir and Plant treated wastewater discharge point is dominated by a short length of deep, swiftly flow water, the Mataura Falls and a 270 m shallow bedrock section (Figure 50). Between the Plant treated wastewater discharge point and the Mataura Falls there is a 155 m length of river characterised by deep moderately swift bedrock habitat (Figure 51).

Figure 50: View of Mataura Falls and immediate downstream environment.

Figure 51: View of Mataura River between the Mataura Township Bridge and weir.

Between the Mataura Falls and the weir there is a shallow bedrock dominated, 270 m length of river (Figure 52). At low flow most of the flow is in a channel that is located near the centre of the river. At higher flows the entire bedrock channel is covered with swiftly flowing water. Bedrock is poor habitat for most benthic invertebrates and fish as it lacks interstitial spaces for refuge from flood and predators and the diversity of habitats required to support productive and diverse biological communities. As a consequence, bedrock sections of rainfed rivers tend to be relatively unproductive areas characterised by low density and diversity biological communities.

Figure 52: View of the weir and river environment immediately downstream.

Water is taken from the hydro-race which is approximately 400 m long and conveys 6–10 m^3/s (Figure 53) via 18 pumps. Pumps 1–11 are fitted with 5 – 6 mm mesh screens (Figure 54) and Pumps 12–18 are behind a 1.5 mm bar screens to prevent debris and fish from being drawn into the takes (Doyle Richardson pers. comm.).

Up to 14,400 m^3/day of the 35,600 m^3/day take is returned to the river via the treated wastewater outlet, while the remaining 21,200 m^3/day (cooling water, refer to Figure 53) is returned to the hydro-electric scheme discharge.

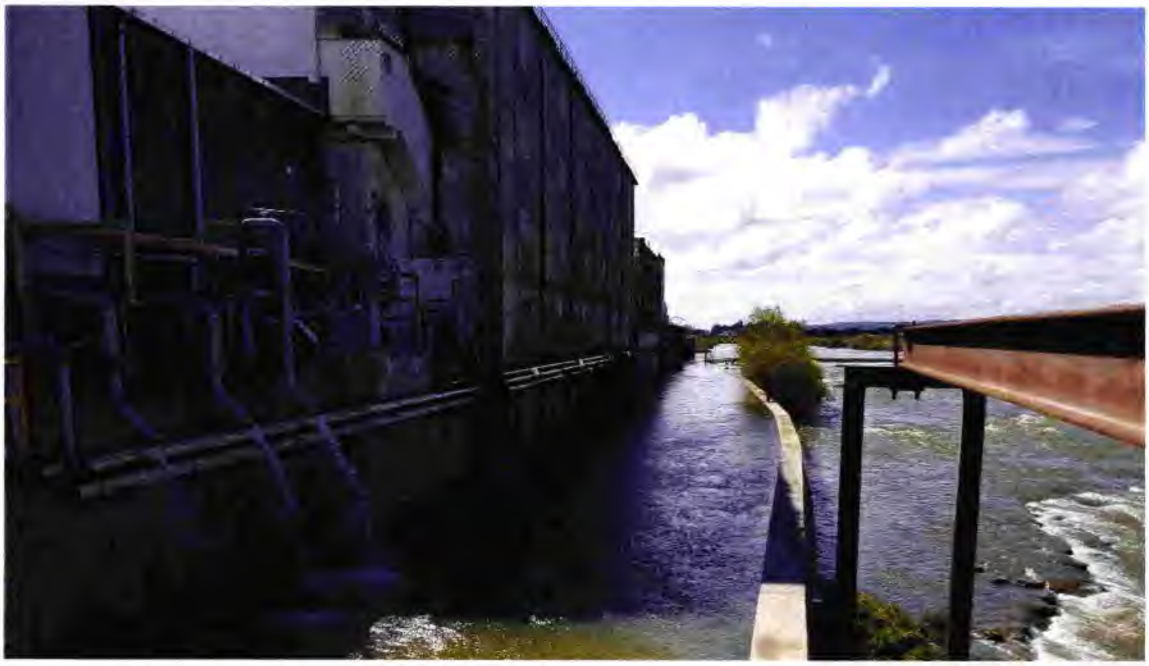


Figure 53: View of hydro-race looking back to the weir.

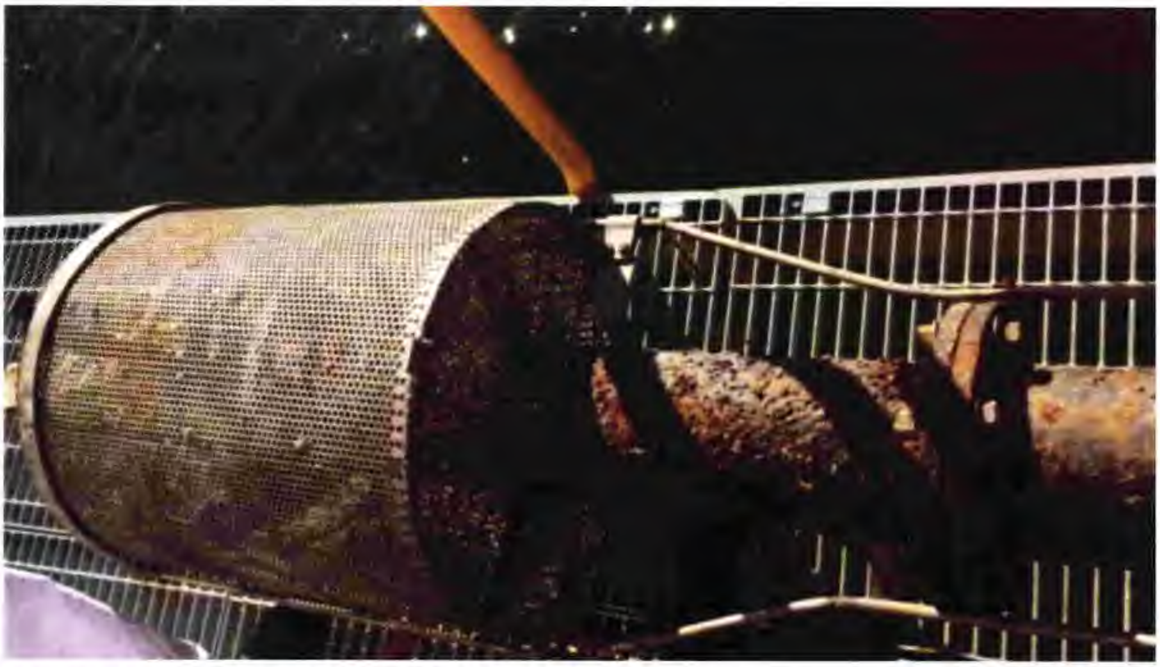


Figure 54: View of the intake pumps located within the hydro-race.

The take has the potential to have the following effects:

- Reduce river water quality downstream of the Plant.
- Reduce the amount and quality of habitat downstream of the Plant.
- Entrain or impinge fish on the intakes screens that are located in the hydro-race.

5.2 Water Quality

Abstracting water from rivers can result in a range of water quality effects including increasing the concentration of contaminants through reduced assimilative capacity, reducing dissolved oxygen concentrations through reduced re-aeration, and increased water temperatures due to decreased thermal buffering.

The small size of the take relative to the river flow and the very minor effect of the take on minimum flow duration and flow variability will result in only very minor effects on dissolved oxygen, contaminant concentrations and river water temperature and is not expected to significantly alter the water quality. The results of all the water quality monitoring to date support this conclusion.

5.3 Instream Habitat Quality

The focus of this assessment is on assessing the potential effects that the maximum total daily abstraction has on low flow, accrual period length, flow variability and the consequent effects on water quality and biological communities downstream between the take at the top of the hydro-race and the two discharge points where 21,600 m^3/day of the total take is returned to the river with the remaining 14,400 m^3/day of the 35,600 m^3/day take is returned to the river in the wastewater discharge, just downstream of the hydro-electric plant outfall

Low or minimum flows set the amount of habitat potentially available for use by biological communities while flow variability can be critical in determining water quality, periphyton and benthic invertebrate community health, as well as potentially influencing native fish and trout populations.

The consumptive component of the take is approximately 14,400 m^3/day or 167 L/s. This represents < 2% of the minimum flow of 10.1 m^3/s recorded at the Tuturau flow gauge and < 1 % of the Mean Annual Low Flow (MALF) of 19 m^3/s. Refer to Freshwater Solutions (2019) for a description of the Mataura River hydrology using data from the Tuturau flow gauge. The biologically relevant flow statistics with and without the 167 L/s take are almost exactly the same. In terms of river flow the effect of the take is very small and the potential risk of water quality and ecological effects are therefore assessed as very low.

The results of the benthic invertebrate community monitoring over many years and the large population of resident brown trout (personal observation) indicate that the water take does not adversely affect the benthic invertebrate community (an important food source for fish), fish habitat or fish migration. Overall the take is very likely to have no detectable effects on ecological communities and responses including:

- Periphyton growth and cover.
- Benthic invertebrate community habitat and health.
- Fish spawning and rearing habitat.
- Fish migration.
- Adult fish habitat and production.

5.4 Entrainment and Impingement

The abstraction of water from the hydro-race has the potential to entrain juvenile fish. The takes and intake screens are located on the true left side of the hydro-race.

The water velocity within the hydro-race is high creating a high sweep velocity across the face of the intake at the screen faces. The potential for entrainment is therefore considerably reduced compared to many water takes in Southland and around New Zealand. Despite the low risk it is recommended that all the intakes be fitted with 2 - 3 mm screens to further reduce the potential for entrainment (NIWA 2007).

Summary

The Mataura River Conservation Order 1997 protects the river from adverse effects associated with abstraction, except at the weir. The small size of the take relative to the river flow and the very minor effect of the take on minimum flow duration and flow variability will result in only very minor effects on dissolved oxygen, contaminant concentrations and river water temperature and is not expected to alter the water quality or affect fish.

The consumptive component of the take is approximately 14,400 m^3/day or 167 L/s. This represents <1 % of MALF. In terms of river flow the effect of the take is very small and the potential risk of water quality and ecological effects are therefore assessed as very low.

The results of the benthic invertebrate community monitoring over many years and the large population of resident brown trout indicate that the water take does a not adversely affect the benthic invertebrate community (an important food source for fish), fish habitat or fish migration. Overall the take is very likely to have no detectable effects on ecological communities and responses.

The abstraction of water from the hydro-race has the potential to entrain juvenile fish. Despite the low risk it is recommended that all the intakes that are currently fitted with 5 – 6 mm screen mesh be fitted with 2 - 3 mm screens to further reduce the potential for entrainment and to meet best practice standards for screening intakes.

6.0 References

Alliance Group 2004. Alliance Group Limited Mataura Plant. Application for resource consent to discharge treated wastewater to the Mataura River. Volume 3: Further Information in Support of Application. 6 August 2004.

ANZECC 2000. Australia and New Zealand Guidelines for Fresh and Marine Water Quality.

Biggs and Kilroy 2002. Stream Periphyton Monitoring Manual. Prepared for The New Zealand Ministry for the Environment.

Clarke K.R. and Gorley R.N. 2006 – PRIMER V6: User Manual/Tutorial. PRIMER-E, Plymouth, 192 p.

Clearwater, S.J.; Thompson, K.A.; Hickey, C.W. (2014). Acute toxicity if copper, zinc and ammonia to larvae (glochidia) of a native freshwater mussel Echyridella menziesii in New Zealand. Archives of Environmental Toxicology and Chemistry (in press).

Dada, 2019a. Determination of mixing of treated wastewater from Alliance Mataura discharged into the Mataura River: A mixing modelling approach using contaminant tracers. Prepared for Alliance Group/Aquatic Environmental Services Limited. March 2019.

Dada, 2019b. Quantitative Microbial Risk Assessment for the discharge of treated meat processing factory wastewater into the Mataura River. Report AES1704. Prepared for Alliance Group/Aquatic Environmental Services Limited.

Davies-Colley, R. & Nagels, J. 1999: Specifying the colour of natural waters. Water and Atmosphere, 6: 14-17. Freshwater Solutions 2017. Alliance Group Ltd Discharge and Mataura River Monitoring Plan. Submitted to Alliance Group Ltd. November 2017.

Environment Southland 2018. Assessing the State of Periphyton in Southland Streams and Rivers. Environment Southland Technical Report. September 2018.

Freshwater Solutions Ltd. 2014. Makarewa River Site Specific Ammonia Receiving Water Evaluation. Report prepared for Alliance Group Ltd. October 2013.

Freshwater Solutions Ltd. 2017. Alliance Group Ltd Discharge and Mataura River Monitoring Plan. November 2017.

Freshwater Solutions Ltd 2018. Mataura River Description of the Receiving Environment. Submitted to Alliance Group Ltd. December 2018.

Hickey, C.W., Golding, L.A., Martin, M.L. and Croker, G.F. (1999). Chronic toxicity of ammonia to New Zealand freshwater invertebrates: A mesocosm study. Archives of Environmental Contamination and Toxicology 37 338-351.

Hickey, C.W. and Martin, M.L. (1999). Chronic toxicity of ammonia to the freshwater bivalve Sphaerium novaezelandiae. Arch. Environ. Contam. Toxicol. 36: 38-46.

Hickey, C.W. and Vickers, M.L. (1994). Toxicity of ammonia to nine native New Zealand freshwater invertebrate species. Archives of Environmental Contamination and Toxicology 26: 292-298.

MFE (1994). Water Quality Guidelines No.2: Guidelines for the Management of Water Colour and Clarity.

MFE (2000). Stream periphyton monitoring manual. Prepared for the Ministry for the Environment.

MfE/MoH (2003). Microbiological water quality guidelines for marine and freshwater recreational areas. Published by the Ministry for the Environment for the Ministry for the Environment and the Ministry of Health, Wellington. National Policy Statement (NPS) 2014 for Freshwater Management 2014. Updated August 2017 to incorporate amendments from the National Policy Statement for Freshwater Amendment Order 2017.

MfE 2017. National Policy Statement – Freshwater Management.

NIWA (2007). Limiting nutrients for controlling undesirable periphyton growth. NIWA client report: HAM2007-006. February 2007.

NIWA 2012. Review of the New Zealand instream plant and nutrient guidelines and development of an extended decision making framework: Phases 1 and 2 final report. Report prepared for the Ministry of Science and Innovation Envirolink Fund. August 2012.

NIWA 2013. National Objectives Framework – temperature, DO and pH. Proposed thresholds for discussion. Report prepared for Ministry of the Environment. November 2013.

SWLP 2018: Southland water and land plan – Decisions version. April 2018.

Richardson, J. (1997). Acute ammonia toxicity for eight New Zealand indigenous freshwater species', New Zealand Journal of Marine and Freshwater Research, 31, 185-190.

Rowe D.K. and Dean T.L. 1998. Effects of turbidity on the feeding ability of the juvenile migrant stage of six New Zealand freshwater fish species, New Zealand. Journal of Marine and Freshwater Research, 32:1, 21-29, DOI: 10.1080/00288330.1998.9516803

Rowe D.K., Smith J. and Williams E. 2002. Effects of turbidity on the feeding ability of adult, riverine smelt (*Retropinna retropinna*) and inanga (*Galaxias maculatus*) , New Zealand Journal of Marine and Freshwater Research, 36:1, 143-150, DOI: 10.1080/00288330.2002.9517077.

Stark, J., Maxted, J. 2007: A user guide for the Macroinvertebrate Community Index. Cawthron Report No 1166. April 2007.

Stevens, L.M., and Robertson, B.P. 2012. Fortrose (Toetoes) Estuary Macroalgal Monitoring 2011/12. Report prepared by Wriggle Coastal Management for Environment Southland.

Stevens, L.M., and Robertson, B.P. 2017. Fortrose (Toetoes) Estuary 2016: Broad Scale Substrate, Macroalgae and Seagrass Mapping. Report prepared by Wriggle Coastal Management for Environment Southland. 28p. Southland Regional Council 2008: 2007/08 State of the Environment Fishery Report. Southland Regional Council Publication No 2008-08.

Stevens, L.M. 2018. Fortrose (Toetoes) Estuary. Broad Scale Habitat Mapping 2018. Prepared for Environment Southland. 46p.

APPENDIX 1

Dada 2019 - Mixing Report

APPENDIX 2

Dada 2019 – QMRA report

3

APPENDIX 3

Quantitative Microbial Risk Assessment of the Mataura Plant's wastewater discharge,

Streamlined Environmental, 2019.

Streamlined ENVIRONMENTAL

Quantitative Microbial Risk Assessment for the discharge of treated meat processing factory wastewater into the Mataura River

Action	Name	Date
Draft prepared by	Christopher A. Dada	6th August 2018
Draft reviewed by	Jim Cooke	25th August 2018
Final prepared by	Christopher A. Dada	21st May 2019

Report AES1704
Prepared for Alliance Group/ Aquatic Environmental Sciences Ltd
May 2019

© Streamlined Environmental Limited, 2019

Dada, A.C (2019) Quantitative Microbial Risk Assessment for the discharge of treated meat processing factory wastewater into the Mataura River. Report AES1704, Streamlined Environmental, Hamilton, 105 pp.

Streamlined Environmental Ltd
Hamilton, New Zealand
www.streamlined.co.nz info@streamlined.co.nz

Contents

Executive Summary

Alliance Group is seeking renewal of consents to continue discharging treated meatworks wastewater into the Mataura River. To support the new discharge consent application, Alliance Group has contracted Aquatic Environmental Sciences (AES) Ltd to provide an assessment of ecological effects (AEE). Microbial contamination will be a key issue for submitters and Streamlined Environmental (SEL) Ltd) have been commissioned to collate and analyse the 2017/18 microbial data from the Mataura River, and assess the potential effects of the meatworks discharges on the receiving environment. The study sought to provide a scientifically-robust assessment, as to whether or not the Alliance Plant Mataura discharges have a 'more than minor' effect on the state of the receiving environment for recreational uses .

The project proceeded in the following phases.

- Collation of existing information on microbial contaminants from the Alliance Plant and the wider receiving environment (the Mataura River). This data, as well as data generated from an additional targeted monitoring of the receiving environment in 2017 and 2018 was used to describe the current microbial status of the Alliance discharge and the Mataura River receiving environment. Baseline (upstream) and post-discharge river concentrations (downstream) were assessed against relevant water quality guidelines for recreational waters (i.e. the revised 2017 National Policy Statement for Freshwater Management and Environment Southland Water and Land Plan).
- Assessment of potential effects of the Alliance Plant discharge(s) in terms of the impacts on faecal indicator bacteria (FIB)[1] loadings into the Mataura River.
- Completion of a quantitative microbial risk assessment modeling (QMRA) using @RISK software utilizing predefined dose-response functions for zoonotic bacterial and protozoan pathogens relevant to human health (*Salmonella, Campylobacter, E. coli* 0157: H7, *Giardia, Cryptosporidium*).

Summary of microbial pathogens in the discharge water

- The current discharge consent does not specify a limit for the allowable number of FIB in the discharge.
- Historical *E. coli* concentrations in the discharge wastewater ranged between 1 x 10^3 CFU/100mL (in 2006 and 2012) and 1 x 10^7 CFU/100mL (in 2016). An analysis of

[1] *E.coli* being the faecal indicator bacteria of choice for freshwaters

historical monitoring data at the plant indicates considerable variability over the years. While an apparent increasing trend in *E. coli* concentrations were observed in 2004 to 2010, a decreasing trend in *E. coli* concentrations is noticeable from 2013-2017.

- Results showed a very high level of E.coli , up to 10^6 CFU/100mL, was being discharged into the Mataura River from the Alliance Plant, but that the levels of the representative pathogens were very much lower and more variable. In autumn 2018, the discharge contained a reasonable number of Salmonella species (120 cells per 100mL), Campylobacter jejuni (22 cells per 100mL) but few E. coli 015: H7 (0.3 cells per 100mL) but zero cysts of either Cryptosporidium or Giardia.
- In contrast, over the summer of 2018/19, Salmonella species and Campylobacter jejuni were lower in concentration (<30 cells per 100mL) while Cryptosporidium and Giardia were detected at comparatively higher levels (up to 310 oocysts per litre). This variability is not unexpected because pathogens in meat works wastewater will depend on the resident population of pathogens in the animals before slaughter, which will vary.

Summary of microbiological quality of the receiving environment

Monitoring data for the Mataura River and its tributaries from 2007 to 2017 were analysed in relation to the revised NPS-FM (2017), a policy document which defines River Attribute States for *E. coli* based on 5-year median and 96th percentile concentrations, as well as the proportions of exceedances of the 260 CFU/100mL and 540 CFU/100mL single bathing water standards. Exceedances of the New Zealand single sample bathing water standards of 260 CFU/100mL and 540 CFU/100mL were common among within the Mataura catchment. Attribute state classification based on the historical *E. coli* data for the Mataura River and tributaries (2011-2015) indicate that the river is classified as E (Red) for most of the monitored sites, regardless of whether the site considered is upstream or downstream from the Alliance discharge.

Historical monitoring data indicate that there is a strong connection between river flow, water clarity and the observed *E. coli* concentrations in the entire Mataura River. *E. coli* concentrations in the Mataura River water column tend to exceed the bathing water standards of 260 CFU/100mL and 540 CFU/100mL more frequently, when water clarity is below 2.0m. Similarly, *E. coli* concentrations more frequently tends to exceed the bathing water standards when river flows are elevated (stormflow). The observed correlations between river water *E.coli* , discharge and water clarity give credence to the influence of a combination of faecal content/faecal bacteria loadings from pastoral catchment overland flows and in-stream processes.

Recent monitoring (2017-2018) indicate that:

- *E. coli* concentrations increase significantly following discharge of the Alliance Plant wastewater. Also, *E. coli* concentrations reduce gradually downstream i.e. with increasing distance away from the discharge point
- Relationships between *E. coli* and Mataura River flow varies depending on the flow conditions. The impact of the Alliance Plant discharge on downstream sites increases during low flow conditions
- There is no relationship between water temperature and *E. coli* concentration at the upstream sites, before the discharge point.

Although elevated *E. coli* in the treated discharge water and receiving water body appears to be a concern, discharged wastewater *E. coli* level or high instream *E. coli* levels do not necessarily equate to high pathogenic risk. High *E. coli* levels above the NZ bathing water standards did not correlate with the levels of *Campylobacter* species and *C. jejuni*, the pathogens, which *form* the basis for the current New Zealand water standards.

Ruminant markers were present both in the treated wastewater and the receiving river. Apart from the Alliance Plant discharge, the Mataura River also receives input from other primary productive lands in the Mataura catchment. While an application of MST in this study has identified ruminants as the predominant faecal signature in the Mataura River, it fails to distinguish between faecal signature from cattle in the meat processing factory (Alliance Mataura plant) versus cows/cattle on the farms in the same catchment.

Avian GFD faecal marker were detected in the receiving water environment indicating that avian sources are another important contributor of faecal loading to the Mataura River.

Summary of the impact of wastewater discharge on faecal bacteria loadings in Mataura River

Mass balance modelling show significant increases in the proportion of samples, at the downstream site (Mataura River 200m d/s Mataura Bridge), exceeding the NPS-FM (2017) bathing water standards following the discharge. This suggests that the Alliance Plant discharge is having an effect on the levels of *E. coli* in the receiving water. However, the observed increase in FIB concentrations as a result of the treated Alliance Plant discharge did not necessarily relate to the abundance of pathogens, as reflected in pathogen monitoring data collected at the receiving environment and the QMRA results.

Results from mass balance modelling presents considerable evidence that other catchment sources e.g. overland flows contribute about 41% of *E. coli* loading into the Mataura River during storm-related or extreme rainfall events. Efforts to improve the bacteriological water quality in the Mataura River should also include considerations for catchment management of faecal pollution sources other than the Alliance Plant.

Five scenarios of mass balance modelling were also used to determine the extent of improvement the Alliance discharge would need to make, such that it would not cause:

1) A NPS-FM attribute state change of the downstream site, if the upstream water quality improved from the current "Red" (worst, median *E. coli* >260 CFU/100mL, 95th percentile >1200 CFU/100mL) attribute state to:
   - Attribute State "Green" (median *E. coli* ≤130 CFU/100mL, 95th percentile ≤ 1000 CFU/100mL) - **Scenario NPS-FM-1a** (Table 11).
   - Attribute State "Yellow" (median *E. coli* ≤130 CFU/100mL, 95th percentile ≤ 1200 CFU/100mL) - **Scenario NPS-FM-1b,**
   - Attribute State "Orange" (median *E. coli* >130 CFU/100mL, 95th percentile >1200 CFU/100mL)- **Scenario NPS-FM-1c;**
2) A downstream site exceedance of:
   - the microbiological standard in the proposed ES Water and Land Plan (i.e. 130 CFU/100mL median *E.coli* concentration), if the upstream water quality improved from the current 5-year median of 361 CFU/100mL to < 130 CFU/100mL **(Scenario ES Water and Land Plan-1),**
   - a hypothetical threshold (i.e. 1000 CFU/100mL 95th percentile *E.coli* concentration), if the upstream water quality improved from the current 5-year 95th percentile of 5401 CFU/100mL to < 1000 CFU/100mL **(Scenario Hypothetical-1).**

If upstream water quality is improved in an NPS-FW context from the current "Red" (worst) attribute state, to:

(a) "Green" **(Scenario NPS-FM-1a),**
   - Alliance Plant wastewater 95th percentile *E. coli* concentrations less than 140,000 CFU/100mL would not cause an attribute state change at the site immediately downstream of the discharge regardless of the season and flow condition.
   - If wastewater 95th percentile *E. coli* concentration exceeds 140,000 CFU/100mL, then an attribute state change downstream from "Green" to "Orange" is predicted.
   - If wastewater 95th percentile *E. coli* concentration exceed 300,000 CFU/100mL, then a further attribute state change downstream from "Orange" to "Red" is predicted.

(b) "Yellow" **(Scenario NPS-FM-1b),**
   - Because of the marginal difference in 95th percentile limits between Green-Yellow-Orange attribute states, when Alliance Plant wastewater 95th percentile *E. coli* concentrations exceed 40,000 CFU/100mL, an attribute state change downstream from "Yellow" to "Orange" is predicted as a result of the discharge.

- When Alliance Plant wastewater 95th percentile *E. coli* concentrations exceed 200,000 CFU/100mL, it is predicted that the attribute state at the downstream site would change further from "Orange" to "Red".

(c) "Orange" **(Scenario NPS-FM-1c),**

- It is predicted that Alliance Plant wastewater 95th percentile *E. coli* concentrations less than 160,000 CFU/100mL would not cause an attribute state change at the downstream site discharge regardless of the season and flow condition.
- If wastewater 95th percentile *E. coli* concentration exceed 160,000 CFU/100mL during summer conditions, then an attribute state change downstream from "Orange" to "Red" is predicted.

Aspects of the proposed ES Water and Land Plan converge with NPS-FM (2017). For instance, a scenario of median concentration <130 CFU/100mL in the ES Water and Land Plan coincides with the NPS-FM attribute states "Yellow" **(Scenario NPS-FM-1b)** and "Green" **(Scenario NPS-FM-1a)**. Similarly, a suggested hypothetical 95th percentile concentration <1000 CFU/100mL coincides with the NPS-FM attribute state "Green" **(Scenario NPS-FM-1a),** and hence the same modelling results.

Summary of quantitative microbial risk assessment

Quantitative microbial risk assessment (QMRA) was used to evaluate the risk to swimmers (both adults and children) in the Mataura River, at the Bridge, ~300m downstream of the alliance discharge. Where the risk to an individual (IIR) is greater than 1% (the accepted threshold for contact recreation), further simulations can be done to determine the degree of treatment required for the IIR to drop below the 1% threshold. This study assessed the health risk from the Alliance discharge with no treatment and with the existing treatment.

The results of QMRA analysis showed:

- **No treatment, normal flow scenario** – children and adults' recreational health risk fall above the 1% threshold in winter and summer for all zoonotic pathogens
- **No treatment, peak flow scenario** – children and adults' recreational health risk fall above the 1% threshold in winter and summer for all zoonotic pathogens
- **Treatment applied, normal flow scenario** – children and adults' recreational health risk fall below the 1% threshold in winter and summer for all zoonotic

pathogens. Thus, there is less than 1% probability of an individual becoming ill due to swimming at the study site.
- **Treatment applied, peak flow scenario** – children and adults' recreational health risk fall below the 1% threshold in winter and summer for all zoonotic pathogens.

Therefore, it is concluded that the current wastewater treatment applied at Alliance Plant is sufficient to reduce health risks associated with swimming below the discharge to levels below 'the NZ threshold for tolerable risk', even at maximum discharge of 14,400 m^3/d.[2]

While the Alliance Plant discharge is having 'more than a minor' effect on the levels of *E. coli* in the receiving water (Section 5), observed increases in *E. coli* concentrations as a result of the treated Alliance Plant discharge did not necessarily relate to the abundance of zoonotic pathogens (Section 3.2) neither did these increases in *E. coli* relate to the individual illness risk (Section 7).

Results in the current QMRA study generally agree with a recent ESR study (Cressey, Hodson, Ward, & Moriarty, 2017) which adopted a combination of faecal source tracking, genotypic analysis and QMRA to assess human health risk of the Mataura River, Southland. Results from the ESR-led investigation affirmed that:

- "Effluent discharged from the Gore WWTP and the meat processing plant contribute a relatively small proportion of the overall Campylobacter risk. This is consistent with other work that indicated that Campylobacter contamination in this region of the Mataura River was predominantly of wild fowl origin".
- The first two modelled QMRA scenarios produced very low risk of *Campylobacter* infection (<0.1%), that is, a very low risk of *Campylobacter* infection under either the old or updated guidelines. (i.e. NPSFM, 2014, 2017).
- The third ESR QMRA scenario would result in a lower water quality categorisation (estimated IIR values of between 1.7 and 2.8%), depending on whether high river flows[3] are excluded from the estimate, as representing 'unswimmable' conditions. This literally translates into a maximum of 2 to 3 cases of Campylobacter infection in 100 individuals. It is important to note that the third scenario in the ESR QMRA considers background Mataura River concentrations with inputs from the Gore WWTP, Alliance Plant discharge and other diffuse sources (e.g. during high river flows) in the estimation of recreational health risks. However, in this study, to distinguish the effect of the Alliance Plant discharge alone, an approach that

---

[2] It is important to note that the discharge in future consent applications could be less than 14,400 m^3/d

[3] During high river flows, overland flows and diffuse source pollution from other sources contribute to the Campylobacter infection risk

assumes no background concentration in the Mataura River was used. This QMRA therefore assessed if the Alliance Plant discharge (only) will cause the IIR to increase beyond an acceptable threshold of 1%. It has been shown from the QMRA using *Campylobacter* concentrations from multiple Alliance Plant discharge samples that the resulting IIR due to the discharge does not exceed 1% and were in most cases below 0.1%.

1. Introduction

Alliance is New Zealand's only wholly farmer-owned red meat co-operative with plants located at varying locations in New Zealand including Mataura, Southland. The Alliance Plant at Mataura produces several waste streams, including slaughter floor, boning room, edible by-products processing, stockyards and truckwash, water treatment plant backwash and domestic waste (which goes to the Mataura Wastewater Treatment Plant). Meat processing wastewater generated in the factory is treated onsite via physical treatments prior to being discharged to the Mataura River, which is the receiving waterway.

The Alliance Group is seeking renewal of consents to continue discharging treated meatworks wastewater into the Mataura River. To support the new discharge consent application, Alliance Group contracted Aquatic Environmental Sciences (AES) Ltd to provide an assessment of ecological effects (AEE). Microbial contamination will be a key issue for submitters and AES has contracted SEL to collate and analyse the 2017/18 microbial data from the Mataura River, and assess the potential effects of the meatworks discharges on the receiving environment. The study sought to provide a scientifically-robust assessment, as to whether or not the Alliance Plant discharges have a 'more than minor' effect on the state of the receiving environment for recreational uses.

2. Water Quality Standards: Existing approaches to managing water quality in New Zealand

2.1 Background

Surface waters are prone to contamination by pathogens from various point and nonpoint sources as a result of faecal wastes from animal processing factories (e.g. wastewater from Alliance Plant) and intensive agriculture-related practices on primary productive lands (e.g. animal waste from pastoral lands in the Mataura catchment). These pathogens are technically referred to as zoonotic —i.e. originate from animals and cause disease in humans. In New Zealand the most significant micro-organisms causing zoonotic diseases are the bacteria Campylobacter spp., some strains of *Escherichia coli*, *Salmonella* spp., and the protozoa *Giardia* and *Cryptosporidium* (MoH, n.d.). Details of pathogens associated with animal related wastewater are presented in Appendix 2 -4.

Enteric zoonotic diseases constitute about 80% of the total notifiable illnesses in New Zealand[4] . Hence, to protect New Zealanders, risks assessment and management systems

[4]https://thewaternetwork.com/_/climate-change-and-the-environment/blog-jl6/zoonoses-in-new-zealand-lNbgfO1psWDbvKpOvPwOWw.

are in place to potentially reduce exposure of water users to these pathogens. In New Zealand, current risk assessment is based on a monitoring system that assesses the levels of *Escherichia coli* (NPS-FM 2017). *E. coli* is typically used an indicator of the presence of potential enteric pathogens given that it is commonly present at high concentrations in the intestinal tracts and faeces of animals, including humans (Cabral, 2010; Payment & Locas, 2011).

2.2 Limitations to current approaches to managing water quality receiving animal-related waste in New Zealand

Despite the widespread use as of *E. coli* as an indicator organism, it is debatable as to whether the levels of FIB adequately predict the presence of all types of pathogens. Zoonotic pathogens from primary productive land are not reliably detected using the *E. coli* proxy. This is because there is often no good correlation between *E. coli* and zoonotic pathogens[5]. Hence, merely measuring *E. coli* as an indicator of risk on streams receiving input from animal-waste dominated sources may fail to protect the public from exposure to zoonotic pathogens. These concerns are well documented (Ahmed, Sawant, Huygens, Goonetilleke, & Gardner, 2009; Payment & Locas, 2011; Savichtcheva & Okabe, 2006; Sobsey, Khatib, Hill, Alocilja, & Pillai, 2006; Wu, Long, Das, & Dorner, 2011). For streams receiving input from animal-waste dominated sources, a more robust risk management appoach would focus on in-depth site-specific assessments that includes a consideration for specific zoonotic pathogens associated with this form of waste. For instance, reliance on quantitative methods[6] with a focus on animal factory wastewater pathogens will provide a more scientifically defensible mechanism to characterize risks from animal-based wastewater sources.

Another limitation to the current risk assessment system, which relies on *E.coli* as indicator bacteria, is that *E.coli* can survive and proliferate outside of animal intestines, in tropical and temperate habitats. This calls into question their reliability as indicators in these habitats. Also, the processes that control the survival and removal of microbes in water, such as competition, ultraviolet radiation, temperature, predation, and transport differ among pathogenic species. Thus, monitoring FIB alone is not sufficient to assess human health risk.

---

[5] National Research Council (US) Committee on Indicators for Waterborne Pathogens. Indicators for Waterborne Pathogens. Washington (DC): National Academies Press (US); 2004. 4, Attributes and Application of Indicators.
[6] QMRA

In New Zealand, levels of *E.coli* in water is used to determine whether the water intended for drinking or recreational purposes are free of zoonotic pathogens. For contact recreation, in the case of single samples, less than 540 CFU/100 mL of *E. coli* are recommended by the NPS -FM and warnings (advisories) are usually issued to the public when contaminant levels exceed these concentrations. However, such advisories do not present an accurate assessments of health risk associated with contact recreation, particularly because of the low-frequency monitoring that usually miss pollution events over shorter timescales. Another key challenge is the delay between measurement and reporting. Routine bacteriological culture requires 24-48 hours before results can guide risk assessment. Invariably, this means that swimming advisories, when issued indicate that 'it may have been safe/unsafe to swim in the past (Dada & Hamilton, 2016)'.

Existing approaches to monitoring *E. coli* levels as a proxy for the presence of zoonotic pathogens does not seem to distinguish between concentrations during different flow conditions. Considerations for flow conditions may warrant the establishment of more stringent limits for *E. coli* during the "swimming season" (typically during base and low flows) and less stringent limits for all other times (storm flows). A conservative threshold set at 540 CFU/100mL regardless of the season may actually mean that health risks associated with exposure to pathogens are over-estimated, particularly during non-swimming periods when the *E.coli* population are largely driven by periods of high flow.

2.3 Approaches to standard setting

2.3.1 National Policy Statement on Freshwater Management

The National Policy Statement for Freshwater Management 2014 (NPS-FM, see Table 1) sets out the objectives and policies for freshwater management under the Resource Management Act 1991. These objectives and policies direct local government to manage water in an integrated and sustainable way, while providing for economic growth within set water quantity and quality limits. The primary responsibility for implementing the NPSFM lies with regional and unitary councils[7], who are required to effect to the NPS-FM in planning documents, report on their progress, and fully implement the NPSFM no later than 31 December 2025. The NPS-FM came into effect on 1 August 2014.

Recent revisions[8] were made to the NPS-FM in August 2017. Based on these revisions, to assess swimmability, four metrics are considered namely % exceedance of the 540 *E. coli*

[7] The Resource Management Act 1991 requires Regional Councils to give effect to national policy statements in regional policy statements and regional plans (Sections 62 and 66 respectively).
[8]www.mfe.govt.nz/fresh-water/acts-and-regulations/national-policy-statement-freshwater-management/2017-changes

/100 ml, median *E. coli* /100 ml, 95th %tile *E. coli* /100 ml and % exceedance of the 260 *E. coli* /100 ml. This combination of metrics enables councils to provide a clearer picture about the nature of progress towards *E. coli* targets for any particular monitored river reach and gives greater assurance when moving between attribute states than would be obtained by using the median and 95th percentile statistics alone.

Table 1 NPS-FM Attribute States and corresponding thresholds

Value	Human health for recreation				
Freshwater Body Type	Rivers				
	Numeric Attribute State				
Attribute State1	% Exceedance over 540 cfu/100 mL	% exceedances over 260 cfu/100 mL	Median concentration (cfu/100 mL)	95th percentile of E. coli/100 mL	Description of risk of Campylobacter infection (based on *E. coli* indicator)
A (Blue)	<5%	<20%	≤130	≤540	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk). The predicted average infection risk is 1%
B (Green)	5-10%	20-30%	≤130	≤1000	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk). The predicted average infection risk is 2%
C (Yellow)	10-20%	20-34%	≤130	≤1200	For at least half the time, the estimated risk is <1 in 1000 (0.1% risk). The predicted average infection risk is 3%
D (Orange)	20-30%	>34%	>130	>1200	20-30% of the time the estimated risk is ≥50 in 1000 (>5% risk). The predicted average infection risk is >3%
E (Red)	>30%	>50%	>260	>1200	For more than 30% of the time the estimated risk is ≥50 in 1000 (>5% risk). The predicted average infection risk is >3%

Concerns about the gradings outlined in the revised national swimming standards have, however, been raised in previous New Zealand literature (e.g. submissions[9] to the Ministry

> *A rapid analysis of Auckland Council's State of the Environment (SoE) freshwater sites using the four proposed E.coli statistics (for a 5-year data period) identified that often the bands for a particular attribute state were not consistently met for each of the four proposed statistics. This contradicts MfEs statement that "there is a high correlation between the tests. If you meet one it is highly likely that all other tests will be met".*

for the Environment). The new attribute states and numeric classifications may make sense statistically, but is likely to create confusion among stakeholders, particularly among regional councils tasked with managing water quality, and the general public. For instance, under the revised classification scheme, it is difficult to classify some rivers into attribute states specified in the revised attribute tables. According to Auckland Council:

To provide an approach to monitor progress towards the achievement of freshwater objectives, Policy CB1 in the revised NPS-FM requires that every regional council develop a monitoring plan that:

- establishes monitoring methods which include surveillance monitoring of microbial health risks to people at primary contact sites (Policy CB1-aa),
- identifies a site or sites at which monitoring will be undertaken that are representative for each freshwater management unit (Policy CB1-b); and,
- recognises the importance of long-term trends in monitoring results and the relationship between results and the overall state of fresh water in a freshwater management unit (Policy CB1-c).

It is unclear where this sampling described in this Policy CB1 should occur - at all swimming sites, for all large rivers, or at sites representing a FMU? The policy document does not specify considerations when the presence of a point source discharge influences the selection of an appropriate FMU for which the policy may be applied for *E. coli* monitoring. In these instances, regional councils need to, in the context of local realities, determine appropriate FMUs to which the policy may be applied.

[9] https://www.mfe.govt.nz/sites/default/files/media/Streamlined%20Environmental.pdf

2.3.2 Proposed Environment Southland (ES) Water and Land Plan

As part of the requirements of NPS-FM Policy CB1, Appendix E of the proposed Environment Southland (ES) Water and Land Plan identifies three management units as representative of the Mataura River. The descriptions of these management units and the microbiological water quality standard for each unit are presented in Table 10. Appendix E of the proposed ES Water and Land Plan also provide guidance on standards which apply following reasonable mixing with the receiving waters for waters receiving point source discharges, as well as standard methodologies for collecting water quality data.

Table 2 Water Quality Standard for freshwater management units, Mataura River (Source: Appendix E, Environment Southland Water and Land Plan*)

Management Unit	Description	Water Quality Standard (microbiological)
"Mataura 1"	The Protected Waters27 between map references NZMS 260 F45:967-503 to F45:963-508 (Mataura River).	Based on no fewer than five samples taken over not more than a 30-day period, the median value of the faecal coliform bacteria content of the water must not exceed 2000 per 100 millilitres and the median value of the total coliform bacteria content of the water must not exceed 10,000 per 100 millilitres.
"Mataura 2"	The Protected Waters between map references NZMS 260 F45:894-581 to F45:885-584 (Mataura River) and NZMS 260 F46:917-391 to F46:924-396 (Mataura River).	Based on no fewer than five samples taken over not more than a 30-day period, the median value of the faecal coliform bacteria content of the water must not exceed 200 per 100 millilitres.
"Mataura 3"	Protected Waters other than those parts classified as Mataura 1 and Mataura 2.	The concentration of faecal coliforms shall not exceed 1,000 coliforms per 100 millilitres, except for popular bathing sites, defined in Appendix G "Popular Bathing Sites" and within 1 km immediately upstream of these sites, where the concentration of Escherichia coli shall not exceed 130 *E. coli* per 100 millilitres.

* It is important to note that Appendix E of the Environment Southland Water and Land Plan has been rolled over and is currently under appeal.

A critical analysis of these microbiological water quality standards brings to forefront some important issues.

First, the Microbiological Standard presented in the proposed ES Water and Land Plan for "Mataura 3" does not specify the frequency of sampling required when an assessment of microbiological water quality is to be made, unlike for other units (Mataura 2 and 1). Notwithstanding, one may however, assume that the sampling frequency is similar to those of "Mataura 2" and "Mataura 1", i.e. no fewer than five samples taken over not more than a 30-day period.

Second, contrary to the approach used in the NPS-FM guidelines which specifies a combination of four metrics, the proposed ES Water and Land Plan seems to apply a single metric in relation to the microbiological Standard for Mataura (median, see "Mataura 2" and "Mataura 1" in Table 10). As outlined in published literature (McBride, 2014, 2017), the use of single statistics (i.e. median or maximum in the case of "Mataura 3" standard) may be biased by unknown statistical sampling error e.g. due to sample variability. The NPSFM requires freshwater quality within a freshwater management unit (FMU) to be maintained at its current level (where community values are currently supported) or improved (where community values are not currently supported). Given the single metric approach for microbiological standards in the proposed ES Water and Land Plan, it is difficult to identify nature of progress towards *E. coli* targets for the Mataura River. It is also impossible to determine whether the monitored river reach maintains or exceed a particular attribute state.

Third, the statistics referred to in the case of "Mataura 3" (Table 10) seems to be ambiguous in that it is not clear whether it is a 'maximum' or 'median' concentration of 5 samples being referred to. Important considerations exist for either interpretation:

i. If the 130 CFU/100mL in the ES Standard for Mataura 3 actually refers to a maximum (instead of median), then this standard would most likely be 'technically unachievable'. This is because the specified 95th percentile or near-maximum for the 'best water quality' in New Zealand is 540 CFU/100mL (i.e. Attribute State A, Blue in the NPS FM). Also, if the 130 CFU/100mL in the ES Standard for Mataura 3 actually refers to a maximum, it is difficult to find a meeting point between the NPS-FM guidelines and the microbiological standards presented in the proposed Southland Water and Land Plan.
ii. If the statistics in the ES Standard for Mataura 3 refers to a median, medians of <130 *E. coli* per 100 mL in the ES Standard tends to relate to any of three attribute states in the NPS-FM guidelines (blue, green and yellow, see Figure 1).

Fourth, the proposed ES Water and Land Plan apparently, does not distinctively separate the different types of faecal indicator bacteria in reference to the specified microbiological water quality standard. For instance, it seems to apply the term 'faecal coliform bacteria', 'total coliform bacteria' and '*E.coli* ' interchangeably without a justification. From an implementation perspective, this many lead to very subjective interpretations as each of these groups of indicator bacteria differ in their performance and purpose of use in water quality assessment[10]. For instance, while faecal coliforms, a subset of the coliform group, are predominantly found in the intestinal tract of humans and other warm-blooded animals, they constitute a mixed group of organisms including bacteria from environmental sources. *E. coli* is a more specific indicator of human health risk from recreational contact with fresh water than faecal coliforms and it provides a definite indication of recent faecal contamination (MfE 2009[11]).

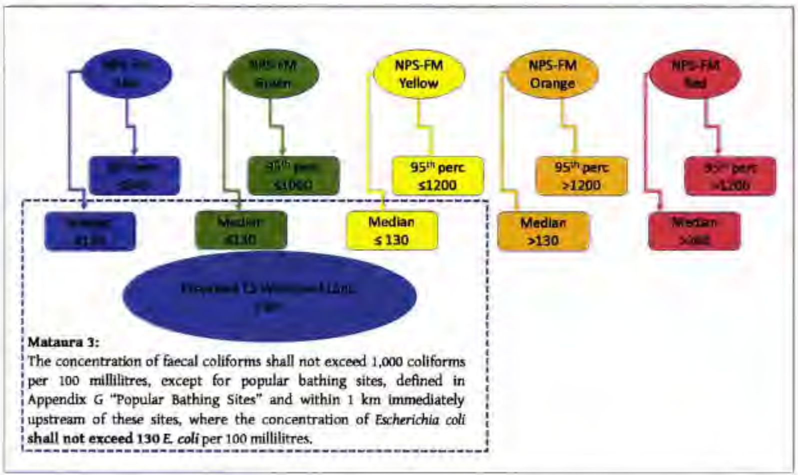


Figure 1 Converging points of the NPS-FM (2017) and the proposed ES Water and Land Plan *E.coli* Standards for "Mataura 3"

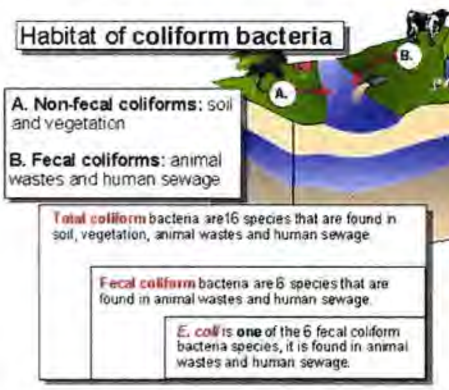


Figure 2 Types and habitats of different indicator bacteria used in the assessment of microbiological water quality (Source: MfE 2009[12])

[10] See Appendix 2 of the Microbiological Water Quality Guidelines for background information on the choice of indicators and advantages of using them.

[11] Microbiological water quality guidelines for recreational water - frequently asked questions. Available online: http://www.mfe.govt.nz/fresh-water/tools-and-guidelines/microbiological-guidelines-recreational-water

[12] As cited in 10

According to the ES Water and Land Plan microbiological standard for "Mataura 3";

> *The concentration of faecal coliforms shall not exceed 1,000 coliforms per 100 millilitres, except for popular bathing sites, defined in Appendix G "Popular Bathing Sites" and within 1 km immediately upstream of these sites, where the concentration of Escherichia coli shall not exceed 130 E. coli per 100 millilitres.*

The faecal coliform aspect of this standard comes with a caveat. It is difficult to justify this limit as there are no existing New Zealand standards in relation to faecal coliforms monitored in receiving water environments. The New Zealand microbiological water quality guidelines for marine and freshwater recreational areas (MfE, 2003) however provides guidance on the incorporation of historical faecal coliform data into available guidelines such as NPS-FM (2017) by applying a numerical relationship between the faecal coliform and *E. coli* indicators. Using this approach, a ratio of 126 *E. coli* per 200 faecal coliforms (for freshwater) could be applied. Although this approach is indicative (as *E. coli* to faecal-coliform ratios differ considerably from site to site[13]), it is useful for management purposes and in helping to identify high-risk bathing sites. By implication, the 1000 faecal coliform limit in the proposed ES Water and Land Plan for non-popular bathing sites in "Mataura 3" will be would be roughly equivalent to 630 CFU/100mL *E. coli* (i.e. 1000*126/200).

This invariably suggests that the microbiological water quality standard for Mataura 3 could be reworded to:

> *The concentration of Escherichia coli shall not exceed <u>630 E. coli</u> per 100 millilitres, except for popular bathing sites, defined in Appendix G "Popular Bathing Sites" and within 1 km immediately upstream of these sites, where the concentration of Escherichia coli shall not exceed <u>130 E. coli</u> per 100 millilitres.*

These defined limits thus appear to need some modification considering that designated '*E.coli* ' thresholds in popular bathing sites should logically be higher than for the non-popular bathing sites.

[13] https://pubs.usgs.gov/wri/1993/4083/report.pdf

3. Microbial Pathogens in the discharge water

The treatment performance of Alliance Plant WWTP was reviewed in terms of *E.coli* concentrations of the discharge water. Additional sampling was conducted specifically for the zoonotic pathogens (details of relevant zoonotic pathogens are described in Appendices 1-3. In this section, the Alliance Plant WWTP compliance monitoring and zoonotic pathogens data are reviewed to assess the:

- microbiological quality of Alliance Plant raw and treated wastewaters and efficacy of current treatment process, and
- microbial contaminants in Alliance Plant discharged wastewaters that could present a human health risk.

3.1 Compliance Monitoring

Two forms of wastewater are generated by Alliance Factory, human waste and animal related wastewater. Human sewage is reticulated separately from meat processing wastewater and conveyed to the Gore District Council Mataura wastewater treatment plant from which treated wastewater is discharged via ponds about 1.5 km south of Mataura (Figure 3). Treated meat processing wastewater is however, discharged through pipes into the Mataura River.

Figure 3 Physical location of meat processing factory and discharge of wastewater into the Mataura River

Box plots of treated wastewater monitoring data for *E. coli* in the treated final effluent were supplied by Alliance Plant, Mataura for the period 10 November 2004 to 14 March 2018 (Figure 4a). Historical *E. coli* concentrations in the discharge generally ranged between 1 x 10^3 CFU/100mL and 1 x 10^7 CFU/100mL (see Summary Data in Appendix 1). An analysis of historical monitoring data of wastewater discharge *E. coli* levels at the plant indicates considerable variability over the years. While an apparent increasing trend in *E. coli* concentrations were observed in 2004 to 2010, a decreasing trend in *E. coli* concentrations is noticeable from 2013-2017 (Figure 4b). In 2017, the median *E. coli* levels was the lowest recorded in the 14-year period (2.4 x 10^4 CFU/100mL) (Figure 4a and Figure 4b).

The current discharge consent does not specify a limit for the allowable number of FIB in the discharge.

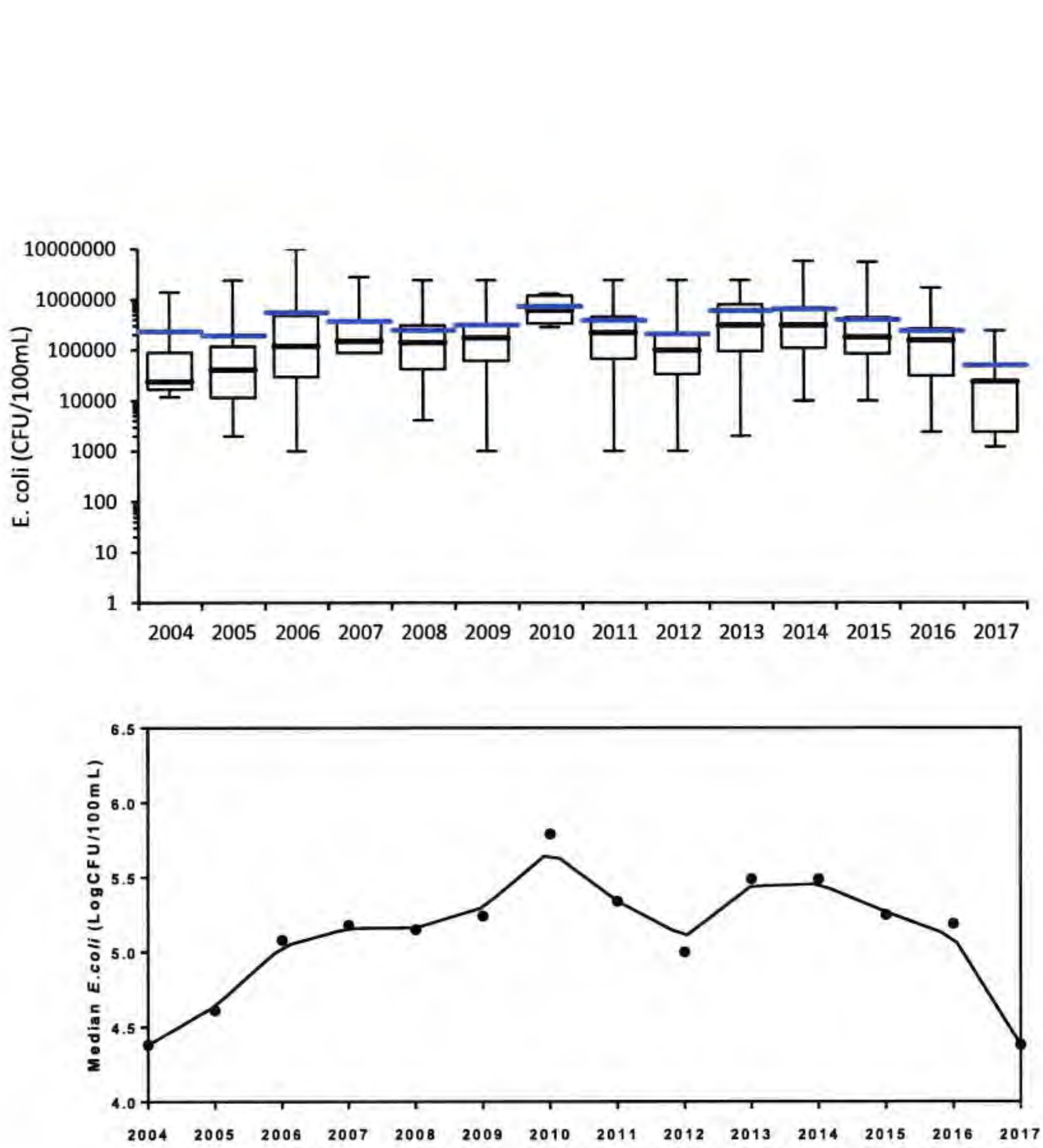


Figure 4 (a) Box plot analysis and (b) Lowess-fitted trend analysis of historical *E. coli* data, WWTP discharge from Alliance Plant, Mataura. Blue lines are the means

3.2 Pathogen Monitoring

Microbial assessment for Mataura River was informed by available literature which affirm that two key groups of pathogens are of most concern in animal wastewater, bacteria and protozoans (Sobsey et al., 2006; USEPA, 2010). There are no substantial risks established for transmission of fungi and viruses through animal wastewater discharge. More details on the justification for inclusion of bacteria and protozoans and exclusion of fungi and viruses in microbial risks assessment for this animal-related discharge are presented in Appendices 2-4.

Bacteria

Because the tests for bacteria pathogens are time-consuming and expensive, it is not practical to implement on a routine basis. Faecal indicator bacteria (FIB-*E.coli*) are typically used instead to assess the quality of treated effluent on the assumption that pathogens die at the same rate as FIB. A monitoring exercise in Autumn 2019 was therefore completed that assessed the bacterial pathogens in Alliance Plant discharged wastewaters that could present a human health risk, with a view to comparing these pathogen concentrations with FIB levels. *Salmonella*, *Campylobacter* and *E. coli* 0157:H7 were the representative bacterial pathogens species tested in treated wastewater samples. Treated wastewater samples were also subjected to molecular source tracking (MST) by analysing for the presence of molecular markers specific to three host sources (cattle, sheep and birds) (Appendix 5). Analysis were conducted at ESR, WaterCare and Hills Laboratory (laboratory results are attached as appendix, see Appendix 6, and summarized in Table 3). Expectedly, MST analysis indicated that ruminant markers were readily detected in the faecal signature of the treated wastewater (Table 3).

Table 3 Molecular markers detected in Alliance Plant discharge, May 2018

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Treated wastewater day1	53,000,000	1,100,000	270	630	36
Treated wastewater day2	25,000,000	330,000	50	280	36
Average	**39,000,000**	**715,000**	**160**	**455**	**36**

Results from the Autumn 2018 pathogen monitoring indicate that a very high level of *E.coli*, up to 10^6 CFU/100mL, was being discharged into the Mataura River from the Alliance Plant but that the levels of the representative pathogens was very much lower and more variable (Table 4). For example, the discharge contained a reasonable number of *Salmonella* species (120 cells per 100mL, Table 4) and *Campylobacter jejuni* (22 cells per 100mL, Table 4). *E.coli* 0157: H7, the pathogenic variant of *E.coli*[14] was also rarely detected despite the high levels of *E.coli* concentrations in the treated wastewater. These data indicate that high FIB concentrations did not result in high levels of pathogens in the treated wastewater (Table 4).

Additional summer pathogen monitoring was conducted in 2019. These summer months monitoring is important because the impact of the Alliance Plant discharge on downstream sites could be most significant during low flow conditions. Similar to the Autumn 2018 results, a very high level of *E.coli* , up to 10^6 CFU/100mL in the Alliance Plant discharge was recorded during the summer pathogen monitoring, but the levels of the representative bacteria pathogens were very much lower (Table 4).

---

[14] rising number of cases of E.coli 0157: H7infection in New Zealand is rising, but the transmission routes remain obscure.

Table 4 Bacteria pathogen monitoring data, Alliance Mataura Plant discharge, Autumn 2018 and Summer 2019

Season	Date	*E.coli* (CFU/100ml)	*Salmonella* (CFU/100ml)	*Campylobacter* (CFU/100ml)	*E.coli 0157: H7* (CFU/100ml)
Autumn 2018	7-May	2,400,000	240	4	0.3
	9-May	520,000	0.6	43	0.3
	Average	1,460,000	120	24	0
Summer 2019	18-Dec	300,000	21	<3	<3
	19-Jan	4,500,000	4	9	<3
	19-Feb	90,000	<3	4	*
	Average	1,630,000	9	5	2

* E. coli O157 was detected in this sample, however quantification was not possible due to the presence of inhibitory substances in the matrix

Protozoans

Among the notifiable gastrointestinal diseases which can be contracted through contaminated water, Cryptosporidiosis and *Giardia*sis are the top two[15] caused by protozoans. Cryptosporidiosis and *Giardia*sis is caused by infection with protozoan parasites of the genus *Cryptosporidium and Giardia.*

As part of this microbial assessment, discharge wastewater samples were analysed for the levels of these two protozoan pathogens. Samples were analysed at WaterCare. Results indicate that protozoan pathogens were very low following treatment. In the first sampling that occurred in Autumn 2018, no oocysts were detected in the discharge (0 cysts per L, see Table 4).

In contrast, over the summer of 2018/19, *Cryptosporidium* and *Giardia* were detected at comparatively higher levels (up to 310 oocysts per litre, Table 5). This variability is not unexpected because pathogens in meat works wastewater will depend on the resident population of pathogens in the animals before slaughter, which will vary (Sobsey et al 2006).

---

[15] http://www.ehinz.ac.nz/assets/Factsheets/Released-2016/EHI47-WaterBorneDiseasesNotificationsUntreatedDrinkingWater2005-2014-released201608.pdf

Table 5 Protozoa pathogen monitoring data, Alliance Mataura Plant discharge, Autumn 2018 and Summer 2019

Season	Date	*Giardia* (oocysts /1000ml)	*Cryptosporidium* (oocysts /1000ml)
Autumn 2018	7-May	<1	<1
	9-May	N.D	N.D
Summer 2019	18-Dec	32	310
	19-Jan	150	250
	19-Feb	2	1

Summary of microbial pathogens in the discharge water.

The current discharge consent does not specify a limit for the allowable number of FIB in the discharge. Historical *E.coli* concentrations in the discharge wastewater generally ranged between 1 x 10^3 CFU/100mL and 1 x 10^7 CFU/100mL. An analysis of historical monitoring data of wastewater discharge *E.coli* levels at the plant indicates considerable variability over the years. While an apparent increasing trend in *E.coli* concentrations were observed in 2004 to 2010, a decreasing trend in *E.coli* concentrations is noticeable from 2013-2017.

Because there had been no pathogen data collected during the routine monitoring for E. coli (Fig. 1), Alliance initiated monitoring for specific pathogens in Autumn 2018 and then again during the summer of 2018/19 (3 successive monthly samples) with a view to comparing these pathogen concentrations with FIB levels. Salmonella, Campylobacter and E. coli 0157:H7 were selected as representative bacterial pathogens species whilst parasites of the genus Cryptosporidium and Giardia were the representative protozoans. Treated wastewater samples were also subjected to molecular source tracking (MST) by analysing for the presence of molecular markers specific to five host sources (humans, cattle, sheep, dogs, birds).

Results showed a very high level of E.coli , up to 10^6 CFU/100mL, was being discharged into the Mataura River from the Alliance Plant, but that the levels of the representative pathogens were very much lower and more variable. For example, in autumn 2018 the discharge contained a reasonable number of Salmonella species (120 cells per 100mL), Campylobacter jejuni (22 cells per 100mL) but few E. coli 015: H7 (0.3 cells per 100mL) but zero cysts of either Cryptosporidium or Giardia. In contrast, over the summer of 2018/19, Salmonella species and Campylobacter jejuni were lower in concentration (<30 cells per 100mL) while Cryptosporidium and Giardia were detected at comparatively higher levels (up to 310 oocysts per litre). This variability is not unexpected because pathogens in meat works wastewater will depend on the resident population of pathogens in the animals before slaughter, which will vary.

4. Microbiological quality of the receiving environment

4.1 Historical monitoring (2007-2017)

Current risk assessment is based on a monitoring system that assesses the levels of *Escherichia coli* in *the* Mataura River. Since 2007, microbiological water quality data has been collected for a number of sites in the Mataura River and associated tributaries (Figure 5 and Figure 6).

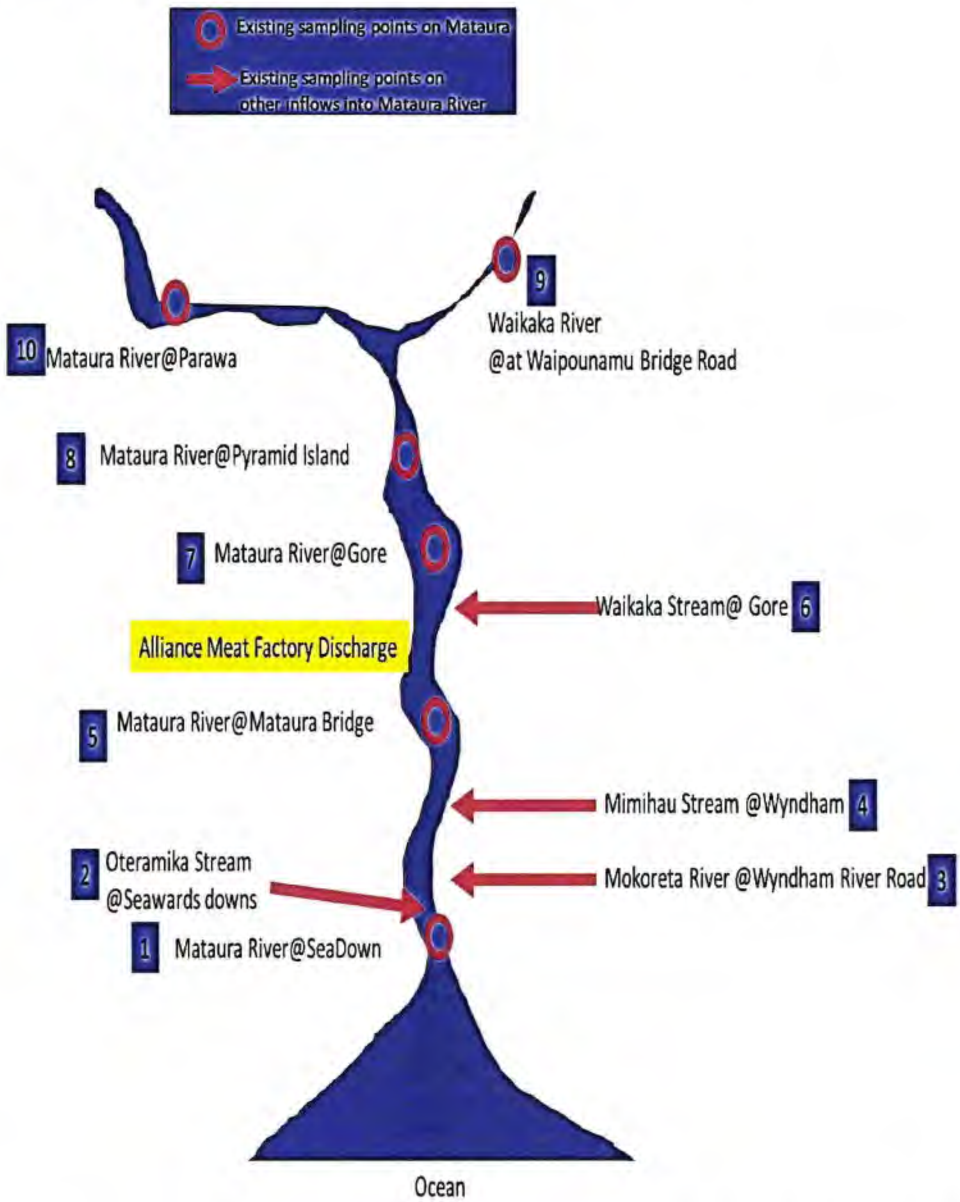


Figure 5 A conceptual model of existing monitoring sites on the Mataura River and tributaries

Analysis of historical monitoring data for Mataura River and its tributaries from 2007 to 2017 indicate that exceedances of the New Zealand single sample bathing water standards of 260 CFU/100mL and 540 CFU/100mL (i.e. 2.42 and 2.73 LogCFU/100mL, in NPS-FM 2017) were common among all the Mataura River sites (sites upstream and downstream of the Alliance Plant) and its tributaries (Figure 6).

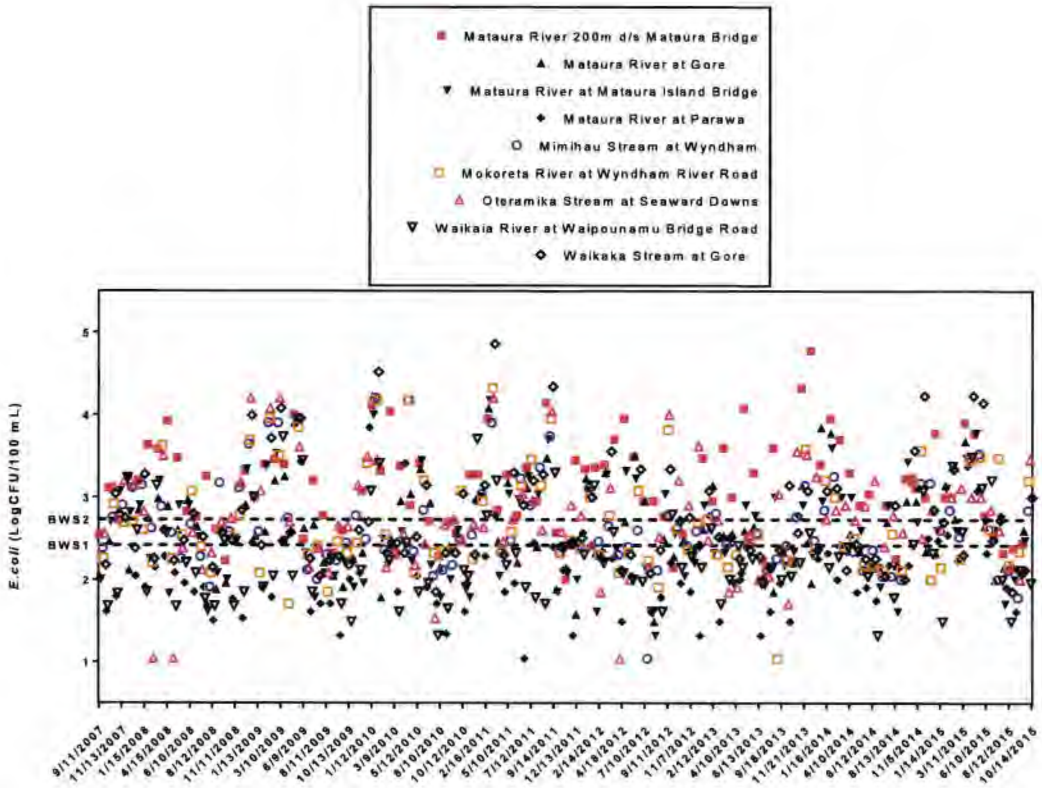


Figure 6 Analysis of historical *E. coli* data, Mataura River and tributaries (2007-2015). The dotted lines, BWS1 and BSW2 are the bathing water thresholds of 260 CFU/100mL and 540 CFU/100mL (equivalent to 2.43 LogCFU/100mL and 2.73 LogCFU/100mL, NPS-FM 2017).

The NPS-FM (2017) sets out the objectives and policies for freshwater management under the Resource Management Act 1991 and also defines River Attribute States for *E. coli* (see revised NPS FM Table for *E. coli* in Table 1). The proportion of samples exceeding the NPS-FM (2017) bathing water standards increased between the upstream and downstream sites. For instance, at the site immediately downstream of the discharge (Mataura River 200m d/s Mataura Bridge), exceedance of the 540 CFU/100mL single sample standard increased from 35% (Mataura River @Gore) to 77%. This suggests that the discharge is having an effect on the levels of *E. coli* in the receiving water.

Attribute State classification based on the historical *E. coli* data for the Mataura River and tributaries (2011-2015)[16] indicate that the river is classified as E (Red) for most monitored sites, regardless of whether the site is an upstream or downstream of the Alliance discharge (Figure 6). The poor baseline microbiological state of Mataura River is not surprising. The 190km long Mataura River flows through several towns whose industries and sewage treatment plants input wastewater to the river. In addition to the meat works wastewater, the river also supports a rapidly growing dairy industry (ESR, 2013) and many other large commercial interests including milk processing plants and a fibreboard factory. These discharges also influence the microbiological quality of the river. Thus, a catchment wide approach would be needed to improve the quality of the river.

Table 6 Attribute State[17] of Mataura River based on historical *E. coli* data. The amended 2017 NPS was used for the Attribute State Classification.

New Standard (Ammended NPS FM 2017)	% exceedances over 540	% exceedences over 260	Median concentration (cfu/100 mL)	95th percentile E. coli/100 mL	Attribute State
Mataura River 200m d/s Mataura Bridge	77	83	1551	12551	E (Red)
Mataura River at Gore	35	59	361	5401	E (Red)
Mataura River at Mataura Island Bridge	42	56	401	4451	E (Red)
Mataura River at Parawa	17	30	156	1066	D (Orange)
Mimihau Stream at Wyndham	39	69	391	2651	E (Red)
Mokoreta River at Wyndham River Rd	35	58	321	3801	E (Red)
Oteramika Stream at Seaward Downs	55	82	601	4551	E (Red)
Waikaia River at Waipounamu Bridge Rd	20	31	161	3751	E (Red)
Waikaka Stream at Gore	42	61	331	19251	E (Red)

Historical data indicate that there is a strong connection between discharge, clarity conditions of the Mataura River and the observed *E. coli* concentrations (Figure 7). For example, *E. coli* concentrations in the Mataura River water column tend to exceed the bathing water standards of 260 CFU/100mL and 540 CFU/100mL (i.e. 2.42 and 2.73 LogCFU/100mL) more frequently when water clarity is below 2.0m (Figure 7). Similarly, *E.*

[16] The amended NPS specifies that a maximum of 5 years or at least 60 water sample be included in the analysis that seeks to determine the Attribute State classification

[17] The amended NPS FM table is often inconclusive in determining Attribute States for some sites. This is a New Zealand wide phenomenon and is not peculiar to Mataura River.

coli concentrations in the Mataura River water column tends to exceed the bathing water standards more frequently when river discharge(flow rate) is high (Figure 7).

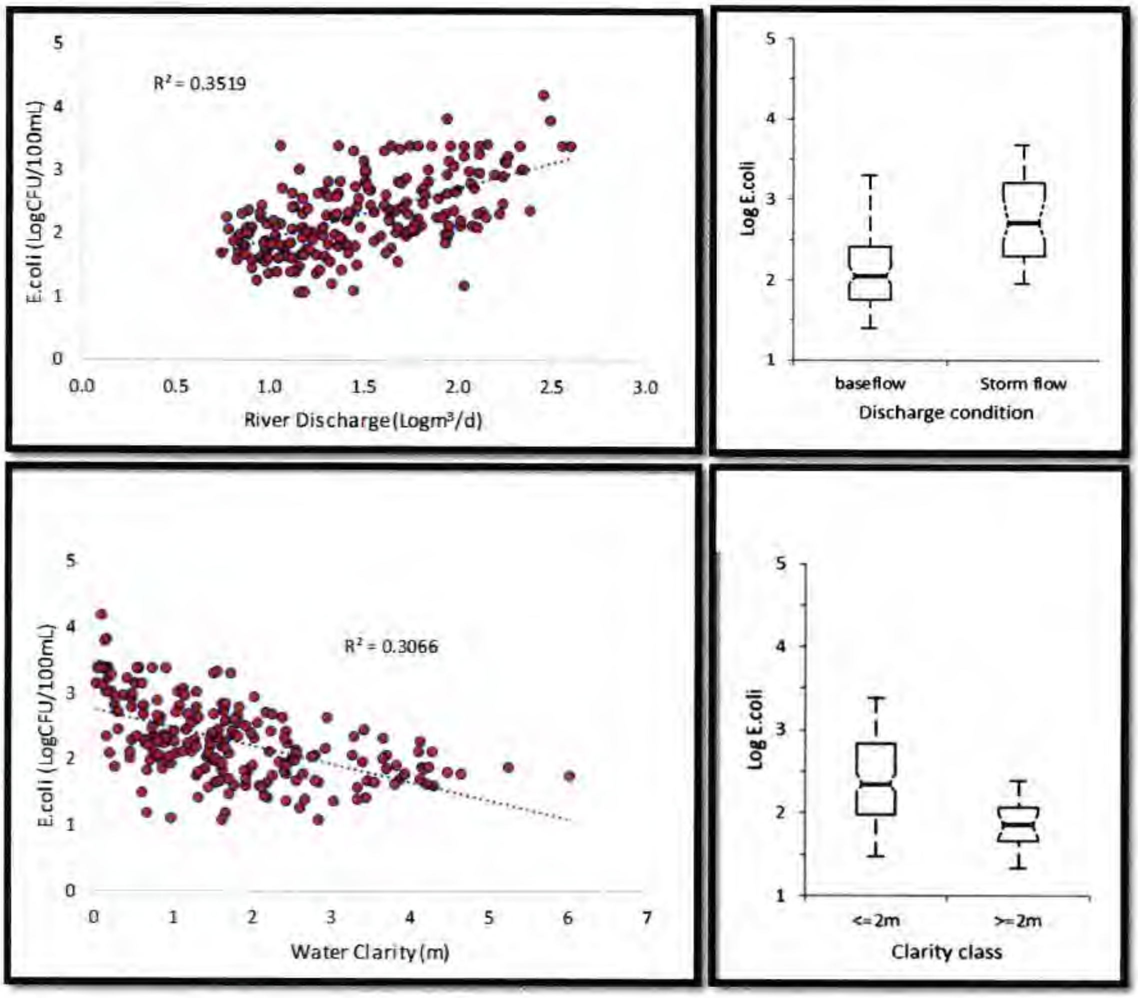


Figure 7 Linear correlation between water column *E. coli* concentrations versus clarity and discharge conditions in the Mataura River.

The observed correlations between river water *E.coli*, river flow and water clarity also give credence to the influence of a combination of high faecal content/faecal bacteria loadings from pastoral catchment overland flows and in-stream processes. Generally, inflows dominated by overland flow will contain elevated loads of suspended particles and bacteria. Once delivered to the river, sediment and bacteria can then accumulate on riverbeds before being re-suspended after an increase in river discharge. Highly erosive stormflow results in the resuspension of particles as a function of flow, which leads to resuspension of bacteria into the water column (often several orders of magnitude higher than baseflow). This report agrees with Stott et al (2011) that a greater understanding of stream channel dynamics with respect to faecal microbes, and consideration of microorganism specific factors is required before these uncertainties can be resolved. This is a wider research question outside the scope of the current study.

4.2 Recent monitoring (2017-2018)

Intensive *E. coli* monitoring of the Mataura River was conducted in the summer of 2017/2018 as part of this study. Sampling sites (Figure 8) were selected in such a way that covered sites on the river upstream and downstream of the discharge from Alliance Plant.

Figure 8 Sampling sites for the intensive monitoring conducted in 2017/2018 summer. Upstream sites are UP1, UP2 and UP3. Post-discharge sites PDP 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 are 50,80,150,370,450,720,850,900, 1670, 2650 and 3340 m, respectively, away from the discharge. Additional summer pathogen monitoring was conducted for samples collected at Mataura Bridge, ~300m downstream of the discharge. The ES compliance monitoring site 'Mataura River 200m d/s Mataura Bridge' is approx. 800m from the outfall, i.e. between PD6 and PD7.

Samples were analysed at Watercare, Auckland. Water quality data generated from the intensive monitoring is presented in Table 7, and further analysed in Figure 9 and Figure

10. Table 7 shows that the contribution of the discharge to *E. coli* concentrations in the receiving water is large.

An analysis of the recent monitoring data indicated that:

i. *E. coli* concentrations increase significantly following discharge of the Alliance Plant wastewater (Figure 9). Also, *E. coli* concentrations reduce gradually downstream i.e. with increasing distance away from the discharge point (Figure 9). The longitudinal *E.coli* survey also suggests that the point of full mixing is somewhere at a distance between the PDP2 (80m downstream of discharge) and PDP3 site (150m downstream), as concentrations remain considerately stable beyond these sites. The exact approximate distance where full mixing of the treated wastewater has occurred will need to be verified using a mixing model.
ii. Relationships between *E. coli* and Mataura River flow varies depending on the flow conditions. The impact of the Alliance Plant discharge on downstream sites increases during low flow conditions (i.e. higher downstream: upstream *E. coli* ratios, see Figure 10e). At the upstream sites, during base flows (typically at <35m^3/s), *E. coli* concentrations reduce with increasing flow due to within stream dilution. As river flow increases beyond base flow, the inverse relationship during baseflow changes to a positive one, as the river becomes increasingly impacted, possibly, by overland flow from the catchment (Figure 10a).
iii. There is no relationship between water temperature and *E. coli* concentration at the upstream sites, i.e. before the discharge (Figure 10c).

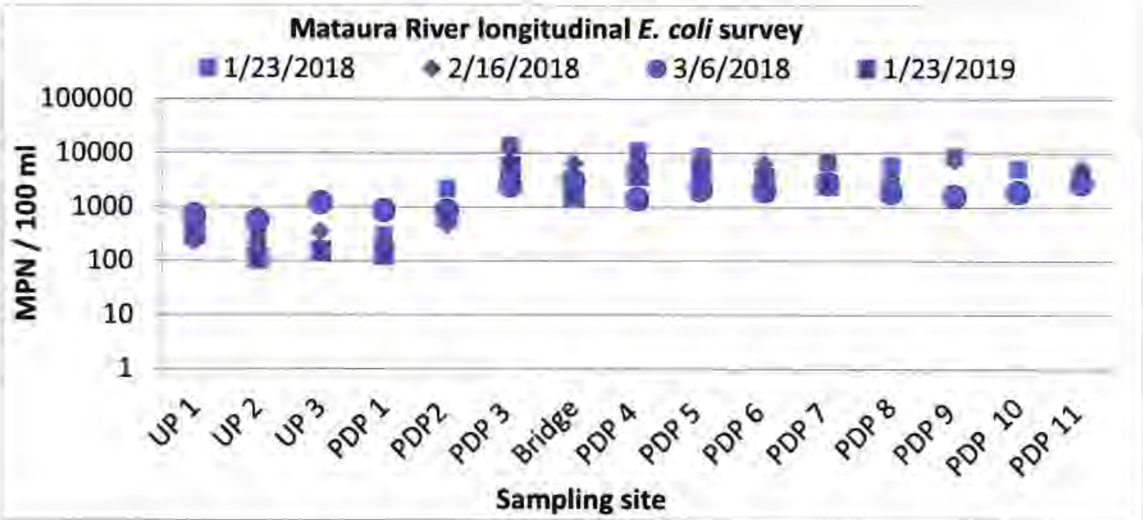


Figure 9 Plots of observed *E. coli* data from longitudinal study, Mataura River, Summer 2017/2018 Upstream sampling sites are designated UP while downstream sites are designated PDP (in m, estimated using the Google Map distance tool). Sampling sites PDP 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 are 50,80,150,370,450,720,850,900, 1670, 2650 and 3340 m, respectively, away from the discharge. Bridge is ~330m downstream of the discharge. The bridge samples were taken on different dates (12/19/2018, 01/21/2019 and 02/18/2019).

Table 7. Water quality data from intensive monitoring of the Mataura River, Summer 2017/2018

Sample#	Day	Date	Approx. Time	River data Flow (m^3/s)	Temp (deg Celcius)	Site 1 Upstream	Site 2 Downstream
						E. coli (MPN/100 mL)	
1	Tue	5-Dec-17	13:25	21.50	18.5	110	4100
2	Wed	13-Dec-17	10:00	20.20	16.0	1100	3400
3	Thur	21-Dec-17	10:50	16.87	17.7	150	2600
4	Thur	4-Jan-18	14:25	13.50	20.7	86	2600
5	Mon	8-Jan-18	13:30	13.52	20.7	660	4600
6	Tue	16-Jan-18	11:45	34.44	17.7	30	3400
7	Tue	23-Jan-18	11:00	12.08	20.51	260	2800
8	Wed	24-Jan-18	11:30	11.64	20.9	200	4900
9	Thur	1-Feb-18	11:35	12.50	19.2	5500	50000
10	Wed	7-Feb-18	12:15	62.10	14.4	480	1100
11	Thur	15-Feb-18	12:20	23.08	17.2	130	5200
12	Fri	16-Feb-18	11:30	21.60	16.5	210	6500
13	Mon	19-Feb-18	10:30	30.40	17.0	420	10000
14	Tue	27-Feb-18	12:15	121.06	13	680	880
15	Tue	6-Mar-18	8:15	52.00	15.7	550	2000
16	Wed	7-Mar-18	9:45	46.46	13.5	400	420
17	Wed	14-Mar-18	13:50	27.48	14.1	98	390
18	Mon	19-Mar-18	11:45	21.65	14.7	160	2800
19	Tue	20-Mar-18	14:50	20.60	15.4	130	2900
20	Wed	21-Mar-18	9:00	20.20	14.5	280	7300

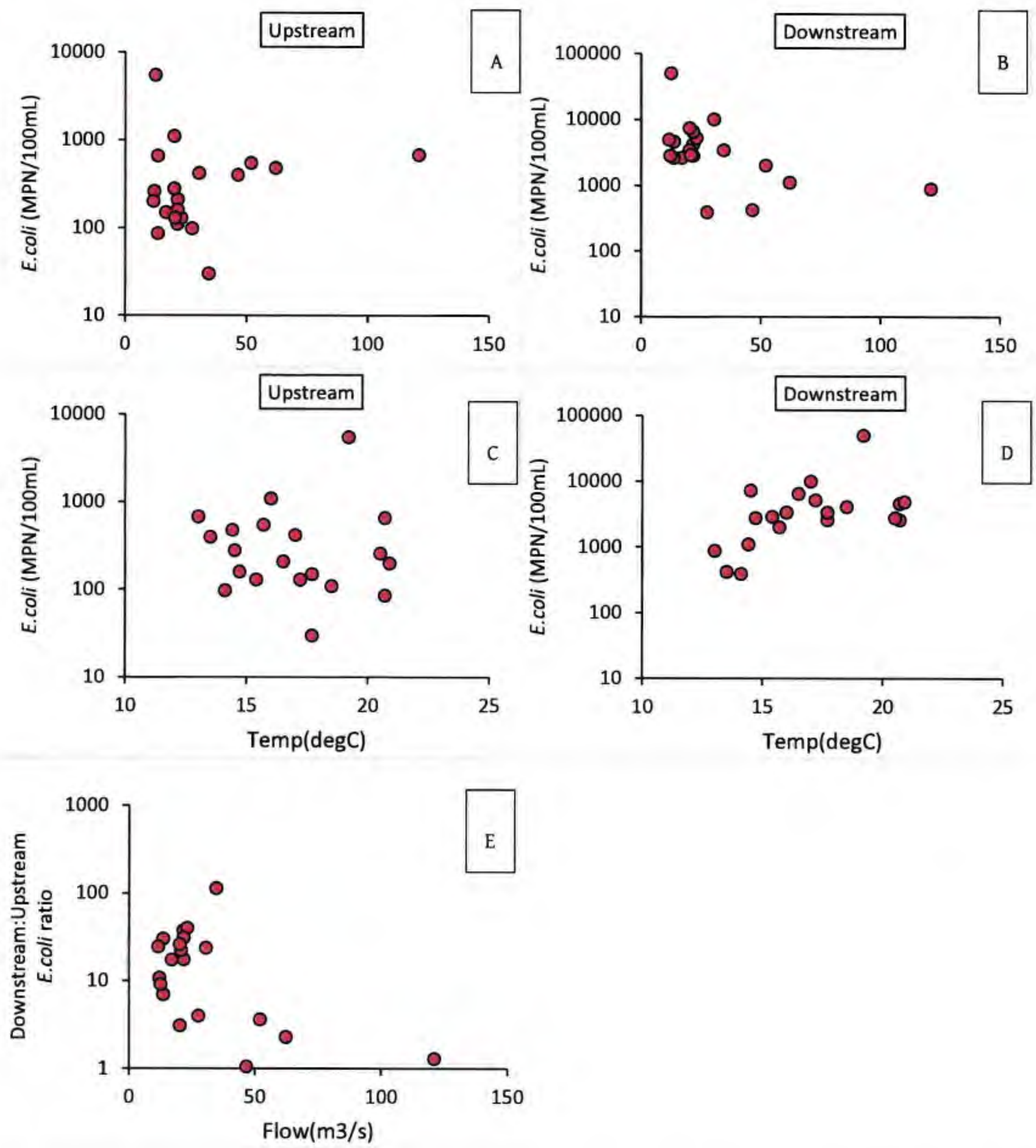


Figure 10 Plots of *E. coli* vs flow and temperature from intensive monitoring, Mataura River, Summer 2017/2018

Although elevated *E. coli* in the treated wastewater and receiving water body may be a concern, is is important to interpret this finding with caution; particularly because wastewater or high instream *E. coli* levels may not necessarily equate to high pathogenic risk (see Limitations to risk management approaches in Section 2.2). Previous reports[18] have suggested that the MfE guidelines cannot be directly used to determine water quality criteria for wastewater discharges because there is the potential for the relationship between indicators and pathogens to be altered by the treatment process. Several international literature have also contested whether the levels of FIB adequately predict or correlate with the presence of zoonotic pathogens (National Research Council, 2004; Sobsey et al., 2006; USEPA, 2010).

As part of this microbial assessment, discharge wastewater from Alliance Plant and the receiving water samples were analysed for a combination of FIB and bacterial pathogens to examine:

a) if there was any correlation between the extremely high FIB concentrations and the levels of bacterial pathogens.
b) the predominant source of faecal pollution in the Mataura River.

Monitoring data reveal that high FIB concentrations did not result in high levels of *Campylobacter* or other pathogens in the treated wastewater (see Table 4 and Table 5 in Section 3.2) or receiving water (Table 8). For instance, both *Campylobacter* and *Salmonella* were detected in very low concentrations in the treated wastewater samples despite the high FIB levels in the treated effluent (Table 4). Similarly, *E.coli* 0157: H7 was rarely detected despite the high levels of *E.coli* concentrations in the receiving water (Table 8) and treated wastewater (Table 4). In the context of the Mataura River risk assessment, the observed lack of correlation between *E. coli* and *Campylobacter* brings into question the applicability of the current New Zealand water standards,[19] which were developed based on the probability of infection with the *Campylobacter* pathogen.

Table 8 Pathogen monitoring data, Mataura River Bridge, May 2018

Description / Site ID	*E. coli* MPN / 100mL	*Salmonella* species MPN / 100mL	*Campy* species MPN / 100mL	*C. jejuni* MPN / 100mL	*E.coli* 0157 MPN / 100mL
Receiving water day1	6,300	0.15	43	4.3	0.15
Receiving water day2	1,900	0.15	24	1.5	0.15
Average	**4,100**	**0.15**	**34**	**3**	**0.15**

[18] For example, see report on "Alliance contribution to health risk for contact recreation in Mataura River" by Desmond Till, 20 July 2004
[19] The 2014 and 2017 amended NPS Attribute State narratives

Ruminant markers were present in the receiving river (Table 9). While an application of MST in this study has identified ruminants as the predominant faecal signature in the Mataura River, it fails to distinguish between faecal signature from cattle in the meat processing factory (Alliance Mataura plant) versus cows grazing pasture in the same catchment.

Table 9 Molecular markers detected in the receiving water, Mataura River Bridge, May 2018

Description / Site ID	General GenBac / 100 ml	Human BacH / 100 ml	Human BiADO / 100 ml	Ruminant BacR / 100 ml	Ruminant Sheep / 100 ml	Ruminant Cow / 100 ml	Dog DogBac / 100 ml	Avian GFD / 100 ml	Relative proportion of the ruminant specific markers (%)*
Receiving water day1	140,000	80	10	4,600	27	9	7.5	230	30
Receiving water day2	300,000	59	10	6,800	10	10	7.5	290	44
Average	**220,000**	**70**	**10**	**5,700**	**19**	**10**	**8**	**260**	**37**

*relative proportion according to the Stapleton et al (2009) methodology, - not determined

Avian GFD faecal marker were detected in the receiving water environment (Table 9) and were present in significantly higher proportions than in the treated discharge water (Table 3), indicating that avian sources are another important contributor of catchment faecal loading to the Mataura River. This finding agrees with a previous ESR-led Mataura River faecal source tracking study (Mataura River 200m d/s Mataura Bridge) which consistently indicated a contribution from wildfowl, with more variable ruminant and human contributions (Cressey et al., 2017). Furthermore, Cressey et al (2017) included some genotypic analysis of Campylobacter isolates and results also consistently implicated wildfowl.

Summary of microbiological quality of the receiving environment

Analysis of historical monitoring data for the Mataura River and its tributaries from 2007 to 2017 indicate that exceedances of the New Zealand single sample bathing water standards of 260 CFU/100mL and 540 CFU/100mL were common among all the Mataura River sites (sites upstream and downstream to the Alliance Plant discharge) and its tributaries. Attribute State classification based on the historical *E.coli* data for Mataura River and tributaries (2011-2015) indicate that the river is classified as E (Red) for most of the monitored sites, regardless of whether the site is upstream or downstream of the Alliance discharges.

Historical monitoring data indicate that there is a strong connection between river flow, clarity conditions of the Mataura River and the observed *E.coli* concentrations. *E.coli* concentrations in the Mataura River water column more frequently tend to exceed the bathing water standards of 260 CFU/100mL and 540 CFU/100mL when water clarity is below 2.0m. Similarly, *E.coli* concentrations in the Mataura River water column more frequently tends to exceed the bathing water standards when river discharge (flow) is high. The observed correlation between river water *E.coli* , discharge and water clarity gives credence to the influence of a combination of high faecal content/faecal bacteria loadings from pastural catchment overland flows and in-stream processes.

Recent monitoring (2017-2018) indicate that:

i. *E.coli* concentrations increase significantly following discharge of the Alliance Plant wastewater. Also, *E.coli* concentrations reduce gradually downstream i.e. with increasing distance away from the discharge point
ii. Relationships between *E.coli* and Mataura River flow varies depending on the flow conditions. The impact of the Alliance Plant discharge on downstream sites increases during low flow conditions
iii. There is no relationship between water temperature and *E.coli* concentration at the upstream sites, before the discharge point.

Although elevated *E.coli* in the treated discharge water and receiving water body appears to be a concern, discharged wastewater *E.coli* level or high instream *E.coli* levels do not necessarily equate to high pathogenic risk. High *E.coli* levels above the NZ bathing water standards did not correlate with the levels of *Campylobacter* species and *C. jejuni*, the pathogens, which form the basis for the current New Zealand water standards.

Ruminant markers were present both in the treated wastewater and the receiving river. Apart from the Alliance Plant discharge, the Mataura River also receives input from other primary productive lands in the Mataura catchment. While an application of MST in this study has identified ruminants as the predominant faecal signature in the Mataura River, it fails to distinguish between faecal signature from cattle in the meat processing factory (Alliance Mataura plant) versus cows/cattle on the farms in the same catchment.

Avian GFD faecal marker were detected in the receiving water environment indicating that avian

5. Impact of wastewater discharge on faecal bacteria loadings in Mataura River

In a mass balance modelling approach, treated wastewater concentrations of *E. coli* in Alliance Plant wastewater (Section 2) were combined with *E. coli* data for receiving waterbody upstream of the discharge (Section 0) to predict how the discharged wastewater will affect the faecal bacteria load in the Mataura river.

Projected concentrations of analytes following the wastewater discharge to the Mataura river were estimated as follows:

$$C_{FIB,FinalConc} = \frac{(C_{FIB,baseline} \cdot Q_{baseline}) + (C_{FIB,WW} \cdot Q_{WW})}{Q_{baseline} + Q_{WW}} \qquad \text{Eqn. (1)}$$

where: $C_{FIB,FinalConc}$ is daily projected concentration of FIB in the Mataura River; $C_{FIB,baseline}$ is the baseline concentration of *E. coli* (in the immediate upstream site on the river, i.e. no discharge of raw wastewater); $C_{FIB,WW}$, is concentration of FIB in the discharged Alliance Plant wastewater; Q_{WW} is the discharge of raw wastewater during two different scenarios (6,638 cubic meters per day or 0.0768 $m^3 s^{-1}$ during normal flow and 14,400 cubic meters per day or 0.1667 $m^3 s^{-1}$ during peak flow conditions[20]); and $Q_{baseline}$ is discharge (flow rate) of the Mataura River.

This mass balance modelling approach assumes: 1) conservation of mass; 2) complete mixing, and; 3) that water quality measurements and projections are accurate and representative. Concentrations were expressed as CFU/100mL.

5.1 National Policy Statement for Freshwater Management

FIB predictions were compared with the Attribute States in the National Policy Statement for Freshwater Management, with consideration of updates made in 2017 (NPS-FM 2017).

Results of a 6-year mass balance modelling (2011-2016) shows that the release of treated wastewater at normal and peak discharge conditions produced increases in the *E. coli* concentrations in the receiving Mataura River water (Figure 11). During baseline conditions (i.e. Mataura River at Gore), the *E. coli* concentrations correspond to the Attribute State designated as E (red). Modelling results show increases in the proportion of samples at the downstream site (Mataura River 200m d/s Mataura Bridge), exceeding the NPS-FM (2017) bathing water standards following the discharge (Table 10). For instance, % exceedances more than doubled after the discharge (Table 10). This suggests that the Alliance Plant discharge is having an effect on the levels of *E. coli* in the receiving water. The modelled *E. coli* % exceedances and median concentrations generally agree

[20] See Section 5.3, discharge volumes of treated wastewater effluent

with the observed *E. coli* data collected during routine monitoring at Mataura River 200m d/s Mataura Bridge, however the 95th percentile *E. coli* concentrations did not. Mass balance modelling using *E. coli* input from the Alliance Plant discharge alone predicted 95th percentile *E. coli* concentrations about 41% less than the current 95th percentile *E. coli* concentrations based on observed data. This provides further evidence suggesting that other catchment sources e.g. overland flows contribute about 41% of *E. coli* loading into the Mataura River during storm-related or extreme rainfall events.

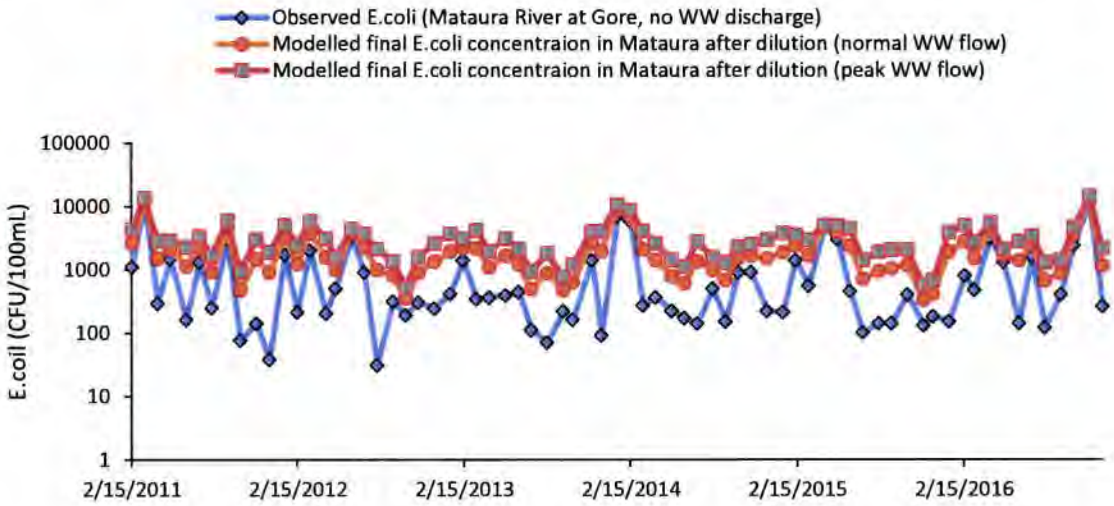


Figure 11 Observed baseline and estimated *E. coli* concentrations before and after the Alliance Plant discharge into Mataura River. Baseline conditions were based on observed *E. coli* concentrations at Mataura River, Gore. Plot of daily wastewater discharge was based on data collected at Alliance Plant, Mataura, 2015-2018

Table 10 Observed baseline and modelled Mataura River Attribute State (*E.coli* , human health for recreation) before and after the Alliance Plant discharge. WW=wastewater

Standard Criteria (Amended NPS FM 2014)	Observed *E. coli* (Mataura River at Gore, no WW discharge)	Observed *E. coli* concentration in Mataura at post-discharge site, 200md/s Mataura Bridge (normal WW flow)	Modelled *E. coli* concentration in Mataura after dilution (normal WW flow)	Modelled final *E. coli* concentration in Mataura after dilution (peak WW flow)
% exceedances over 540 (CFU/100 mL)	35	77	92	99
% exceedances over 260 (CFU/100 mL)	59	83	100	100
Median concentration (CFU/100 mL)	361	1551	1516	2741
95th percentile of *E. coli* (CFU/100 mL)	5401	12551	6108	7358
Attribute State (Band)	E (Red)	E (Red)	E (Red)	E (Red)

With the Alliance Plant discharge, the estimated *E. coli* concentrations in the downstream Mataura River site following dilution still correspond to the NPS-FM Attribute State designated as E (red). Given that there is no Attribute State beyond E (red), Table 10 does not show whether the continued discharge of treated wastewater will impact baseline concentrations in downstream sites, to the extent that it would have otherwise caused an Attribute State change (Table 10). Instead, Table 10 only shows that in terms of *E coli* concentrations, the Alliance discharge contributes to a cumulative effect that results in the Mataura River and tributaries being Attribute State E. Hence, the need to conduct additional modelling scenarios to determine the extent of improvement the Alliance discharge would need to make, such that it would not cause a NPS-FM attribute state change if the upstream water quality improved from the current "Red" (worst, median *E. coli* >260 CFU/100mL, 95th percentile >1200 CFU/100mL) attribute state in an NPS-FM context, to:

- Attribute State "Green" (median *E. coli* ≤130 CFU/100mL, 95th percentile ≤ 1000 CFU/100mL) - **Scenario NPS-FM-1a** (Table 11),
- Attribute State "Yellow" (median *E. coli* ≤130 CFU/100mL, 95th percentile ≤ 1200 CFU/100mL) - **Scenario NPS-FM-1b,**
- Attribute State "Orange" (median *E. coli* >130 CFU/100mL, 95th percentile >1200 CFU/100mL)- **Scenario NPS-FM-1c;**

Achieving improvement in the upstream Mataura River sites such that it maintained an attribute State of "Blue" was considered unrealistic, hence this scenario was not included in the modelling.

A range of distributions[21] were used to reliably fit the Mataura River *E. coli* concentrations and the best performing distribution was selected (Figure 12). To model the assumed improvement, current median and 95th percentile concentrations were reduced by an improvement factor (in %) until the metrics[22] fell within those specified for each attribute state in the NPS-FM (2017) guideline. To achieve orange, yellow or green band status at Mataura upstream sites, water quality needs to be improved such that *E. coli* concentrations are reduced by at least 63% 77% or 90%, respectively (Table 11).

---

[21] See Appendix 7

[22] Out of the four metrics in the NPS-FM (2017), two metrics, median and 95% percentile were modelled. It is often practically impossible to include all four metrics into modelling applications as often the bands for a particular attribute state are not consistently met for each of the four proposed statistics in monitoring data (e.g. see Auckland Council Submission to MfE on Cleanwater Consultation. Most recent modelling approaches has instead focused on the combination of median and 95th percentiles (e.g. see MPI 2017 Technical Paper No: 2017/10 on the 'Modelling the effect of stock exclusion on E. coli in rivers and streams')

Using a mass balance modelling approach, 11 different scenarios of treated wastewater concentrations of *E. coli* in Alliance Plant wastewater (0-1000, 1000-10,000 CFU/100mL etc, see Table 12) were combined with *E. coli* data for the 'improved receiving waterbody' upstream of the discharge (**Scenario NPS-FM-1a, b** and **c**, see Table 11) to predict how the discharged wastewater will affect the annual and summer *E. coli* concentrations in the immediate downstream site on the Mataura River. Discharge volumes (236 - 6776 m^3/d) of treated WWTP effluent used for the calculations were based on monitoring data (See Section 6.3).

Table 11 Modelled scenarios of improvements in upstream Mataura River *E. coli* concentrations

		Modelled *E. coli* (Mataura River at Gore, no WW discharge)		
Parameter	Observed *E. coli* (Mataura River at Gore, no improvement)	Scenario NPS-FM-1a (Green band)	Scenario NPS-FM-1b (Yellow band)	Scenario NPS-FM-1c (Orange band)
Improvement (reduction %) in median or 95th percentile *E. coli* concentrations	N/A	90	77	63
Median	361	38	83	132
95th percentile	5401	538	1183	1883
Attribute State	Red	Green	Yellow	Orange
Attribute Band	E	B	C	D

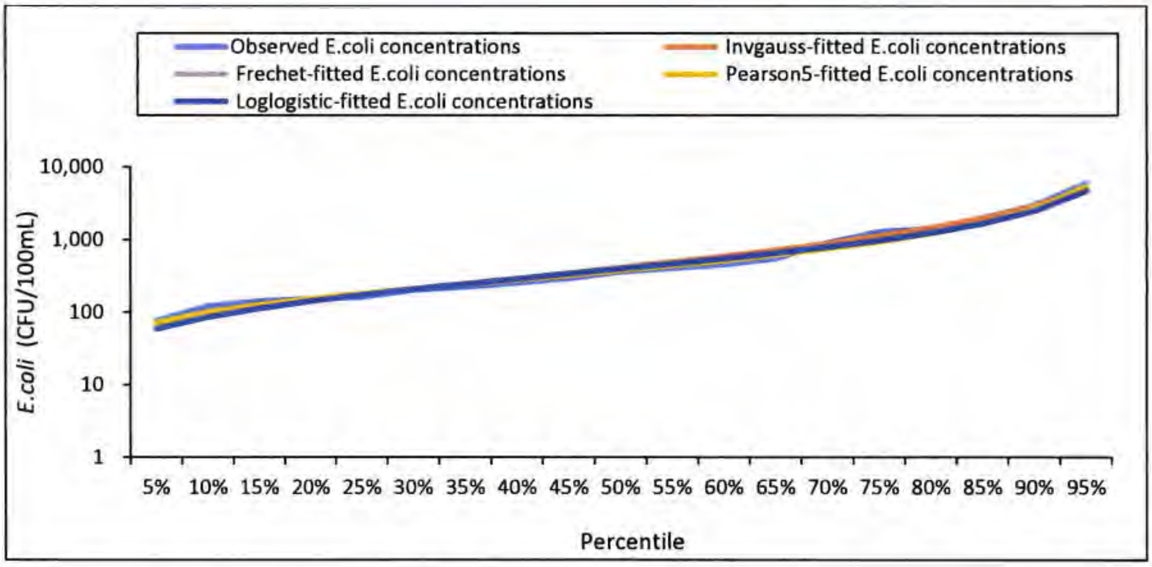


Figure 12 Fitted versus observed *E. coli* concentrations at upstream site, Mataura Gore (2007-2015)

Results of the mass balance modelling is presented in Table 12. If upstream water quality is improved from the current "Red" (worst) attribute state, in an NPS-FM context, to "Orange", it is predicted that when Alliance Plant wastewater 95th percentile *E. coli* concentrations are less than 200,000 CFU/100mL, the median or 95th percentile *E. coli* concentrations at the site immediately downstream of the discharge will not increase to the extent that an attribute state change is caused as a result of the discharge. However, during summer (low-flow conditions) when 95th percentile *E. coli* concentrations from the discharge exceed 160,000 CFU/100mL, an attribute state change from "Orange" to "Red' is predicted (Table 12).

If upstream water quality is improved to "Yellow", it is predicted that when Alliance Plant wastewater 95th percentile *E. coli* concentrations exceed 40,000 CFU/100mL, the median or 95th percentile *E. coli* concentrations at the site immediately downstream of the discharge increases to the extent that an attribute state change to "Orange" is caused as a result of the discharge (Table 12)[23]. When Alliance Plant wastewater 95th percentile *E. coli* concentrations exceed 200,000 CFU/100mL, the attribute state at the site immediately downstream of the discharge changes further from "Orange" to "Red" (Table 12).

If upstream water quality is improved to "Green", it is predicted that when 95th percentile *E. coli* concentrations from the discharge are less than 180,000 CFU/100mL, the median or 95th percentile *E. coli* concentrations at the site immediately downstream of the discharge will not increase to the extent that an attribute state change is caused as a result of the discharge (Table 12). However, during low-flow conditions in summer, when the 95th percentile *E. coli* concentration from the discharge exceed 140,000 CFU/100mL, a double attribute state change from "Green" to "Orange" is predicted (Table 12). The double attribute state change is understandable given the marginal differences in the 95th percentile limit for "Green" and "Orange". Meanwhile, when the Alliance Plant wastewater 95th percentile *E. coli* concentration exceed 300,000 CFU/100mL, a further attribute state change from "Orange" to "Red" is predicted (Table 12).

---

[23] The relatively lower concentrations required to cause an attribute state change from "Yellow" is understandable because of the marginal difference between 95th percentile limit for 'Green" (i.e. <1000) and "Yellow" (i.e. <1200). Hence, 95th percentile concentrations classified as "Yellow" tend to quite easily approach the upper limit for this attribute state.

Table 12 Predicted Annual (A) and Summer (S) downstream Mataura River FIB concentrations as a result of Alliance Plant discharge into an 'improved' upstream Mataura River. Upstream water quality is assumed to have improved from the current "Red" (worst) attribute state in an NPS-FM context, to (a) orange, (b) yellow or (c) green[24] before the discharge.

(a) Upstream site improved to 'Green' band (Scenario NPS-FM-1a)

Season		Discharge FIB Concentration in CFU/100mL										
		Baseline	1000-80000	80000-100000	100000-120000	120000-140000	140000-160000	160000-180000	180000-200000	200000-300000	300000-500000	500000-1500000
A	50% Perc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	136	163	202	[illegible]
	95% Perc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	775	897	1082	[illegible]
S	50% Perc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	138	146	164	197	[illegible]	[illegible]
	95% Perc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	773	859	949	1147	[illegible]	[illegible]

(b) Upstream site improved to 'Yellow' band (Scenario NPS-FM-1b)

Season		Discharge FIB Concentration in CFU/100mL										
		Baseline	1000-40000	40000-60000	60000-80000	80000-100000	100000-120000	120000-140000	140000-160000	160000-200000	200000-500000	500000-1500000
A	50% Perc	83	93	109	121	131	139	149	158	169	[illegible]	[illegible]
	95% Perc	1180	1181	1222	1248	1266	1299	1302	1366	1384	[illegible]	[illegible]
S	50% Perc	83	99	119	130	145	159	172	186	202	[illegible]	[illegible]
	95% Perc	1180	1186	1267	1302	1321	1325	1360	1400	1453	[illegible]	[illegible]

(c) Upstream site improved to 'Orange' band (Scenario NPS-FM-1c)

Season		Discharge FIB Concentration in CFU/100mL (Annual)										
		No discharge	1000-40000	40000-60000	60000-80000	80000-100000	100000-120000	120000-140000	140000-160000	160000-200000	200000-500000	500000-1500000
A	50% Perc	132	142	160	170	179	190	200	212	226	[illegible]	[illegible]
	95% Perc	1906	1909	1920	1920	1929	1945	1961	1979	2009	[illegible]	[illegible]
S	50% Perc	132	150	174	188	203	219	232	247	[illegible]	[illegible]	[illegible]
	95% Perc	1906	1909	1921	1968	1989	1992	1995	2002	[illegible]	[illegible]	[illegible]

5.2 Environment Southland Water and Land Plan

Apart from the NPS-FM provisions, a proposed Environment Southland Water and Land Microbiological Water Quality Standards[25] for "Mataura 3" require that the concentration of faecal coliforms shall not exceed 1,000 coliforms per 100 millilitres, except for popular bathing sites, defined in Appendix G "Popular Bathing Sites", and within 1 km immediately upstream of these sites, where the concentration of *E. coli* shall not exceed

[24] If the attribute state criteria for either of the metrics is not satisfied such that one of the metrics is associated with a poorer state, e.g. median concentration falls within 'Yellow' band and 95th percentile concentration falls within "Orange" band, the poorer state (i.e. Orange) is selected as representative fo the river condition.
[25] Appendix E - ES Water and Land Water Quality Standards

130 coliforms per 100 millilitres. The 'Mataura River 200m d/s Mataura Bridge' site is a designated "Popular Bathing Site", hence the 130 *E. coli* per 100 millilitres reference point applies.

Two scenarios of mass balance modelling were used to determine the extent of improvement the Alliance discharge would need to make, such that it would not cause a downstream site exceedance of:

- the microbiological standard in the proposed ES Water and Land Plan (i.e. 130 CFU/100mL median *E.coli* concentration), if the upstream water quality improved from the current 5-year median of 361 CFU/100mL to < 130 CFU/100mL **(Scenario ES Water and Land Plan-1),**
- an hypothetical threshold (i.e. 1000 CFU/100mL 95th percentile *E.coli* concentration), if the upstream water quality improved from the current 5-year 95th percentile of 5401 CFU/100mL to < 1000 CFU/100mL **(Scenario Hypothetical-1).**

Aspects of the proposed ES Water and Land Plan converge with NPS-FM (2017) (see Figure 1). For instance, a scenario of median concentration <130 CFU/100mL in the ES Water and Land Plan coincides with the NPS-FM attribute states "Yellow" **(Scenario NPS-FM-1b)** and "Green" **(Scenario NPS-FM-1a)** already modelled and reported in Section 5.1. Similarly, a suggested hypothetical 95th percentile concentration <1000 CFU/100mL coincides with the NPS-FM attribute state "Green", and hence the same modelling result (Table 12a and b).

Summary of the impact of wastewater discharge on faecal bacteria loadings in Mataura River

Mass balance modelling show significant increases in the proportion of samples at the downstream site (Mataura River 200m d/s Mataura Bridge), exceeding the NPS-FM (2017) bathing water standards following the discharge. This suggests that the Alliance Plant discharge is having an effect on the levels of *E.coli* in the receiving water. However, the observed increase in FIB concentrations as a result of the treated Alliance Plant discharge does not necessarily relate to the abundance of pathogens, as reflected in pathogen monitoring data collected at the receiving environment.

Results from mass balance modelling presents further evidence that other catchment sources e.g. overland flows contribute about 41% of *E.coli* loading into the Mataura River during storm-related or extreme rainfall events.

If upstream water quality is improved in an NPS-FW context from the current "Red" (worst) attribute state, to:

(a) "Green" **(Scenario NPS-FM-1a)**,
- Alliance Plant wastewater 95th percentile *E. coli* concentrations less than 140,000 CFU/100mL would not cause an attribute state change at the site immediately downstream of the discharge regardless of the season and flow condition.
- If wastewater 95th percentile *E. coli* concentration exceeds 140,000 CFU/100mL, then an attribute state change downstream from "Green" to "Orange" is predicted.
- If wastewater 95th percentile *E. coli* concentration exceed 300,000 CFU/100mL, then a further attribute state change downstream from "Orange" to "Red" is predicted.

(b) "Yellow" **(Scenario NPS-FM-1b)**,
- Because of the marginal difference in 95th percentile limits between Green-Yellow-Orange attribute states, when Alliance Plant wastewater 95th percentile *E. coli* concentrations exceed 40,000 CFU/100mL, an attribute state change downstream from "Yellow" to "Orange" is predicted as a result of the discharge.
- When Alliance Plant wastewater 95th percentile *E. coli* concentrations exceed 200,000 CFU/100mL, it is predicted that the attribute state at the downstream site would change further from "Orange" to "Red".

(c) "Orange" **(Scenario NPS-FM-1c)**,
- It is predicted that Alliance Plant wastewater 95th percentile *E. coli* concentrations less than 160,000 CFU/100mL would not cause an attribute state change at the downstream site discharge regardless of the season and flow condition.
- If wastewater 95th percentile *E. coli* concentration exceed 160,000 CFU/100mL during summer conditions, then an attribute state change downstream from "Orange" to "Red" is predicted.

Aspects of the proposed ES Water and Land Plan converge with NPS-FM (2017). For instance, a scenario of median concentration <130 CFU/100mL in the ES Water and Land Plan coincides with the NPS-FM attribute states "Yellow" **(Scenario NPS-FM-1b)** and "Green" **(Scenario NPS-FM-1a)**. Similarly, a suggested hypothetical 95th percentile concentration <1000 CFU/100mL coincides with the NPS-FM attribute state "Green" **(Scenario NPS-FM-1a)**, and hence the same modelling result.

6. Quantitative Microbial Risk Assessment (QMRA)

6.1 Overview

In line with available literature (USEPA, 2010), current monitoring at Mataura River has highlighted considerations of the inadequacies of the FIB to assess risk. Also, multiple stressors contribute to the faecal loading in the Mataura River. Hence, a better approach to safeguarding public health is to assess risks to health as a result of the discharge from the Alliance Mataura plant using a quantitative approach. Quantitative microbial risk assessment (QMRA) is a framework that applies information and data incorporated into mathematical models that predict the health risk from pathogens through environmental exposures and characterizes the nature of any adverse outcomes.

Although several QMRAs have been documented for human waste discharge into receiving waters in New Zealand, a QMRA study that assesses the effect of discharge from animal factory wastewater discharge is comparatively rare. At a given level of FIB, risks for animal-impacted water may differ from human-impacted water because the mix and densities of pathogens in animal manure are different from those in human excreta. As argued in Section 2.2, QMRA with a focus on animal factory wastewater thus provides a scientifically defensible mechanism to characterize risks from animal-based wastewater. This QMRA employs peer-reviewed microbial risk assessment tools and approaches (USEPA, 2010).

Typically, four steps are involved in a QMRA (Haas, Rose, & Gerba, 1999a):

- hazard identification;
- exposure assessment;
- dose-response analysis, and;
- risk characterization.

6.2 Hazard analysis

Wastewater from the Mataura Plant can pose potential risks to human health if the wastes are not adequately treated or contained. In line with published literature. The most critical microbial groups in terms of public health risk from such wastewaters are bacteria and protozoans (Courault et al., 2017; Prevost et al., 2015)

Factors taken into consideration for the selection of representative pathogens for this QMRA are summarized below:

<u>*Campylobacter:*</u>

- *Campylobacter* spp. is prevalent in livestock, particularly poultry and sheep.

- Several dose-response relationships for *C. jejuni* have been published (Medema, Teunis, Havelaar, & Haas, 1996; Teunis et al., 2005; USEPA, 2010).

<u>*E. coli* O157:H7</u>

- It is representative of Shiga toxin producing *E. coli* (STEC), which potentially causes serious adverse health outcomes, and has been implicated in waterborne outbreaks.
- It is frequently isolated from cattle manure, often in very high densities
- It can potentially grow in soil, sediment, water, and possibly other environmental matrices—all of which emphasize its potential to be found in animal factory wastewater-impacted waters (USEPA, 2010).

<u>Salmonella</u>

- It is very heterogeneous as its serotypes have adapted to a wide variety of host-specific environments including humans.
- It can persist in environmental median for up to 180 days or longer (Holley, Arrus, Ominski, Tenuta, & Blank, 2006).
- *Salmonella* can be detected throughout the year, with densities and serotype diversity typically higher during summer months than winter months (Haley, Cole, & Lipp, 2009).

<u>*Cryptosporidium* and *Giardia* spp.</u>

- These species have been implicated in many waterborne disease outbreaks both in New Zealand and globally
- Dose-response models are available for both protozoa, and both parasites can infect a significant proportion of the exposed population at low doses (Medema et al., 1996; Teunis et al., 2005; USEPA, 2010).
- *Cryptosporidium* and *Giardia* spp. are frequently isolated from livestock manure, and their respective oocysts and cysts can survive for extended periods of time in the environment (USEPA, 2010).

6.3 Exposure Assessment

Exposure assessment involves identification of populations that could be affected by pathogens. The main individuals at risk of exposure to pathogens from the Mataura Plant wastewater discharge are those that engage in contact recreation sites potentially impacted by this discharge. In order to assess the potential level of exposure, the following considerations are necessary:

- proximity of site to the discharge

- the possible exposure pathways that allow the pathogen to reach people and cause infection (through ingesting polluted water, etc.);
- range (minimum, maximum and median) of zoonotic pathogen concentrations in treated effluent;
- discharge volumes of the treated wastewater
- the environmental fate of the zoonotic pathogens in the receiving environment e.g. dilution, and die-off from UV irradiation
- how much water a child/adult will ingest over a period of time during a particular recreational activity;
- estimation of the amount, frequency, length of time of exposure, and doses for an exposure.

Exposure Assessment site

Treated wastewater from Alliance Plant is discharged directly into the Mataura River. Selection of the exposure site was guided by the direction of the plume following dilution. It was thus logical to select an exposure site on the Mataura River that is immediately downstream of the discharge point. The selected assessment site (Mataura River bridge) is approximately 330m downstream of the discharge. It is also more proximate to the discharge, compared to the ES designated compliance monitoring site ('Mataura River 200m d/s Mataura Bridge'), which is approximately 880 metres downstream of the outfall.

WWTP treated effluent pathogen concentrations

Effluent concentrations used in this QMRA were based on laboratory-analysed monitoring data collected at the Alliance Plant. To adequately estimate potential health risk, it is important to estimate the proportion of human-infectious strains of each reference pathogen in each animal source. In this QMRA, a very conservative approach was applied, which assumed that all strains of each reference pathogen from the animal wastewater are human-infectious strains.

Pathogen concentrations fed into the model were based on treated wastewater monitoring. Untreated wastewater concentrations were either based on monitoring or 100 multiplied by the concentrations in the treated wastewater; whichever was higher (Table 13).

Table 13 Pathogen concentrations applied in the QMRA model

Pathogen	Treated wastewater Min (CFU/100ml or oocysts per L)	Treated wastewater Max (CFU/100ml or oocysts per L)	Untreated wastewater Min (CFU/100ml or oocysts per L)	Untreated wastewater Max (CFU/100ml or oocysts per L)
Salmonella	2	240	200	24000
Campylobacter	2	43	200	4300
E.coli 0157: H7	1	10	10	1000
Giardia	2	150	200	15000
Cryptosporidium	2	310	200	31000

Discharge volumes of treated WWTP effluent

A plot of most recent (2015-2018) Alliance Plant discharge data is presented in Figure 13. Analysis of the data reveal that treated effluent discharge volumes ranged from a minimum of 0 cubic meters on days of no discharge, to a maximum of 6,638 cubic meters per day (Table 4).

In a previous consent application for the Mataura Plant discharge, a maximum limit of 14,4000 cubic meters per day was used. Thus, this very high volume, referred to peak discharge scenario, was applied as the worst-case maximum discharge (Table 14).

Observed wastewater discharge also varied with season, for instance, discharge appears to be lowest in spring and winter (Figure 14). Thus, the effect of the wastewater discharged during different discharge conditions (normal flow and peak flow) was assessed against different flow conditions in Mataura River (summer versus other seasons-annual).

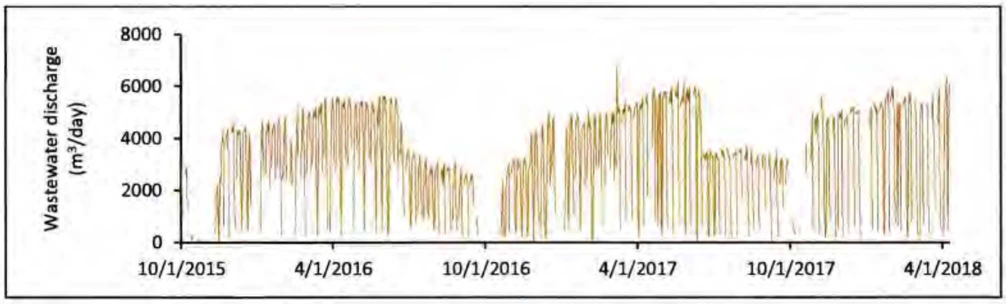


Figure 13 Plot of daily wastewater discharge data, Alliance Plant, Mataura, 2015-2018

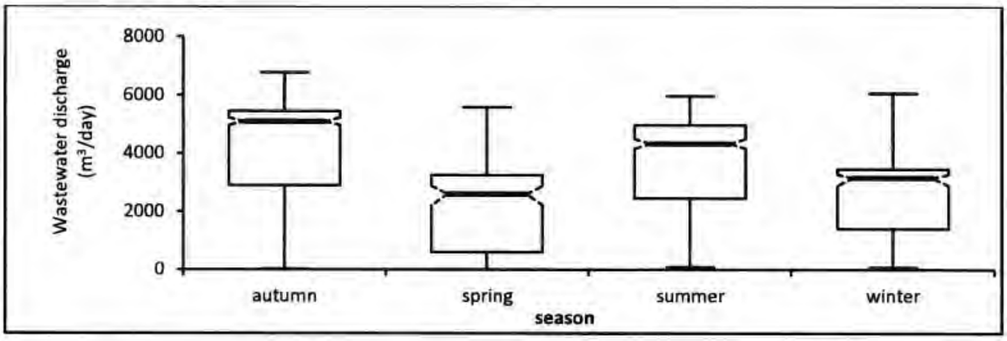


Figure 14 Seasonal box plots of wastewater discharge, Alliance Plant, Mataura, 2015-2018

Table 14. Effluent discharge rates for Alliance WWTP system applied in the QMRA model

Scenario	Statistics	Discharge (m^3/day)	Comment
Normal discharge	Minimum	236	Monitoring data (2015-2018), 5% Percentile used as minimum is zero
	Maximum	6,776	Monitoring data (2015-2018),
Peak discharge	Minimum	236	Monitoring data (2015-2018), 5% Percentile used as minimum is zero
	Maximum	14,400	Historical data for distant years (in 2003 consent application)

Dilution of pathogens in receiving environment

Mass balance dilution modelling was used to model the dilution that would typically occur following the discharge of treated wastewater into the Mataura River (See Section 5).

Mataura River flow rates were informed by available monitoring data (Figure 15 and Table 15). Considering that the wastewater flow rate (Table 14) is just a small fraction of the discharge at the Mataura River, it is expected that 50 percent of the time, during normal discharge conditions (i.e. when a maximum of 6,776 m^3/day of treated wastewater is released into the Mataura River), the wastewater discharge will be diluted by at least 5,400 times in summer and at least 6900 times at other times of the year (Table 16). At a worst-case discharge scenario (i.e. when a maximum of 14,400 m^3/day of treated wastewater is released into the Mataura River), the wastewater discharge will be diluted by at least 2300 times in summer and at least 4900 times at other times of the year (Table 16).

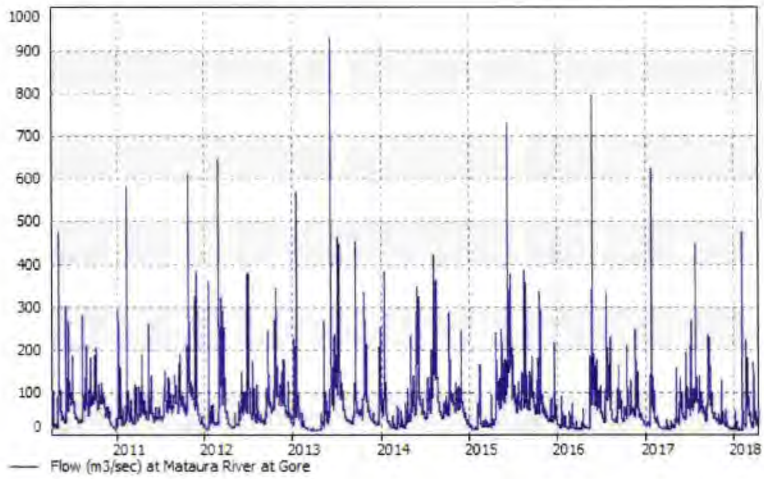


Figure 15 Flow rates for Mataura River @ Gore. Source: Environment Southland

Table 15. Mataura River flow rates (m^3/s) applied in the QMRA model

Scenario	Min	Median	Max
Summer	10	32	630
Annual	10	80	800

Table 16 Effective (a) summer and (b) annual dilution plots of wastewater contaminant in Mataura River at the Bridge site during normal and worst-case scenarios of discharge at the plant (i.e. max discharge of 6776 and 14,400 m^3/d, respectively)

Statistics	Effective dilution, normal flow, annual	Effective dilution, normal flow, Summer	Effective dilution, worst case flow, annual	Effective dilution, worst case flow, Summer
Minimum	809	387	199	108
50% Perc	6927	5458	4934	2332
70% Perc	12181	7414	8315	3699
75% Perc	13474	8902	9280	4457
80% Perc	16625	12295	11571	5010
85% Perc	20055	14944	15243	6398
90% Perc	33660	21929	25250	9425
95% Perc	48868	30052	48606	19502
Maximum	80278	152332	255975	77964

Predicting exposure doses

Typically, the dose of the pathogen that an individual ingests, inhales or comes into contact with feeds in to the dose response models to predict the probability of infection or illness. In order to convert pathogen concentrations into doses, reference was made to the influent pathogen concentrations (as in Section 2) and the ingestion rates for the water users (adults and children, in the case of swimming or other contact recreation, Figure 16). Water ingestion rates applied in the QMRA were based on previous studies that have applied biochemical procedures to trace a decomposition product of chlorine-stabilizing chloroisocyanurate which passes through the surveyed swimmers' bodies unmetabolized (Dufour, Evans, Behymer, & Cantu, 2006; McBride, 2016). Details of these dose response models are presented in Appendices 8 and 9.

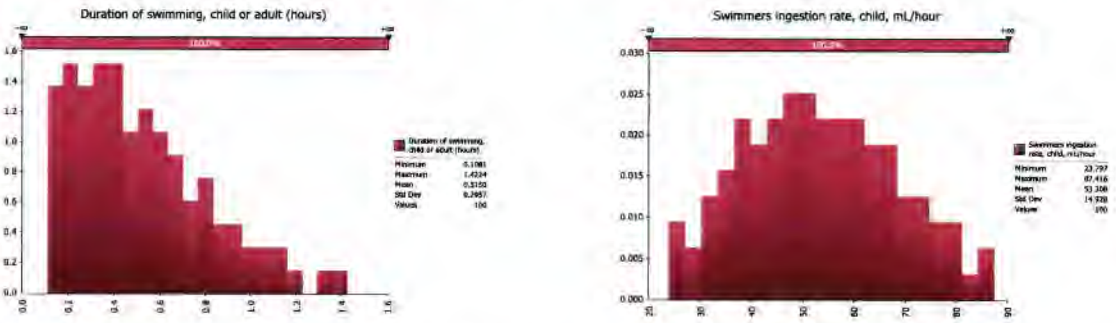


Figure 16 Duration of swimming and swimmers' ingestion rates applied in this QMRA.

Dose-response characterization

Dose response models are mathematical functions which describe the dose response relationship for specific pathogens, transmission routes and hosts. They estimate the risk of a response (for example, infection or illness) given a known dose of a pathogen. Dose-response relationships applied in this QMRA were taken from the peer-reviewed literature. Dose response model equations and parameters used in this QMRA, and justifications for their inclusion are presented in Appendices 8 and 9.

Risk characterization

Information from the previous steps was incorporated into a Monte Carlo simulation to determine the likelihood of illness from exposure to zoonotic pathogens, that is *Campylobacter*, *E. coli O157:H7*, *Salmonella*, *Cryptosporidium* and *Giardia* (Appendix 10). The Monte Carlo simulation is a randomization method that applies multiple random sampling from distributions assigned to key input variables in a model, in a way that incorporates the uncertainty profiles of each key input variables into the uncertainty profile of the output. Typically, in a Monte Carlo model run, 100 individuals who do not have prior knowledge of existing contamination in the water are 'exposed' to potentially infectious water on a given day and this exposure is repeated 1,000 times. Therefore, the total number of exposures is 100,000. Monte Carlo simulations were undertaken using @Risk software (Palisade, NY).

The result of the analysis is a full range of possible risks associated with exposure to pathogens during the identified recreational activities. The predicted risk is reported as the IIR (individual illness risk), calculated as the total number of infection cases divided by the total number of exposures, expressed as a percentage. The IIR are then compared with relevant guidelines. In New Zealand, the 1% tolerable risk level is the widely accepted threshold when assessing the effect of wastewater discharge on recreational health risk (Dada 2018a; 2018b; McBride 2011; 2012; 2007; Stewart et al 2017). Hence, when the IIR is greater than 1%, the discharge is predicted to be associated with some health risks. For instance, when IIR values are less than 1%, this relates to an average probability of one case of Campylobacter infection. If estimated IIR falls between 1 and 5%, this relates to a maximum of 5 cases of Campylobacter infection in 100 individuals. IIR values above 5% present an even greater chance of Campylobacter infection (1 in 20[26]).

7. Results and Discussion

The results of the QMRA analysis for adults and children exposed to a range of reference pathogens under the various discharge scenarios are presented in Appendices 11-15 and summarised in Table 17 and Table 18.

Regardless of the QMRA reference pathogen used, some conclusions were more or less the same, for instance, risks associated with illness is generally higher among children than adults (Table 17 and Table 18). This is generally understandable given that children tend to ingest a higher volume of water during recreation in potentially polluted waters. QMRA results also generally indicate that risks increase with increasing wastewater flows. For instance, risks during normal flow conditions (maximum discharge of 6,776 m^3/d) were generally lower than during worst case flow conditions (maximum discharge of 14,400 m^3/d). Risks were marginally higher during summer due to low flow and characteristically lower dilutions within the Mataura River, compared to other times in the year. This is because a conservative principle that assumes no or negligible microbial inactivation in the Mataura River following discharge[27] was applied in this QMRA. For instance, during summer and normal flow discharge conditions from Alliance Plant, the child IIR was 0.02%

[26] MfE (2003) Ministry of Health Guideline values for microbiological quality of freshwater recreational waters

[27] With the effect of microbial inactivation in the Mataura River following discharge, risks reported here would be slightly lower than is reported in this study.

but was 0.01% when wastewater containing *Giardia* cysts was discharged into the Mataura River during winter (Table 17).

The results of QMRA analysis generally show:

i. **No treatment, normal discharge scenario** - Very large dilution of the discharged wastewater occurred in the receiving environment even in instances when there was no treatment or an assumed treatment failure of the entire wastewater plant. Despite the dilutions, the IIR was still above the 1% threshold in winter and summer for children (Table 17) and adults (Table 18).
ii. **No treatment, peak discharge scenario** – Risks were higher than in the normal discharge scenario. IIRs were also higher than the 1% threshold in winter and summer for children (Table 17) and adults (Table 18).
iii. **Treatment applied, normal discharge scenario** – A combination of wastewater treatment and the effect of dilution of the discharged wastewater in the receiving environment produced significant reductions of risks associated with swimming to very low levels (below 0.1 in most cases). For instance, during normal flow discharge conditions, the IIR was below the 1% threshold for both adults and children (Table 17 and Table 18). Thus, there is less than 1% probability of an individual becoming ill due to swimming at the study site.
iv. **Treatment applied, peak discharge scenario** – Risks associated with swimming at the study site was below the 1% tolerable threshold for both adults and children. There is thus little or no identifiable microbial health risk associated with swimming at the study site. Therefore, the current wastewater treatment applied at Alliance Plant is sufficient to reduce health risks associated with swimming below the discharge to levels below 'the NZ threshold for tolerable risk', even at maximum discharge of 14,400 m^3/d.[28]

Understandably, there have been very few studies carried out on the effect of animal faecal material and animal derived wastewater discharges as a source of waterborne infections. A previous report[29] by Desmond Till had earlier attempted to assess the contribution that the discharge makes to the health risk associated with contact recreation downstream in the river and estuary. The report concluded that there is insufficient microbiological data to fully assess the downstream health risk associated with the discharge from the Alliance Mataura plant. The current study thus fills some very crucial study gaps in the animal wastewater risk assessment terrain, as it shows using a robust microbiological monitoring program and quantitative risk assessment that the contribution that the discharge makes to the health risk associated with contact recreation downstream in the river and estuary is negligible.

---

[28] It is important to note that the discharge in future consent applications could be less than 14,400 m^3/d

[29] Alliance contribution to health risk for contact recreation in Mataura River. Desmond Till, 20 July 2004

Table 17. Child Individual's Illness Risk (%) per 100 swimmers who are exposed to Mataura River water that potentially contains zoonotic pathogens following Alliance Plant wastewater discharge

	Giardia	*Crypto*	*E.coli O157:h7*	*Campylobacter*	*Salmonella*
Statistics	IIR (%)	IIR (%)	IIR (%)	IIR (%)	IIR (%)
SummerSite1C_NormalDischarge_notreatment_ill	1.41	16.63	2.73	4.48	12.66
WinterSite1C_NormalDischarge_notreatment_ill	0.93	11.05	1.92	3.08	8.56
SummerSite1C_Worstcase_notreatment_ill	2.33	21.56	4.03	5.81	16.67
WinterSite1C_Worstcase_notreatment_ill	1.46	15.05	2.90	4.09	11.63
SummerSite1C_NormalDischarge_withtreatment_ill	0.02	0.33	0.0001	0.11	0.03
WinterSite1C_NormalDischarge_withtreatment_ill	0.01	0.20	0.0001	0.07	0.02
SummerSite1C_Worstcase_withtreatment_ill	0.03	0.54	0.0001	0.18	0.05
WinterSite1C_Worstcase_withtreatment_ill	0.02	0.28	0.0001	0.09	0.03

Table 18. Adult Individual's Illness Risk (%) per 100 swimmers who are exposed to Mataura River water that potentially contains zoonotic pathogens following Alliance Plant wastewater discharge

	Giardia	*Crypto*	*E.coli O157:h7*	*Campylobacter*	*Salmonella*
Statistics	IIR (%)	IIR (%)	IIR (%)	IIR (%)	IIR (%)
SummerSite1A_NormalDischarge_notreatment_ill	0.70	10.34	1.50	2.93	8.11
WinterSite1A_NormalDischarge_notreatment_ill	0.47	6.58	1.06	1.94	5.49
SummerSite1A_Worstcase_notreatment_ill	1.23	14.23	2.34	3.87	11.07
WinterSite1A_Worstcase_notreatment_ill	0.75	9.75	1.61	2.67	7.64
SummerSite1A_NormalDischarge_withtreatment_ill	0.01	0.16	0.0001	0.05	0.02
WinterSite1A_NormalDischarge_withtreatment_ill	0.01	0.1	0.0001	0.04	0.01
SummerSite1A_Worstcase_withtreatment_ill	0.01	0.24	0.0001	0.10	0.03
WinterSite1A_Worstcase_withtreatment_ill	0.01	0.18	0.0001	0.04	0.01

Results from this QMRA agree with a recent ESR study (Cressey et al 2017) which adopted a combination of faecal source tracking, genotypic analysis and QMRA to assess recreational human health risk of the Mataura River, Southland. The ESR QMRA applied three scenarios viz;

- Scenario 1 - measured *Campylobacter* concentrations in the river (May 2017),
- Scenario2 - simulated concentrations based on dilution of Gore WWTP and Alliance Mataura effluent *Campylobacter* in the river (May 2017), and
- Scenario 3 - based on regression of *Campylobacter* concentrations against flow rate.

Results from the ESR-led investigation affirmed that:

- "Effluent discharged from the Gore WWTP and the meat processing plant contribute a relatively small proportion of the overall Campylobacter risk. This is consistent with other work that indicated that Campylobacter contamination in this region of the Mataura River was predominantly of wild fowl origin".

The first two modelled QMRA scenarios produced very low risk of *Campylobacter* infection (<0.1%). The ESR QMRA predicted that these scenarios "would result in this region of the Mataura River being classified in the highest water quality category for microbiological quality under either the old or updated categorisation schemes [i.e. NPS 2014 or NPS 2017-updated".

- The ESR QMRA predicted that the third ESR scenario would result in a lower water quality categorisation (estimated IIR values of between 1.7 and 2.8%), depending on whether high river flows[30] are excluded from the estimate, as representing 'unswimmable' conditions. This literally translates into a maximum of 2 to 3 cases of Campylobacter infection in 100 individuals. It is important to note that only 8 datapoints were used in the regression fitting for the third ESR scenario, hence, the result of this scenario may have over-estimated in-stream concentrations beyond what exists in the receiving environment. Additionally, the third scenario in the ESR QMRA considers background Mataura River concentrations with inputs from the Gore WWTP, Alliance Plant discharge and other diffuse sources (e.g. during high river flows) in the estimation of recreational health risks. The current QMRA on the other hand, distinguishes the effect of the Alliance Plant discharge alone, using an approach that assumes no background *Campylobacter* concentration in the Mataura River. This QMRA therefore assessed if the Alliance Plant discharge (only) will cause the IIR to increase beyond an acceptable threshold of 1%. It has been shown using *Campylobacter* concentrations from multiple Alliance Plant discharge samples that the resulting IIR due to the discharge does not exceed 1% and were in most cases below 0.1%.

[30] During high river flows, overland flows and diffuse source pollution from other sources contribute to the Campylobacter infection risk

Summary of quantitative microbial risk assessment

The results of QMRA analysis show:

- No treatment, normal flow scenario - children and adults' recreational health risk fall above the 1% threshold in winter and summer for all zoonotic pathogens
- No treatment, peak flow scenario - children and adults' recreational health risk fall above the 1% threshold in winter and summer for all zoonotic pathogens
- Treatment applied, normal flow scenario - children and adults' recreational health risk fall far below the 1% threshold in winter and summer for all zoonotic pathogens
- Treatment applied, peak flow scenario - children and adults' recreational health risk fall far below the 1% threshold in winter and summer for all zoonotic pathogens.
- Therefore, the current wastewater treatment applied at Alliance Plant is sufficient to reduce health risks associated with swimming at the study site (Mataura Bridge) to levels below 'the NZ threshold for tolerable risk', even at maximum discharge of 14,400 m^3/d.

8. Conclusion

While the Alliance Plant discharge is having 'more than a minor' effect on the levels of *E. coli* in the receiving water, observed increases in *E. coli* concentrations as a result of the treated Alliance Plant discharge did not necessarily relate to the abundance of zoonotic pathogens neither did these increases in *E. coli* relate to the individual illness risk.

9. References

Ahmed, W., Sawant, S., Huygens, F., Goonetilleke, A., & Gardner, T. (2009). Prevalence and occurrence of zoonotic bacterial pathogens in surface waters determined by quantitative PCR. *Water Research*, *43*(19), 4918–4928.

Baker, M. G., Kvalsvig, A., Zhang, J., Lake, R., Sears, A., & Wilson, N. (2012). Declining Guillain-Barré syndrome after campylobacteriosis control, New Zealand, 1988–2010. *Emerging Infectious Diseases*, *18*(2), 226.

Banks, M., Bendall, R., Grierson, S., Heath, G., Mitchell, J., & Dalton, H. (2004). Human and porcine hepatitis E virus strains, United Kingdom. *Emerging Infectious Diseases*, *10*(5), 953.

Black, R. E., Levine, M. M., Clements, M. L., Hughes, T. P., & Blaser, M. J. (1988). Experimental Campylobacter jejuni infection in humans. *Journal of Infectious Diseases*, *157*(3), 472–479.

Cabral, J. P. (2010). Water microbiology. Bacterial pathogens and water. *International Journal of Environmental Research and Public Health, 7*(10), 3657–3703.

Courault, D., Albert, I., Perelle, S., Fraisse, A., Renault, P., Salemkour, A., & Amato, P. (2017). Assessment and risk modeling of airborne enteric viruses emitted from wastewater reused for irrigation. *Science of The Total Environment, 592*, 512–526.

Cressey, P., Hodson, R., Ward, R., & Moriarty, E. (2017). *Cressey, P., Hodson, r. Ward, N. and Moriarty, E (2017) Use of QMRA to Assess the Human Health Risk of the Mataura River, Southland http://isrs2017.com/images/Cressey_Peter.pdf.*

Dada, A. C., & Hamilton, D. P. (2016). Predictive Models for Determination of E. coli Concentrations at Inland Recreational Beaches. *Water, Air, & Soil Pollution, 227*(9), 347.

Dada, A.C. (2018a) Quantitative Microbial Risk Assessment for the discharge of treated wastewater into Whitford Embayment through Turanga Creek, LCL1702, Streamlined Environmental, Hamilton, 41 pp.

Dada, A.C. (2018b) Quantitative Microbial Risk Assessment for the discharge of treated wastewater at Army Bay. Report WSL1701, Streamlined Environmental, Hamilton, 73 pp.

Dick, L. K., Simonich, M. T., & Field, K. G. (2005). Microplate subtractive hybridization to enrich for Bacteroidales genetic markers for fecal source identification. *Applied and Environmental Microbiology, 71*(6), 3179–3183.

Dufour, A. P., Evans, O., Behymer, T. D., & Cantu, R. (2006). Water ingestion during swimming activities in a pool: a pilot study. *Journal of Water and Health, 4*(4), 425–430.

ES. (2013). *Land Use Change in the Southland region Environment Southland Technical Report, June, Publication No 2013-13.*

Glynn, J., & Bradley, D. (1992). The relationship between infecting dose and severity of disease in reported outbreaks of Salmonella infections. *Epidemiology & Infection, 109*(3), 371–388.

Graczyk, T. K., Fayer, R., Trout, J. M., Lewis, E. J., Farley, C. A., Sulaiman, I., & Lal, A. A. (1998). Giardia sp. cysts and infectious Cryptosporidium parvum oocysts in the feces of migratory Canada geese (Branta canadensis). *Applied and Environmental Microbiology, 64*(7), 2736–2738.

Green, H. C., Dick, L. K., Gilpin, B., Samadpour, M., & Field, K. G. (2012). Genetic markers for rapid PCR-based identification of gull, Canada goose, duck, and chicken fecal contamination in water. *Applied and Environmental Microbiology, 78*(2), 503–510.

Haas, C. N., Rose, J. B., & Gerba, C. P. (1999a). *Quantitative microbial risk assessment*. John Wiley & Sons.

Haas, C. N., Rose, J. B., & Gerba, C. P. (1999b). *Quantitative microbial risk assessment*. John Wiley & Sons.

Haley, B. J., Cole, D. J., & Lipp, E. K. (2009). Distribution, diversity, and seasonality of waterborne salmonellae in a rural watershed. *Applied and Environmental Microbiology*, *75*(5), 1248–1255.

Holley, R. A., Arrus, K. M., Ominski, K. H., Tenuta, M., & Blank, G. (2006). Salmonella survival in manure-treated soils during simulated seasonal temperature exposure. *Journal of Environmental Quality*, *35*(4), 1170–1180.

Jones, P. (1976). The effect of temperature, solids content and pH on the survival of salmonellas in cattle slurry. *British Veterinary Journal*, *132*(3), 284–293.

Lake, I., Pearce, J., & Savill, M. (2008). The seasonality of human cryptosporidiosis in New Zealand. *Epidemiology & Infection*, *136*(10), 1383–1387.

Lane, R., & Briggs, S. (2014). Campylobacteriosis in New Zealand: room for further improvement. *The New Zealand Medical Journal (Online)*, *127*(1391).

Learmonth, J. J., Ionas, G., Ebbett, K. A., & Kwan, E. S. (2004). Genetic characterization and transmission cycles of Cryptosporidium species isolated from humans in New Zealand. *Applied and Environmental Microbiology*, *70*(7), 3973–3978.

Lebeau, B., Pinel, C., Grillot, R., & Ambroise-Thomas, P. (1998). Fungal and parasitic nosocomial infections: importance and limitations of disinfection methods. *Pathologie-Biologie*, *46*(5), 335–340.

Legrand-Abravanel, F., Mansuy, J.-M., Dubois, M., Kamar, N., Peron, J.-M., Rostaing, L., & Izopet, J. (2009). Hepatitis E virus genotype 3 diversity, France. *Emerging Infectious Diseases*, *15*(1), 110.

Leotta, G. A., Miliwebsky, E. S., Chinen, I., Espinosa, E. M., Azzopardi, K., Tennant, S. M., … Rivas, M. (2008). Characterisation of Shiga toxin-producing Escherichia coli O157 strains isolated from humans in Argentina, Australia and New Zealand. *Bmc Microbiology*, *8*(1), 46.

Matsuki, T., Watanabe, K., Fujimoto, J., Kado, Y., Takada, T., Matsumoto, K., & Tanaka, R. (2004). Quantitative PCR with 16S rRNA-gene-targeted species-specific primers for analysis of human intestinal bifidobacteria. *Applied and Environmental Microbiology*, *70*(1), 167–173.

McBride. (2014). *National Objectives Framework for Freshwater: Statistical considerations for assessing progress towards objectives – with emphasis on secondary contact recreation values. Prepared for the Ministry for the Environment, 34p.*

McBride. (2017). *National Objectives Framework – Statistical Considerations for Design and Assessment. Prepared for the Ministry for the Environment by NIWA. Client Report Number Ham 16022. 47p.*

McBride, G. (2016). *Quantitative Microbial Risk Assessment for the discharge of treated wastewater: Warkworth wastewater treatment plan. Report prepared by NIWA for Watercare Services Limited. HAM2016-037.*

2016b Quantitative Microbial Risk Assessment for the Discharge of Treated Wastewater: Snells Beach Wastewater Treatment Plan. Report Prepared by NIWA for Watercare Services Limited. HAM2016-038.

McBride, Graham 2007 Microbial Risk Assessment Modeling. Statistical Framework for Recreational Water Quality Criteria and Monitoring: 135–151.

McBride, G., 2012. An assessment of human health effects for a quantitative approach based on Norovirus. NIWA Client Report No: HAM2012-150, prepared for New Plymouth District Council, Project NPD13202.

McBride, G., 2011. A quantitative microbial risk assessment for Napier City's ocean wastewater discharge.

Medema, G., Teunis, P., Havelaar, A., & Haas, C. (1996). Assessment of the dose-response relationship of Campylobacter jejuni. *International Journal of Food Microbiology, 30*(1–2), 101–111.

Messner, M. J., Chappell, C. L., & Okhuysen, P. C. (2001). Risk assessment for Cryptosporidium: a hierarchical Bayesian analysis of human dose response data. *Water Research, 35*(16), 3934–3940.

MfE. (2003). *Microbiological water quality guidelines for marine and freshwater recreational areas. Ministry for the Environment.*

Mintz, E., Cartter, M., Hadler, J., Wassell, J., Zingeser, J., & Tauxe, R. (1994). Dose–response effects in an outbreak of Salmonella enteritidis. *Epidemiology & Infection, 112*(1), 13–23.

Mitscherlich, E., & Marth, E. (1984). Microbial survival in the environment. 1984.

MoH. (n.d.). *Enteric Zoonotic Disease Research in New Zealand. https://www.health.govt.nz/system/files/documents/pages/zoonosespmlt_0.pdf.*

National Research Council. (2004). Committee on Indicators for Waterborne Pathogens (ed.). 2004. Indicators for waterborne pathogens.

Newell, D. G., Koopmans, M., Verhoef, L., Duizer, E., Aidara-Kane, A., Sprong, H., … Scheutz, F. (2010). Food-borne diseases—the challenges of 20 years ago still persist while new ones continue to emerge. *International Journal of Food Microbiology, 139*, S3–S15.

NPSFM. (2014). *National Policy Statement for Freshwater Management 2014.*

NPSFM. (2017). *National Policy Statement for Freshwater Management 2014, updated and gazetted 2017.*

Okhuysen, P. C., Rich, S. M., Chappell, C. L., Grimes, K. A., Widmer, G., Feng, X., & Tzipori, S. (2002). Infectivity of a Cryptosporidium parvum isolate of cervine origin for healthy adults and interferon-γ knockout mice. *The Journal of Infectious Diseases, 185*(9), 1320–1325.

Olivieri, A. W., & Seto, E. (2007). *Application of microbial risk assessment techniques to estimate risk due to exposure to reclaimed waters.*

Payment, P., & Locas, A. (2011). Pathogens in water: value and limits of correlation with microbial indicators. *Groundwater, 49*(1), 4–11.

Prevost, B., Lucas, F., Goncalves, A., Richard, F., Moulin, L., & Wurtzer, S. (2015). Large scale survey of enteric viruses in river and waste water underlines the health status of the local population. *Environment International, 79*, 42–50.

Reischer, G. H., Kasper, D. C., Steinborn, R., Farnleitner, A. H., & Mach, R. L. (2007). A quantitative real-time PCR assay for the highly sensitive and specific detection of human faecal influence in spring water from a large alpine catchment area. *Letters in Applied Microbiology, 44*(4), 351–356.

Reischer, G. H., Kasper, D. C., Steinborn, R., Mach, R. L., & Farnleitner, A. H. (2006). Quantitative PCR method for sensitive detection of ruminant fecal pollution in freshwater and evaluation of this method in alpine karstic regions. *Applied and Environmental Microbiology, 72*(8), 5610–5614.

Rose, J. B., Haas, C. N., & Regli, S. (1991). Risk assessment and control of waterborne giardiasis. *American Journal of Public Health, 81*(6), 709–713.

Rutjes, S. A., Lodder, W. J., Lodder-Verschoor, F., Van den Berg, H. H., Vennema, H., Duizer, E., ... de Roda Husman, A. M. (2009). Sources of hepatitis E virus genotype 3 in The Netherlands. *Emerging Infectious Diseases, 15*(3), 381.

Savichtcheva, O., & Okabe, S. (2006). Alternative indicators of fecal pollution: relations with pathogens and conventional indicators, current methodologies for direct pathogen monitoring and future application perspectives. *Water Research, 40*(13), 2463–2476.

Schill, W. B., & Mathes, M. V. (2008). Real-time PCR detection and quantification of nine potential sources of fecal contamination by analysis of mitochondrial cytochrome b targets. *Environmental Science & Technology, 42*(14), 5229–5234.

Shanks, O. C., Atikovic, E., Blackwood, A. D., Lu, J., Noble, R. T., Santo Domingo, J., … Haugland, R. A. (2008). Quantitative PCR for detection and enumeration of genetic markers of bovine fecal pollution. *Applied and Environmental Microbiology*, *74*(3), 745–752.

Shanks, O. C., Kelty, C. A., Sivaganesan, M., Varma, M., & Haugland, R. A. (2009). Quantitative PCR for genetic markers of human fecal pollution. *Applied and Environmental Microbiology*, *75*(17), 5507–5513.

Siefring, S., Varma, M., Atikovic, E., Wymer, L., & Haugland, R. (2008). Improved real-time PCR assays for the detection of fecal indicator bacteria in surface waters with different instrument and reagent systems. *Journal of Water and Health*, *6*(2), 225–237.

Sinclair, R., Jones, E., & Gerba, C. (2009). Viruses in recreational water-borne disease outbreaks: A review. *Journal of Applied Microbiology*, *107*(6), 1769–1780.

Sobsey, M., Khatib, L., Hill, V., Alocilja, E., & Pillai, S. (2006). Pathogens in animal wastes and the impacts of waste management practices on their survival, transport and fate.

Stewart, M, Cooke, J, Dada, A.C. (2017) Assessment of ecological effects on the receiving environment associated with the discharge from the proposed membrane bioreactor wastewater treatment system. Option 1: Treatment of all wastewater generated by Te Kauwhata (current and future), Springhill Prison (current and future) and the Lakeside development. Report LDL1701–FINAL, Streamlined Environmental, Hamilton, 168 pp.

Stott, R., Davies-Colley, R., Nagels, J., Donnison, A., Ross, C., & Muirhead, R. (2011). Differential behaviour of Escherichia coli and Campylobacter spp. in a stream draining dairy pasture. *Journal of Water and Health*, *9*(1), 59–69.

Takahashi, K., Okamoto, H., Abe, N., Kawakami, M., Matsuda, H., Mochida, S., … Yamamoto, K. (2009). Virulent strain of hepatitis E virus genotype 3, Japan. *Emerging Infectious Diseases*, *15*(5), 704.

Teunis, P., Ogden, I., & Strachan, N. (2008). Hierarchical dose response of E. coli O157: H7 from human outbreaks incorporating heterogeneity in exposure. *Epidemiology & Infection*, *136*(6), 761–770.

Teunis, Van den Brandhof, W., Nauta, M., Wagenaar, J., Van den Kerkhof, H., & Van Pelt, W. (2005). A reconsideration of the Campylobacter dose–response relation. *Epidemiology & Infection*, *133*(4), 583–592.

USEPA. (2006). Water supply: National primary drinking water regulations Long Term 2 Enhanced Surface Water Treatment Rule. *Federal Register*, *67*(9), 1811.

USEPA. (2010). *Quantitative Microbial Risk Assessment to Estimate Illness in Freshwater Impacted by Agricultural Animal Sources of Fecal Contamination. EPA 822-R-10-005.*

Wu, J., Long, S., Das, D., & Dorner, S. (2011). Are microbial indicators and pathogens correlated? A statistical analysis of 40 years of research. *Journal of Water and Health*, *9*(2), 265–278.

Appendices

Appendix 1. Summary, yearly data of Alliance Plant wastewater discharge *E. coli* concentrations

LogE. coli by Year	Minimum	1st Quartile	Median	3rd Quartile	95th percentile	Maximum
2004	12,000	16,833	24,000	88,833	1,010,000	1,400,000
2005	2,000	11,667	41,000	118,000	844,000	2,400,000
2006	1,000	29,667	120,000	486,667	1,910,000	10,000,000
2007	0	88,000	150,000	365,000	1,170,000	2,800,000
2008	4,100	42,250	140,000	310,000	569,500	2,400,000
2009	1,000	60,917	175,000	327,500	963,500	2,400,000
2010	280,000	335,000	610,000	1,185,000	1,231,000	1,300,000
2011	1,000	66,333	220,000	456,667	1,390,000	2,400,000
2012	1,000	33,167	99,000	206,667	658,000	2,400,000
2013	2,000	94,250	310,000	795,000	2,400,000	2,400,000
2014	10,000	110,000	310,000	686,667	2,400,000	5,800,000
2015	10,000	85,000	180,000	440,000	972,500	5,500,000
2016	2,400	30,833	155,000	262,500	807,500	1,700,000
2017	1,200	2,400	24,000	24,000	240,000	240,000

Bacteria

Several bacteria species and genus in animal processing settings are classified as potentially pathogenic and hence present risks to human health (Sobsey et al., 2006). It is important to note that while these pathogens can cause infections in both humans and their animal host, some are only present in their animal host as normal flora and do not cause infections in animals. However, when wastes containing these pathogens are not properly managed, they could be transmitted through environmental media (soil and water mainly) to human hosts where they can initiate diseases. Among these, of particular concern are those which could be transmitted through ingestion of contaminated drinking water, for example, *Campylobacter jejuni*, pathogenic *E. coli* and *Salmonella* species. It is thus an important public health consideration for the discharge of untreated or partially treated animal processing factory waste containing elevated amounts of these pathogens (Graczyk et al., 1998).

*Campylobacter*iosis, caused by *Campylobacter* species, is the most common human bacteria-related diarrhoeal illness in New Zealand, as well as in developed and developing countries of the world (Lane & Briggs, 2014). Although seldom disease-causing in animals, *Campylobacter* infects most warm-blooded wild and domestic animals. Humans become infected through ingestion of contaminated unpasteurized milk, drinking water, or undercooked meat. Infection rates in New Zealand have steadily increased since 1980, peaking in 2006 at over 15,000 notifications (Baker et al., 2012). While the incidence rate for *Campylobacter*iosis in New Zealand has reduced since 2016, the current incidence is still 1.5 to 3 times higher than reported incidence rates in Australia, England and Wales, and several other developed countries (Lane & Briggs, 2014). Although previous surveillance efforts identified poultry as the primary source of human disease, other animal sources such as sheep and cows account for disease transmission, probably due to environmental and occupational exposures (Lane & Briggs, 2014).

Although *E. coli* are normal intestinal flora of warm blooded organisms, pathogenic strains of this organism, which can be present in high concentration in animal feces, when transmitted through wastewater can cause human diseases. *E. coli* can be present in human and animal feces at concentration of about 1×10^9 organisms per gram. They are also present at high concentrations (up to 1×10^9 per 100 ml) in manure and other animal fecal wastes. Pathogenic *E. coli* strains such as O157:H7 tend to predominate intestinal tracts of cattle and are fecally shed at high concentrations. This explains why they may be abundant in the manure from these animals and in environmental media (food and water) contanminated by them. Globally, infections caused by pathogenic *E. coli* strains are a major cause of public health concern because of the potential for human infection and illness from fecally contaminated water (Newell et al., 2010). In New Zealand, infections cased by Shigga-toxin producing *E. coli* strains has been documented to cause infections (Leotta et al., 2008).

Another important human pathogen that may be associated with wastewater from animal processing factories is *Salmonella* species. The human infectious doses of *Salmonella* can be as high as >10^5 organisms or as low as only 10 cells depending on *Salmonella* species, serotype and strain (Glynn & Bradley, 1992; Mintz et al., 1994). In feces, *Salmonella* can survive for up to 190 days at room temperature. In manure, at 10 C , it has been found to survive for up to 140 days (Mitscherlich & Marth, 1984). *Salmonella* inoculated into cattle slurry were observed to survive for 2- months when storage temperatures were 20ºC or less (Jones, 1976; USEPA, 2010). Improperly manged wastewater could thus potentially contribute to the spread of human salmonellosis through ingestion of fecally contaminated drinking water during recreational activities.

Salmonella outbreaks continue to occur in developed countries globally. In New Zealand, it is the fourth leading notifiable disease. It should be noted that not all the notifications are necessarily due to consumption of polluted water because, unlike other bacterial infections, *Salmonella* transmission may also occur between people[31] either directly by the faecal-oral route or indirectly via inanimate but shared objects.

Fungi

There is the possibility of sewage fungus, aquatic periphyton organisms growing the receiving water environment as a result of the discharge. This is however, not restricted to the sites downstream of the discharge site. Kingett Mitchell[32] previously undertook quantitative sampling upstream and downstream of the discharge and confirmed that sewage fungus was present upstream and downstream of the discharge. Fungi can produce endotoxins that have been identified to be key respiratory irritant (Sobsey et al., 2006), however there is a lack of information on their dose response models. Meanwhile, fungal infections or mycoses from exposure to animal waste are not usually a major public health concern because most fungal infections are a result of exposure to one's own fungal microflora on or in the body (Lebeau, Pinel, Grillot, & Ambroise-Thomas, 1998). Hence in this microbial assessment, it was not logical to analyse for human fungi in the treated wastewater from Alliance Plant as there is no substantial risks established for transmission of animal fungal pathogens that cause infections in humans.

Viruses

A wide plethora of viruses are typically associated with animal faecal wastes and manures. These include enteroviruses, rotaviruses, adenoviruses, hepatitis E viruses, caliciviruses, reoviruses, parvoviruses and other nonenveloped viruses. While infections and diseases

---

[31] secondary spread

[32] Alliance Group Limited (2004) Mataura Plant Application for resource consent to discharge treated wastewater to the Mataura River, Volume 3: Further Information in Support of Application, pp1-221

caused by human enteric and respiratory viruses transmitted through the faecal-oral route are well documented. The transmission of faecally-associated viruses of animal origin to a human host is however, not common. Understandably, this may be as a result of the relative specificity of the viruses to their host (Banks et al., 2004; Legrand-Abravanel et al., 2009; Rutjes et al., 2009; Sinclair, Jones, & Gerba, 2009; Takahashi et al., 2009; USEPA, 2010). It was thus, not logical to analyse for human viruses in the treated wastewater from Alliance Plant as there is no substantial risks established for transmission of animal viral pathogens that cause infections in humans.

Protozoans

Among the notifiable gastrointestinal diseases which can be contracted through contaminated water, Cryptosporidiosis and *Giardia*sis are the top two caused by protozoans (USEPA, 2010). Cryptosporidiosis is an important cause of gastroenteritis worldwide, and New Zealand has one of the highest reported rates in the world with between 26·1 and 32·3 new cases per 100,000 population per year (Learmonth, Ionas, Ebbett, & Kwan, 2004). Cryptosporidiosis is caused by infection with protozoan parasites of the genus *Cryptosporidium*. Symptoms of gastroenteritis typically last from several days to several weeks. Routes of transmission are largely from poorly treated drinking water, swimming in swimming pools, contact with farm animals and person-to-person transmission. In New Zealand, Lake et al (2008) argued that human cryptosporidiosis demonstrates spring and autumn peaks of incidence. For instance, in spring, livestock are most infectious due to the birth of large numbers of new, and hence highly infectious livestock while the autumn cryptosporidiosis peak is related to increased recreational water use, swimming, outdoor activities and increased person-to-person spread.

Appendix 3. Important bacteria potentially present in animals and their wastes (Source: Sobsey et al 2006)

Genus and Species	Animal Hosts	Presence in manure?	Presence in Non-Faecal Sources?	Disease in Animal Hosts	Human Infection and Disease	Transmission Routes
Aeromonas hydrophila	Many	Yes	Yes	Usually no	Yes, but only virulent strains	Water, wounds, food
Arcobacter butzleria	Many	Yes	No	Yes, often	Yes	Direct contact, maybe food and water
Bacillus anthracis	Goats; others	Yes	Yes	Yes	Yes	Aerosols, skin (wounds), ingestion
Brucella abortus	Cattle	Yes, rare	No	Yes	Yes	Direct contact, food, air, water
Campylobacter jejuni	Poultry, other fowl	Yes	Maybe	No	Yes	Food and water
Chlamydia psittaci	Parrots; other fowl	Unlikely	No		Yes	Direct contact; airborne
Clostridium perfringens	Many	Yes	Yes, soil and sediments	Sometimes	Yes	Food, wounds
Clostridium botulinum	Many	Maybe	Yes, soil and sediments	Sometimes	Yes	Food
Escherichia coli	All mammals	Yes	No, but natural occurrence atimes	No	Yes, pathogenic strains. e.g. *E. coli* O157:H7, non-O157 STEC, Enterotoxigenic, other diarrheogenic	Food and water
Erysipelothrix rhusiopathiae	Swine, other animals, fish and shellfish	Yes	Yes, infected animals	Sometimes	Yes, rare	Direct contact, skin abrasions
Francisella tularensis	Many animals, ticks	Yes	Animal tissue	No	Yes	Direct contact, fomites
Leptospira interrogans and other species	Many animals	Yes	Urine	No	Yes	Direct contact
Listeria monocytogenes	Many animals		Soil, vegetation	No	Yes	Food, water, fomites
Mycobacterium tuberculosis	Rare; some animals	Yes	No	?	Yes	Respiratory exposure
Mycobacterium paratuberculosis	Some animals	Yes	No	?	Yes	Respiratory
Salmonella species	Many animals	Yes	No	No	Yes	Food, water, fomites
Yersinia pestis	Rats, squirrels, other animals	Yes	Animal tissue	No	Yes	Flea bite, direct contact
Yersinia enterocolitica	Swine, other animals	Yes	Possibly environmental sources	No	Yes	Direct contact, food, water

Appendix 4. Important viral pathogens associated with animal waste (Source: Sobsey et al 2006)

Virus or Virus Group	Taxonomic Group	Animal Hosts	Disease in Animals	Human Infection/ Disease	Trans-mission Routes	Presence in Manure
Enteroviruses	Pieornaviridae	Bovine, poreine, avian	Yes in some	No, but needs study	Fecal-oral and respiratory	Yes
Caliciviruses	Caliciviridae	Bovine, poreine, avian	Yes in some	No, but needs study	Fecal oral and respiratory	Yes
Reoviruses	Reoviridae	Wide host range for some	Yes in some	Yes/No	Fecal-oral; respiratory?	Yes
Rotavimses	Reoviridae	Found in many animals	Yes in some	No, but needs study	Fecal-oral; respiratory?	Yes
Adenovimses	Adenoviridae	In many animals	Yes in some	No, but needs study	Fecal-oral and respiratory	Yes
Herpes viruses	Herpesviridae	In many animals	Yes, some	No, but needs study	Respiratory	Yes
Myxoviruses	Myxoviridae	In many animals	Yes in some	Yes, some; no, others	Respiratory	Yes
Pestivimses	Pestiviridae	In many animals	Yes in some	No	Fecal-oral and respiratory	Yes, some
Corona-viruses	Coronaviridae	In many animals	Yes in some	No	Respiratory	Yes
Hepatitis E virus	Uncertain	Swine, rat, chicken, maybe others	Yes, but mild effects	Maybe	Respiratory and enteric?	Yes
Vesieular stomatitis virus	Rhabdovirus	Cattle, horses, swine; others	Yes	Yes, occu-pationally	Contact with infected animals	Maybe

Appendix 5. Quantitative PCR markers used to identify sources of faecal contamination in this study.

Target group - Assay abbreviation	Microbial target	Detected in faeces from:	Reference
General faecal marker -GenBac3	Bacteroidales 16S rRNA	Human, Cow, Sheep, Deer, Goat, Pig, Rabbit, Possum, Cat, Dog, Horse, Duck, Swan, Seagull, Geese, Chicken	(Siefring, Varma, Atikovic, Wymer, & Haugland, 2008)
Human -BacH	Bacteroidales 16S rRNA	Human, Cat, Dog, Rabbit, Possum, Chicken, Goat	(Reischer, Kasper, Steinborn, Farnleitner, & Mach, 2007)
Human -BiADO	Bifidobacterium adolescentis 16S rDNA	Human, Seagulls	(Matsuki et al., 2004)
Human -HumM3	Bacteroidales cell wall protein	Human, Possum, Rabbit	(Shanks, Kelty, Sivaganesan, Varma, & Haugland, 2009)
Ruminant -BacR	Bacteroidales 16S rRNA	Cow, Sheep, Deer, Goat	(Reischer, Kasper, Steinborn, Mach, & Farnleitner, 2006)
Ruminant -Sheep	Avian-specific faecal 16S rRNA	Sheep	(Schill & Mathes, 2008)
Ruminant -Cow	Avian-specific faecal 16S rRNA	Cow, Deer	(Shanks et al., 2008)
Canine DogBac	Avian-specific faecal 16S rRNA	Dog	(Dick, Simonich, & Field, 2005)
Avian -GFD	Avian-specific faecal 16S rRNA	Duck, Swan, Seagull, Geese, Chicken	(Green, Dick, Gilpin, Samadpour, & Field, 2012)

Hill Laboratories
TRIED, TESTED **AND TRUSTED**

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis

Page 1 of 1

Client:	Alliance Group Limited - Mataura Plant	Lab No:	1947049 SPv2
Contact:	Jessica McKee	Date Received:	20-Mar-2018
	C/- Alliance Group Limited - Mataura Plant	Date Reported:	26-Mar-2018
	1 McQueen Avenue	Quote No:	89769
	Mataura 9712	Order No:	06859266
		Client Reference:	Pathogens - Upstream / Downstream
		Submitted By:	Jessica McKee

Sample Type: Aqueous

	Sample Name:	Upstream 19-Mar-2018 12:00 pm	Downstream 19-Mar-2018 12:55 pm	Wastewater Discharge 19-Mar-2018 1:30 pm		
	Lab Number:	1947049.1	1947049.2	1947049.3		
Salmonella	per 500mL	Not Detected	Not Detected	Not Detected	-	-
Campylobacter	per 100mL	Not Detected	Not Detected	Not Detected	-	-
E.coli O157:H7 - IMS Test	per 500mL	-	Not Detected	-	-	-
E. coli O157:H7 Screen Test	per 500mL	Not Detected	**Detected**	Not Detected	-	-

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Salmonella	Detection of Salmonella by qualitative real-time PCR. Analysis performed at Hill Laboratories - Microbiology, 101C Waterloo Road, Christchurch.	-	1-3
Campylobacter	Presence / Absence. Bolton broth, CCDA agar. Latex confirmation. Analysed at Hill Laboratories - Microbiology; 101C Waterloo Road, Christchurch. APHA 30 5th Ed.	-	1-3
E.coli O157:H7 - IMS Test	IMS Capture following Screen positive result. Analysed at Hill Laboratories - Microbiology; 101C Waterloo Road, Christchurch. Assurance GDS.	-	2
E. coli O157:H7 Screen Test	Presence / Absence. 500mL filtered, mEHEC Broth incubated at 42°C for 16-24 hours, Assurance GDS MPX. Analysed at Hill Laboratories - Microbiology; 101C Waterloo Road, Christchurch. Assurance GDS.	-	1-3

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Yu (Dominique) Gao BASc
Laboratory Technician - Microbiology

Watercare
Laboratory Services

Auckland
52 Airtree Ave,
PO Box 107028,
Auckland Airport,
Auckland, 2150
Tel: (09) 539 7614
Fax: (09) 539 7601

Invercargill
142 Esk Street,
PO Box 747,
Invercargill, 9840
(03) 214 4040
(03) 214 4041

Queenstown
74 Glenda Drive,
PO Box 2614,
Wakatipu,
Queenstown, 9349
(03) 409 0559

www.watercarelabs.co.nz
clientsupport@water.co.nz

Certificate of Analysis
Laboratory Reference: 180507-146

Attention:	Bruce Vetters	Final Report:	271975-0
Client:	ALLIANCE GROUP LTD	Report Issue Date:	30-May-2018
Address:	PO Box 1, Mataura, 9356	Received Date:	10-May-2018
Client Reference:	Untreated & Treated Effluent (Giardia,Cryptosporidium)	Sampled By:	Client
Purchase Order:	06852407	Quote Reference:	7887

Sample Details		WATERS	WATERS
Lab Sample ID:		180507-146-1	180507-146-2
Client Sample ID:			
Sample Date/Time:		07/05/2018	07/05/2018
Description:		Untreated Effluent	Treated Effluent
Microbiology			
Giardia and Cryptosporidium by Microscopy			
Colorseed Cryptosporidium Recovery	%	10	19
Colorseed Giardia Recovery	%	5.0	12
Confirmed Cryptosporidium	per 1L	<5.0	<1.0
Confirmed Cryptosporidium (count)		0	0
Confirmed Giardia	per 1L	<5.0	<1.0
Confirmed Giardia (count)		0	0
Envirochek G&C sample volume	L	1	1
Oocyst details	Legd 3	Refer Legend3	Refer Legend3
Presumptive Cryptosporidium	per 1L	<5.0	<1.0
Presumptive Cryptosporidium (count)		0	0
Presumptive Giardia	per 1L	40	<1.0
Presumptive Giardia (count)		8	0

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Legend 3

Presumptive Giardia & Cryptosporidium

Cysts and oocysts which cannot be confirmed by DAPI stain.

Giardia cysts with apple green fluorescence and typical shape and size 8-18 µm long and 5-15 µm wide.

Cryptosporidium oocysts with apple green fluorescence and typical shape and size 4-6 µm in length.

Organisms with a single large DAPI positive nucleus excluded. Organisms with diffuse blue staining are included.

Confirmed Giardia & Cryptosporidium

Giardia cysts with apple green fluorescence and typical shape and size 8-18 µm long and 5-15 µm wide, which are DAPI positive. Typically, they contain 2-4 nuclei but cells with 1 nucleus of typical size which stains DAPI positive are confirmed.

Cryptosporidium oocysts with apple green fluorescence and typical shape and size 4-6 µm in length which are DAPI positive. Typically, they contain 4 nuclei but cells with 3 nuclei which stain DAPI positive are confirmed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Giardia and Cryptosporidium by Microscopy				
Colorseed Cryptosporidium Recovery	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Colorseed Giardia Recovery	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Confirmed Cryptosporidium (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland

Microbiology				
Giardia and Cryptosporidium by Microscopy				
Confirmed Cryptosporidium	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 per 1L	All	Auckland
Confirmed Giardia (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Confirmed Giardia	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 per 1L	All	Auckland
Oocyst details	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Presumptive Cryptosporidium (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Presumptive Cryptosporidium	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 per 1L	All	Auckland
Presumptive Giardia (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Presumptive Giardia	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 per 1L	All	Auckland
Preparations				
Envirochek G&C sample volume	USEPA 1623, modified (Dec 2005)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited.

This report may not be reproduced, except in full, without the written authority of the Operations Manager.

ilac-MRA IANZ ACCREDITED LABORATORY

Report Signatory 30/05/2018

Marina Fisher
KTP Signatory

Watercare
Laboratory Services

Auckland
52 Aintree Ave,
PO Box 107028,
Auckland Airport,
Tel: (09) 539 7614
Fax: (09) 539 7601

Invercargill
142 Esk Street,
PO Box 747,
Invercargill, 9840
(03) 214 4040
(03) 214 4041

Queenstown
74 Glenda Drive,
PO Box 2614,
Wakatipu,
(03) 409 0559

www.watercarelabs.co.nz
clientsupport@water.co.nz

Certificate of Analysis
Laboratory Reference:180320-100

Attention:	Frances Wise	*Final Report:*	**264826-0**
Client:	**ALLIANCE GROUP LTD**	*Report Issue Date:*	**29-Mar-2018**
Address:	**PO Box 1, Mataura, 9356**	*Received Date:*	**20-Mar-2018**
Client Reference:	**Giardia/Cryptosporidium Waste Water**	*Sampled By:*	**Client**
Purchase Order:	**Not Available**	*Quote Reference:*	**8706**

Sample Details		**WATERS**
Lab Sample ID:		**180320-100-1**
Client Sample ID:		
Sample Date/Time:		19/03/2018
Description:		Waste Water
Microbiology		
Giardia and Cryptosporidium by Microscopy		
Colorseed Cryptosporidium Recovery	%	11 *
Colorseed Giardia Recovery	%	14 *
Confirmed Cryptosporidium	per 1L	<1.0 *
Confirmed Cryptosporidium (count)		0 *
Confirmed Giardia	per 1L	<1.0 *
Confirmed Giardia (count)		0 *
Envirochek G&C sample volume	L	1 *
Oocyst details	Legd 3	Refer Legend3 *
Presumptive Cryptosporidium	per 1L	1.0 *
Presumptive Cryptosporidium (count)		1 *
Presumptive Giardia	per 1L	1.0 *
Presumptive Giardia (count)		1 *

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Legend 3

Presumptive Giardia & Cryptosporidium

Cysts and oocysts which cannot be confirmed by DAPI stain.

Giardia cysts with apple green fluorescence and typical shape and size 8-18 µm long and 5-15 µm wide.

Cryptosporidium oocysts with apple green fluorescence and typical shape and size 4-6 µm in length.

Organisms with a single large DAPI positive nucleus excluded. Organisms with diffuse blue staining are included.

Confirmed Giardia & Cryptosporidium

Giardia cysts with apple green fluorescence and typical shape and size 8-18 µm long and 5-15 µm wide, which are DAPI positive. Typically, they contain 2-4 nuclei but cells with 1 nucleus of typical size which stains DAPI positive are confirmed.

Cryptosporidium oocysts with apple green fluorescence and typical shape and size 4-6 µm in length which are DAPI positive. Typically, they contain 4 nuclei but cells with 3 nuclei which stain DAPI positive are confirmed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	**Method Reference**	**MDL**	**Samples**	**Location**
Microbiology				
Giardia and Cryptosporidium by Microscopy				
Colorseed Cryptosporidium Recovery	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Colorseed Giardia Recovery	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland

Microbiology				
Giardia and Cryptosporidium by Microscopy				
Confirmed Cryptosporidium (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Confirmed Cryptosporidium	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 per 1L	All	Auckland
Confirmed Giardia (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Confirmed Giardia	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 per 1L	All	Auckland
Oocyst details	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Presumptive Cryptosporidium (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Presumptive Cryptosporidium	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 per 1L	All	Auckland
Presumptive Giardia (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Presumptive Giardia	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 per 1L	All	Auckland
Preparations				
Envirochek G&C sample volume	USEPA 1623, modified (Dec 2005)		All	Auckland
Glass Fibre Filtration	APHA (online edition) 2540 C (Filtration)		All	Invercargill

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited.

This report may not be reproduced, except in full, without the written authority of the Operations Manager.

ACCREDITED LABORATORY

Report Signatory 29/03/2018

Tonia Bulling
KTP Signatory

Watercare
Laboratory Services

Auckland
52 Aintree Ave,
PO Box 107028,
Auckland Airport,
Auckland, 2150
Tel: (09) 539 7614
Fax: (09) 539 7601

Invercargill
142 Esk Street,
PO Box 747,
Invercargill, 9840
(03) 214 4040
(03) 214 4041

Queenstown
74 Glenda Drive,
PO Box 2614,
Wakatipu,
Queenstown, 9349
(03) 409 0559

www.watercarelabs.co.nz
clientsupport@water.co.nz

Certificate of Analysis
Laboratory Reference: 180216-089

Attention:	Frances Wise	*Final Report:*	261548-0
Client:	ALLIANCE GROUP LTD	*Report Issue Date:*	07-Mar-2018
Address:	PO Box 1, Mataura, 9356	*Received Date:*	06-Mar-2018
Client Reference:	River Samples for E. Coli	*Sampled By:*	Client
Purchase Order:	06852407	*Quote Reference:*	7887

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		180216-089-1	180216-089-2	180216-089-3	180216-089-4
Client Sample ID:		UP1	UP2	UP3	PDP1
Sample Date/Time:		06/03/2018 08:10	06/03/2018 08:15	06/03/2018 08:20	06/03/2018 08:30
Description:		River Sample	River Sample	River Sample	River Sample
Microbiology					
Escherichia coli by MPN(Colilert-18)					
Escherichia coli (Colilert-18)	MPN/100 mL	710	550	1200	860

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		180216-089-5	180216-089-6	180216-089-7	180216-089-8
Client Sample ID:		PDP2	PDP3	PDP4	PDP5
Sample Date/Time:		06/03/2018 08:35	06/03/2018 08:40	06/03/2018 08:45	06/03/2018 08:50
Description:		River Sample	River Sample	River Sample	River Sample
Microbiology					
Escherichia coli by MPN(Colilert-18)					
Escherichia coli (Colilert-18)	MPN/100 mL	840	2500	1400	2100

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		180216-089-9	180216-089-10	180216-089-11	180216-089-12
Client Sample ID:		PDP6	PDP7	PDP8	PDP9
Sample Date/Time:		06/03/2018 08:55	06/03/2018 09:00	06/03/2018 09:05	06/03/2018 09:10
Description:		River Sample	River Sample	River Sample	River Sample
Microbiology					
Escherichia coli by MPN(Colilert-18)					
Escherichia coli (Colilert-18)	MPN/100 mL	2000	2700	1900	1600

Sample Details		WATERS	WATERS
Lab Sample ID:		180216-089-13	180216-089-14
Client Sample ID:		PDP10	PDP11
Sample Date/Time:		06/03/2018 09:15	06/03/2018 09:20
Description:		River Sample	River Sample
Microbiology			
Escherichia coli by MPN(Colilert-18)			
Escherichia coli (Colilert-18)	MPN/100 mL	1900	2800

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by MPN(Colilert-18)				
Escherichia coli (Colilert-18)	APHA (online edition) 9223 B Colilert Quantitray	1 MPN/100 mL	All	Invercargill

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited.

This report may not be reproduced, except in full, without the written authority of the Operations Manager.

ilac-MRA IANZ ACCREDITED LABORATORY

Report Signatory 07/03/2018
Tonia Bulling KTP Signatory

Watercare
Laboratory Services

Auckland
52 Aintree Ave,
PO Box 107028,
Auckland Airport,
Tel: (09) 539 7614
Fax: (09) 539 7601

Invercargill
142 Esk Street,
PO Box 747,
Invercargill, 9840
(03) 214 4040
(03) 214 4041

Queenstown
74 Glenda Drive,
PO Box 2614,
Wakatipu,
(03) 409 0559

www.watercarelabs.co.nz
clientsupport@water.co.nz

Certificate of Analysis
Laboratory Reference: 180216-132

Attention:	Frances Wise	*Final Report:*	**259398-0**
Client:	**ALLIANCE GROUP LTD**	*Report Issue Date:*	**19-Feb-2018**
Address:	**PO Box 1, Mataura, 9356**	*Received Date:*	**16-Feb-2018**
Client Reference:	**River Samples E. coli**	*Sampled By:*	**Client**
Purchase Order:	**06852407**	*Quote Reference:*	**7887**

Sample Details		**WATERS**	**WATERS**	**WATERS**	**WATERS**
Lab Sample ID:		**180216-132-1**	**180216-132-2**	**180216-132-3**	**180216-132-4**
Client Sample ID:		PDP 1	PDP 2	PDP 3	PDP 4
Sample Date/Time:		16/02/2018 11:25	16/02/2018 11:30	16/02/2018 11:40	16/02/2018 11:45
Description:		River Sample	River Sample	River Sample	River Sample
Microbiology					
Escherichia coli by MPN(Colilert-18)					
Escherichia coli (Colilert-18)	MPN/100 mL	200	470	12000	6500

Sample Details		**WATERS**	**WATERS**	**WATERS**	**WATERS**
Lab Sample ID:		**180216-132-5**	**180216-132-6**	**180216-132-7**	**180216-132-8**
Client Sample ID:		PDP 5	PDP 6	PDP 7	PDP 8
Sample Date/Time:		16/02/2018 11:55	16/02/2018 12:00	16/02/2018 12:15	16/02/2018 12:20
Description:		River Sample	River Sample	River Sample	River Sample
Microbiology					
Escherichia coli by MPN(Colilert-18)					
Escherichia coli (Colilert-18)	MPN/100 mL	5500	6500	8900	3300

Sample Details		**WATERS**	**WATERS**	**WATERS**	**WATERS**
Lab Sample ID:		**180216-132-9**	**180216-132-10**	**180216-132-11**	**180216-132-12**
Client Sample ID:		PDP 9	PDP 10	PDP 11	UP 1
Sample Date/Time:		16/02/2018 12:40	16/02/2018 12:50	16/02/2018 13:00	16/02/2018 10:30
Description:		River Sample	River Sample	River Sample	River Sample
Microbiology					
Escherichia coli by MPN(Colilert-18)					
Escherichia coli (Colilert-18)	MPN/100 mL	7700	2200	5200	230

Sample Details		**WATERS**	**WATERS**
Lab Sample ID:		**180216-132-13**	**180216-132-14**
Client Sample ID:		UP 2	UP 3
Sample Date/Time:		16/02/2018 10:50	16/02/2018 11:10
Description:		River Sample	River Sample
Microbiology			
Escherichia coli by MPN(Colilert-18)			
Escherichia coli (Colilert-18)	MPN/100 mL	210	350

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	**Method Reference**	**MDL**	**Samples**	**Location**
Microbiology				
Escherichia coli by MPN(Colilert-18)				
Escherichia coli (Colilert-18)	APHA (online edition) 9223 B Colilert Quantitray	1 MPN/100 mL	All	Invercargill

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.
For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited.

This report may not be reproduced, except in full, without the written authority of the Operations Manager.

ilac-MRA IANZ ACCREDITED LABORATORY

Report Signatory 19/02/2018

Tonia Bulling
KTP Signatory

Watercare
Laboratory Services
www.watercarelabs.co.nz

Auckland
52 Airtree Ave,
PO Box 107028,
Auckland Airport.
Tel: (09) 539 7614
Fax: (09) 539 7601

Invercargill
142 Esk Street,
PO Box 747,
Invercargill, 9840
(03) 214 4040
(03) 214 4041

Queenstown
74 Glenda Drive,
PO Box 2614,
Wakatipu.
(03) 409 0559

clientsupport@water.co.nz

Certificate of Analysis
Laboratory Reference: 180123-161

Attention:	Frances Wise	*Final Report:*	**256575-0**
Client:	ALLIANCE GROUP LTD	*Report Issue Date:*	**24-Jan-2018**
Address:	**PO Box 1, Mataura, 9356**	*Received Date:*	**23-Jan-2018**
Client Reference:	**River Samples for E. Coli**	*Sampled By:*	**Client**
Purchase Order:	**06852407**	*Quote Reference:*	**7887**

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**180123-161-1**	**180123-161-2**	**180123-161-3**	**180123-161-4**
Client Sample ID:		UP1	UP2	UP3	PDP1
Sample Date/Time:		23/01/2018 10:45	23/01/2018 11:00	23/01/2018 11:10	23/01/2018 11:20
Description:		River Sample	River Sample	River Sample	River Sample
Microbiology					
Escherichia coli by MPN(Colilert-18)					
Escherichia coli (Colilert-18)	MPN/100 mL	280	260	160	300

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**180123-161-5**	**180123-161-6**	**180123-161-7**	**180123-161-8**
Client Sample ID:		PDP2	PDP3	PDP4	PDP5
Sample Date/Time:		23/01/2018 11:25	23/01/2018 11:30	23/01/2018 11:45	23/01/2018 12:00
Description:		River Sample	River Sample	River Sample	River Sample
Microbiology					
Escherichia coli by MPN(Colilert-18)					
Escherichia coli (Colilert-18)	MPN/100 mL	2200	14000	11000	8700

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**180123-161-9**	**180123-161-10**	**180123-161-11**	**180123-161-12**
Client Sample ID:		PDP6	PDP7	PDP8	PDP9
Sample Date/Time:		23/01/2018 12:20	23/01/2018 12:25	23/01/2018 12:30	23/01/2018 12:45
Description:		River Sample	River Sample	River Sample	River Sample
Microbiology					
Escherichia coli by MPN(Colilert-18)					
Escherichia coli (Colilert-18)	MPN/100 mL	2900	6900	5800	8700

Sample Details		WATERS	WATERS
Lab Sample ID:		**180123-161-13**	**180123-161-14**
Client Sample ID:		PDP10	PDP11
Sample Date/Time:		23/01/2018 12:50	23/01/2018 13:00
Description:		River Sample	River Sample
Microbiology			
Escherichia coli by MPN(Colilert-18)			
Escherichia coli (Colilert-18)	MPN/100 mL	5200	3900

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by MPN(Colilert-18)				
Escherichia coli (Colilert-18)	APHA (online edition) 9223 B Colilert Quantitray	1 MPN/100 mL	All	Invercargill

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. *For more information please contact the Operations Manager.*

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited.

This report may not be reproduced, except in full, without the written authority of the Operations Manager.

ilac-MRA IANZ ACCREDITED LABORATORY

Report Signatory 24/01/2018
Tonia Bulling KTP Signatory

ESR
Science for Communities

30 May 2018

To: Christopher Dada
Streamlined Environmental Ltd
PO Box 7003,
HAMILTON EAST 3247

Email: chris@streamlined.co.nz

From: ESR Christchurch Science Centre
PO Box 29181
CHRISTCHURCH 8540

Email: faecalsource@esr.cri.nz

REPORT ON FAECAL SOURCE TRACKING ANALYSIS

The following samples were received on 8th May and 10th May 2018 and were analysed for faecal source PCR markers, and pathogen enumeration.

ESR Number	Client Reference	Date Sampled	Site Description
CMB180934	TW1	7/5/18 11:00am	Treated Wastewater Day1
CMB180935	RW1	7/5/18 11:25am	Receiving Water Day1
CMB180936	UW1	7/5/18 11:10am	Untreated wastewater Day1
CMB180937	TW2	9/5/18 1:15pm	Treated Wastewater Day2
CMB180938	RW2	9/5/18 1:45pm	Receiving Water Day2
CMB180939	UW2	9/5/18 1:30pm	Untreated wastewater Day2

Notice of Confidential Information:

If you receive this report in error, please notify the sender immediately. The information contained in this report is legally privileged and confidential. Unauthorised use, dissemination, distribution or reproduction of this report is prohibited.

Results of faecal source PCR Marker Analysis:

Please refer to the appendix for guidance on interpretation of these results

ESR Number	Client Reference	Description / Site ID	General GenBac / 100 ml	Human BacH / 100 ml	Human BiADO / 100 ml	Ruminant BacR / 100 ml	Proportion Ruminant	Ruminant Sheep / 100 mls	Ruminant Cow / 100 mls	Dog DogBac / 100 ml	Avian GFD / 100 ml	Conclusion
CMB180935	RW1	Receiving Water Day1	140,000	80	<21	4,600	10-50%	27	9	<16	230	Ruminant (10-50%) + avian faecal sources. Ruminant source = cow & sheep
CMB180938	RW2	Receiving Water Day2	300,000	59	<21	6,800	10-50%	<21	10	<16	290	Ruminant (10-50%) + avian faecal sources. Ruminant source = cow & possible sheep (sheep marker detected but <LOQ)
CMB180934	TW1	Treated Wastewater Day1	53,000,000	<83	<110	1,100,000	10-50%	270	630	<79	<72	Ruminant faecal source (10-50%). Ruminant source = cow & sheep
CMB180937	TW2	Treated Wastewater Day2	25,000,000	<83	<110	330,000	1-10%	<100	280	<79	<72	Ruminant faecal source (1-10%). Ruminant source = cow

Abbreviations: NA = sample was not analysed for this marker
NC = not calculated
LOQ = limit of quantitation

Results of Pathogen Enumeration Analysis:

ESR Number	Client Reference	Sampled	Description / Site ID	*E. coli* MPN / 100mL	*Salmonella* species MPN / 100mL	*Campylobacter* species MPN / 100mL	*C. jejuni* MPN / 100mL	*E.coli* 0157 MPN / 100mL
CMB180935	RW1	7/05/2018 11:25	Receiving water day1	6,300	<0.3	43	4.3	<0.3
CMB180938	RW2	9/05/2018 13:45	Receiving water day2	1,900	<0.3	24	1.5	<0.3
CMB180936	UW1	7/05/2018 11:10	Untreated wastewater day1	>2,400,000	1,100	<3.0	<3.0	<3.0
CMB180939	UW2	9/05/2018 13:30	Untreated wastewater day2	>2,400,000	4	>11,000	>11,000	<3.0
CMB180934	TW1	7/05/2018 11:00	Treated wastewater day1	>2,400,000	240	4.0	<3.0	<0.6
CMB180937	TW2	9/05/2018 13:15	Treated wastewater day2	520,000	0.6	43	43	<0.6

Comment: The *Campylobacter* "species" count reported above represents all thermotolerant *Campylobacter* detected by the assay including *C.jejuni* and *C.coli*.

Notes:
Brief details of the methods of analysis are available on request.
These results relate to samples as received.
This report may not be reproduced except in full.

Paula Scholes
Laboratory Operations Coordinator

Beth Robson
Principal Technician

Wendy Williamson
Senior Scientist

APPENDIX: Assay Interpretation Guidance Notes

PCR Marker interpretation notes

- Each marker is strongly associated with, but not exclusive to the source tested for. They each have some degree of non-specificity.
- Each marker is a separate test and the levels of the various markers within the same sample cannot be compared. For example, if sample A has a BacH result of 1,000 and a BacR of 100 it is not valid to say there is more human contamination than ruminant in sample A.
- Levels of the same marker in different samples can be compared. For example;
    - If sample A has a BacH result of 1,000 and sample B has a BacH of 10,000 it is valid to conclude there is more human faecal contamination in sample B than in sample A; or
    - If site H sampled in January has a GFD result of 500 and when sampled in February has a GFD result of 10,000, it is valid to conclude the level of avian faecal contamination in February is greater.
    - To be classified as a significantly greater or lesser result the level of marker should vary by a factor of 10.
- Both Human markers are required to be present for a positive human result.
- Ruminant specific markers are reported using a percentage value based on levels of this marker relative to the general marker in fresh ruminant faeces.
    - Samples reported as 50-100% ruminant are consistent with all of the general faecal marker having come from a ruminant source.
    - The lower levels reported (10-50%) may be a consequence of the presence of other sources of pollution, or in fact ruminant sources may still account for all the pollution, but this may include aged faecal material where relative levels of the ruminant marker decline more rapidly than the general marker.
    - Levels less than 10% ruminant suggest a very minor contribution from ruminant sources.

The detection limits of these methods vary depending on the volume of water filtered for analysis. We recommend a minimum volume of 200 mls and a maximum of 1000 mls, this range gives the following detection limits:

mls sample filtered	General GenBac / 100 mls	Human BacH / 100 mls	Human BiADO / 100 mls	Human HumM3 / 100 mls	Ruminant BacR / 100 mls	Ruminant Sheep / 100 mls	Ruminant Cow / 100 mls
< 400 mls	<110	<83	<110	<8	<91	<100	<11
400-700mls	<42	<33	<43	<3	<36	<41	<5
700-1000mls	<21	<17	<21	<2	<18	<21	<2

mls sample filtered	Dog DogBac / 100 mls	Avian GFD / 100 mls	Avian E2 / 100 mls	Gull- 2
> 400 mls	<79	<72	<99	presence / absence test
400-700mls	<31	<29	<40	
700-1000mls	<16	<14	<20	

FWA interpretation notes

The analysis of FWAs in septic tank and community wastewater consistently identifies levels between 10 and 70 µg/L. In previous analysis of water samples levels of FWA greater than 0.1 µg/L suggest human sewage, with levels greater than 0.2 µg/L strongly indicative of human sewage. Levels greater than 0.1 µg/L correlate well with other indicators of human pollution and indicate a local or recent source of pollution. FWAs degrade under sunlight exposure and will undergo dilution. Levels lower than 0.1 µg/L may be indicative of dilute or distant sources of human pollution.

Reference: Devane M., Saunders D. and Gilpin B. (2006). Faecal sterols and fluorescent whiteners as indicators of the source of faecal contamination. Chemistry in New Zealand 70(3), 74-7. http://www.nzic.org.nz/CiNZ/articles/Devane_70_3.pdf

Faecal sterol Intepretation Notes:

Faecal sterol ratios must be interpreted with consideration to the levels of sterols, and relative to one another. For example H1 is typically also above 5-6% in ruminant faeces. Human and ruminant sources generally require at least two of three ratios to reach thresholds.
Plant sterols and mixed sources also have differing effects on sterol interpretations which must be considered.

Conclusions are the best interpretation of sterols in our opinion. Conclusions in **bold** are highly supported by the sterol data, conclusions in brackets are supported by sterol data with some variation from a pure source, or with a lower degree of certainty.

Ratio Key:

Ratios indicative of faecal pollution (either human or animal)		
F1	coprostanol/cholestanol..	>0.5 indicative of faecal source of sterols
F2	24ethylcoprostanol/ 24-ethylcholestanol.	>0.5 indicative of faecal source of sterols.
Human indicative ratios (values exceeding threshold in red)		
H3	coprostanol/ 24-ethylcoprostanol	Ratio >1 suggests human source
H1	% coprostanol	Ratio >5-6% suggests human source
H2	coprostanol/(coprostanol+cholestanol)	Ratio >0.7 suggests human source
H4	coprostanol/(coprostanol+24-ethylcoprostanol)	Ratio >0.75 suggests human source
Ruminant indicative ratios (values exceeding threshold in blue)		
R3	24-ethylcholesterol/24-ethylcoprostanol	Ratio <1 suggests ruminant source, ratio >4 suggests plant decay
R1	% 24-ethylcoprostanol	Ratio >5-6% suggests ruminant source
R2	coprostanol/(coprostanol+24-ethylcoprostanol)	Ratio <30% suggests ruminant source
Avian indicative ratios (values exceeding threshold in yellow)		
A1	24-ethylcholestanol/(24-ethylcholestanol+24-ethylcoprostanol+24-ethylepicoprostanol)	A1 Ratio >0.4 suggests avian source AND A2 Ratio >0.5 suggests avian source
A2	cholestanol/(cholestanol+coprostanol+epicoprostanol)	

Appendix 7. Distribution fitting for upstream Mataura River *E. coli* concentrations

Parameters		Observed *E.coli*, Mataura Gore (2017-2015)	Invgauss-fitted *E. coli* concentrations	Frechet-fitted *E. coli* concentrations	Pearson5-fitted *E. coli* concentrations	Loglogistic-fitted *E. coli* concentrations
Fit						
	Function		RiskInvgauss(1200.9,290.79,RiskShift(-1.3926))	RiskFrechet(-18.699,273.42,0.99005)	RiskPearson5(0.98946,270.61, RiskShift(-19.318))	RiskLoglogistic(29.805,367.49,1.157)
Information Criteria						
	Akaike (AIC)		1,110	1,111	1,111	1,112
	Bayesian (BIC)		1,116	1,117	1,117	1,119
Rankings By Fit Statistic						
	Akaike (AIC)		#1	#2	#3	#4
	Bayesian (BIC)		#1	#2	#3	#4
Distribution Percentiles						
	5%	76	67	72	72	59
	10%	121	93	99	99	85
	15%	141	118	125	125	112
	20%	151	145	150	150	141
	25%	161	174	178	178	172
	30%	201	208	208	208	206
	35%	221	246	242	242	245
	40%	251	291	280	280	289
	45%	291	345	324	324	339
	50%	361	409	377	377	397
	55%	401	489	441	441	467
	60%	451	589	520	520	552
	65%	551	717	621	620	657
	70%	901	886	756	754	794
	75%	1,301	1,119	944	942	980
	80%	1,401	1,457	1,225	1,222	1,248
	85%	2,001	1,981	1,695	1,690	1,676
	90%	3,001	2,904	2,636	2,628	2,485
	95%	6,001	4,989	5,473	5,456	4,712

Parameters	Observed *E. coli*	Invgauss-fitted *E. coli* concentrations	Frechet-fitted *E. coli* concentrations	Pearson5-fitted *E. coli* concentrations	Loglogistic-fitted *E. coli* concentrations
Fit					
Function		RiskInvgauss(1200.9,290.79, RiskShift(-1.3926))	RiskFrechet(-18.699,273.42,0.99005)	RiskPearson5(0.98946,270.61, RiskShift(-19.318))	RiskLoglogistic(29.805,367.49,1.157)
Method		MLE	MLE	MLE (Modified)	MLE (Modified)
Information Criteria					
Akaike (AIC)		1,109.67	1,111.04	1,111.04	1,112.26
Bayesian (BIC)		1,116.10	1,117.47	1,117.47	1,118.69
Rankings By Fit Statistic					
Akaike (AIC)		#1	#2	#3	#4
Bayesian (BIC)		#1	#2	#3	#4
Distribution Percentiles					
5%	76.00	67.17	71.57	71.64	58.65
10%	121.00	92.87	99.05	99.15	84.82
15%	141.00	118.06	124.50	124.60	111.87
20%	151.00	144.83	150.38	150.47	140.69
25%	161.00	174.38	177.89	177.96	171.99
30%	201.00	207.78	207.98	208.01	206.49
35%	221.00	246.25	241.62	241.61	245.02
40%	251.00	291.27	279.96	279.88	288.66
45%	291.00	344.78	324.49	324.32	338.78
50%	361.00	409.42	377.22	376.93	397.30
55%	401.00	488.90	441.02	440.57	466.90
60%	451.00	588.63	520.18	519.51	551.53
65%	551.00	716.79	621.40	620.44	657.30
70%	901.00	886.40	755.86	754.50	794.15
75%	1,301.00	1,119.48	943.70	941.74	979.59
80%	1,401.00	1,456.50	1,225.22	1,222.33	1,247.71
85%	2,001.00	1,981.29	1,694.69	1,690.22	1,675.52
90%	3,001.00	2,903.99	2,635.75	2,628.08	2,484.55
95%	6,001.00	4,989.35	5,473.35	5,456.32	4,712.37

E/S/R

FINAL REPORT - PUBLIC HEALTH LABORATORY 4 February 2019

Attention: Christopher Dada
To: Streamlined Environmental Ltd

P.O. Box 7003
HAMILTON 3247

Date/Time Received:	22 January 2019 09:00	**Client PO #/Ref:**	
Temperature at Receipt:	4.2°C		
Sampled By:			
Date/Time Tested:	22 January 2019 10:00		
Weather at Sampling:			
Weather previous 2 days:			

Client Sample Ref:		**Zone code:**	
ESR Sample Ref:	19PH0044-001-0	**Source/Type:**	
Collection Details:	21 January 2019	**Treatment:**	

Sample Description: Wastewater - treated; Mataura Alliance

Test:	Result:	
- *Escherichia coli* (generic)	4.5x10^6	CFU/100mL
- *Salmonella* species	4.0	MPN/100mL
- *Campylobacter* species	9.0	MPN/100mL
- *Escherichia coli* O157	<3.0	MPN/100mL

Report comments

The methods of analysis are available on request.
These results relate to the samples as received.

Reported by: **Maurice Wilson**
Senior Scientist
Public Health Laboratory

Enquiries: **Maurice Wilson**
Phone: 03 351 0081
Email: Maurice.Wilson@esr.cri.nz

NOTICE OF CONFIDENTIAL INFORMATION: If you receive this message in error, please notify us immediately. The information contained in the report is legally privileged and confidential. Unauthorised use, dissemination, distribution or reproduction of the message is prohibited THIS REPORT MAY NOT BE REPRODUCED EXCEPT IN FULL

INSTITUTE OF ENVIRONMENTAL SCIENCE AND RESEARCH
Christchurch Science Centre: 27 Creyke Road, Ilam, Christchurch 8041 | PO Box 29181, Christchurch 8540, New Zealand
T: +64 3 351 6019 F: +64 3 351 0010
www.esr.cri.nz

E/S/R

FINAL REPORT - PUBLIC HEALTH LABORATORY 4 February 2019

Attention: Christopher Dada
To: Streamlined Environmental Ltd

P.O. Box 7003
HAMILTON 3247

Date/Time Received:	22 January 2019 09:00	**Client PO #/Ref:**	
Temperature at Receipt:	4.2°C		
Sampled By:			
Date/Time Tested:	22 January 2019 10:00		
Weather at Sampling:			
Weather previous 2 days:			

Client Sample Ref:		**Zone code:**	
ESR Sample Ref:	19PH0043-001-0	**Source/Type:**	
Collection Details:	21 January 2019	**Treatment:**	
Sample Description:	River Water - Downstream; Mataura Alliance		

Test:	**Result:**	
- *Escherichia coli* (generic)	6.5x10^3	CFU/100mL

Report comments

The methods of analysis are available on request.
These results relate to the samples as received.

Reported by: **Maurice Wilson**
Senior Scientist
Public Health Laboratory

Enquiries: **Maurice Wilson**
Phone: 03 351 0081
Email: Maurice.Wilson@esr.cri.nz

NOTICE OF CONFIDENTIAL INFORMATION: If you receive this message in error, please notify us immediately. The information contained in the report is legally privileged and confidential. Unauthorised use, dissemination, distribution or reproduction of the message is prohibited. THIS REPORT MAY NOT BE REPRODUCED EXCEPT IN FULL.

INSTITUTE OF ENVIRONMENTAL SCIENCE AND RESEARCH
Christchurch Science Centre: 27 Creyke Road, Ilam, Christchurch 8041 | PO Box 29181, Christchurch 8540, New Zealand
T: +64 3 351 6019 F: +64 3 351 0010
www.esr.cri.nz

E/S/R

AMENDED REPORT - PUBLIC HEALTH LABORATORY

4 February 2019

Attention: Christopher Dada
To: Streamlined Environmental Ltd

P.O. Box 7003
HAMILTON 3247

Date/Time Received: 5 December 2018 09:15
Temperature at Receipt: 10°C
Sampled By:
Date/Time Tested: 5 December 2018 09:25
Weather at Sampling:
Weather previous 2 days:
Client PO #/Ref:

Client Sample Ref: Wastewater
ESR Sample Ref: 18PH0716-001-0
Collection Details: 4 December 2018
Sample Description: Wastewater
Zone code:
Source/Type:
Treatment:

Test:	Result:	
- *Escherichia coli* (generic)	3.0x10^6	CFU/100mL
- *Salmonella* species	21	MPN/100mL
- *Campylobacter* species	<3.0	MPN/100mL
- *Escherichia coli* O157	<3.0	MPN/100mL

Report comments

AMENDED REPORT: This replaces the report issued on 12 December 2018. The units for *Escherichia coli* (generic) have been corrected from CFU/mL to CFU/100mL.

The methods of analysis are available on request.
These results relate to the samples as received.

Reported by: **Maurice Wilson**
Senior Scientist
Public Health Laboratory

Enquiries: **Maurice Wilson**
Phone: 03 351 0081
Email: Maurice.Wilson@esr.cri.nz

NOTICE OF CONFIDENTIAL INFORMATION: If you receive this message in error, please notify us immediately. The information contained in the report is legally privileged and confidential. Unauthorised use, dissemination, distribution or reproduction of the message is prohibited. THIS REPORT MAY NOT BE REPRODUCED EXCEPT IN FULL.

INSTITUTE OF ENVIRONMENTAL SCIENCE AND RESEARCH
Christchurch Science Centre: 27 Creyke Road, Ilam, Christchurch 8041 | PO Box 29181, Christchurch 8540, New Zealand
T: +64 3 351 6019 F: +64 3 351 0010
www.esr.cri.nz

Watercare
Laboratory Services

Auckland
52 Airtree Ave,
PO Box 107028,
Auckland Airport,
Auckland, 2150
Tel: (09) 539 7614
Fax: (09) 539 7601

Invercargill
142 Esk Street,
PO Box 747,
Invercargill, 9840
(03) 214 4040
(03) 214 4041

Queenstown
74 Glenda Drive,
PO Box 2614,
Wakatipu,
Queenstown, 9349
(03) 409 0559

www.watercarelabs.co.nz
clientsupport@water.co.nz

Certificate of Analysis
Laboratory Reference: 190122-175

Attention:	Chris Dada	*Final Report:*	**305755-0**
Client:	**STREAMLINED ENVIRONMENTAL LIMITED**	*Report Issue Date:*	**19-Feb-2019**
Address:	**510 Grey Street, Hamilton East, 3216**	*Received Date:*	**22-Jan-2019**
Client Reference:	**Wastewater Giardia**		
Purchase Order:	**Not Available**	*Quote Reference:*	**9644**

Sample Details		**WATERS**
Lab Sample ID:		**190122-175-2**
Client Sample ID:		
Sample Date/Time:		21/01/2019 14:52
Description:		Wastewater
Microbiology		
Giardia and Cryptosporidium (Envirochek) by Microscopy		
Colorseed Cryptosporidium Recovery	%	30
Colorseed Giardia Recovery	%	4.0
Confirmed Cryptosporidium	/100 L	<50
Confirmed Cryptosporidium (count)		0
Confirmed Giardia	/100 L	<50
Confirmed Giardia (count)		0
Envirochek G&C sample volume	L	2.0
Envirochek G&C Sampled time		22/01/2019 12:00:00 AM
Oocyst details	Legd 3	Refer Legend3
Presumptive Cryptosporidium	/100 L	250
Presumptive Cryptosporidium (count)		5
Presumptive Giardia	/100 L	150
Presumptive Giardia (count)		3

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Legend 3

Presumptive Giardia & Cryptosporidium

Cysts and oocysts which cannot be confirmed by DAPI stain.

Giardia cysts with apple green fluorescence and typical shape and size 8-18 µm long and 5-15 µm wide.

Cryptosporidium oocysts with apple green fluorescence and typical shape and size 4-6 µm in length.

Organisms with a single large DAPI positive nucleus excluded. Organisms with diffuse blue staining are included.

Confirmed Giardia & Cryptosporidium

Giardia cysts with apple green fluorescence and typical shape and size 8-18 µm long and 5-15 µm wide, which are DAPI positive. Typically, they contain 2-4 nuclei but cells with 1 nucleus of typical size which stains DAPI positive are confirmed.

Cryptosporidium oocysts with apple green fluorescence and typical shape and size 4-6 µm in length which are DAPI positive. Typically, they contain 4 nuclei but cells with 3 nuclei which stain DAPI positive are confirmed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Giardia and Cryptosporidium (Envirochek) by Microscopy				
Colorseed Cryptosporidium Recovery	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Colorseed Giardia Recovery	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland

Microbiology				
Giardia and Cryptosporidium (Envirochek) by Microscopy				
Confirmed Cryptosporidium (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Confirmed Cryptosporidium	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 /100 L	All	Auckland
Confirmed Giardia (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Confirmed Giardia	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 /100 L	All	Auckland
Oocyst details	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Presumptive Cryptosporidium (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Presumptive Cryptosporidium	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 /100 L	All	Auckland
Presumptive Giardia (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Presumptive Giardia	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 /100 L	All	Auckland
Preparations				
Envirochek G&C sample volume	USEPA 1623, modified (Dec 2005)		All	Auckland
Envirochek G&C Sampled time	USEPA 1623, modified (Dec 2005)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited.

This report may not be reproduced, except in full, without the written authority of the Operations Manager.

ilac-MRA IANZ ACCREDITED LABORATORY

Report Signatory 19/02/2019

Marina Fisher
KTP Signatory

Watercare
Laboratory Services

Auckland
52 Airtree Ave,
PO Box 107028,
Auckland Airport,
Auckland, 2150
Tel: (09) 539 7614
Fax: (09) 539 7601

Invercargill
142 Esk Street,
PO Box 747,
Invercargill, 9840
(03) 214 4040
(03) 214 4041

Queenstown
74 Glenda Drive,
PO Box 2614,
Wakatipu,
Queenstown, 9349
(03) 409 0559

www.watercarelabs.co.nz
clientsupport@water.co.nz

Certificate of Analysis
Laboratory Reference: 181220-117

Attention:	Renee Murrell	*Final Report:*	**298822-0**
Client:	**ALLIANCE GROUP LTD**	*Report Issue Date:*	**31-Dec-2018**
Address:	**PO Box 1, Mataura, 9356**	*Received Date:*	**20-Dec-2018**
Client Reference:	**Treated Wastewater**		
Purchase Order:	**Not Available**	*Quote Reference :*	**8706**

Sample Details		WATERS
Lab Sample ID:		181220-117-1
Client Sample ID:		
Sample Date/Time:		19/12/2018 13:50
Description:		Treated Wastewater
Microbiology		
Giardia and Cryptosporidium (Envirochek) by Microscopy		
Colorseed Cryptosporidium Recovery	%	28
Colorseed Giardia Recovery	%	5.0
Confirmed Cryptosporidium	/100 L	<11
Confirmed Cryptosporidium (count)		0
Confirmed Giardia	/100 L	21
Confirmed Giardia (count)		2
Envirochek G&C sample volume	L	9.5
Envirochek G&C Sampled time		19/12/2018 03:30:00 PM
Oocyst details	Lagd 3	Refer Legend3
Presumptive Cryptosporidium	/100 L	310
Presumptive Cryptosporidium (count)		29
Presumptive Giardia	/100 L	32
Presumptive Giardia (count)		3

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Legend 3

Presumptive Giardia & Cryptosporidium
Cysts and oocysts which cannot be confirmed by DAPI stain.

Giardia cysts with apple green fluorescence and typical shape and size 8-18 µm long and 5-15 µm wide.

Cryptosporidium oocysts with apple green fluorescence and typical shape and size 4-6 µm in length.

Organisms with a single large DAPI positive nucleus excluded. Organisms with diffuse blue staining are included.

Confirmed Giardia & Cryptosporidium
Giardia cysts with apple green fluorescence and typical shape and size 8-18 µm long and 5-15 µm wide, which are DAPI positive. Typically, they contain 2-4 nuclei but cells with 1 nucleus of typical size which stains DAPI positive are confirmed.

Cryptosporidium oocysts with apple green fluorescence and typical shape and size 4-6 µm in length which are DAPI positive. Typically, they contain 4 nuclei but cells with 3 nuclei which stain DAPI positive are confirmed. Cells with more than 4 nuclei are not confirmed.

Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Giardia and Cryptosporidium (Envirochek) by Microscopy				
Colorseed Cryptosporidium Recovery	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Colorseed Giardia Recovery	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Confirmed Cryptosporidium (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Confirmed Cryptosporidium	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 /100 L	All	Auckland

Microbiology				
Giardia and Cryptosporidium (Envirochek) by Microscopy				
Confirmed Giardia (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Confirmed Giardia	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 /100 L	All	Auckland
Oocyst details	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Presumptive Cryptosporidium (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Presumptive Cryptosporidium	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 /100 L	All	Auckland
Presumptive Giardia (count)	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)		All	Auckland
Presumptive Giardia	In house based on APHA 9711B, USEPA 1623.1, modified (Jan 2012)	5 /100 L	All	Auckland
Preparations				
Envirochek G&C sample volume	USEPA 1623, modified (Dec 2005)		All	Auckland
Envirochek G&C Sampled time	USEPA 1623, modified (Dec 2005)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

This report may not be reproduced, except in full, without the written authority of the Operations Manager.

Report Signatory 31/12/2018

You-Sing Yong
KTP Signatory

Appendix 8. Additional notes on dose-response characterization

This section presents descriptions of and justifications for the reference pathogen dose-response relationships for this QMRA.

Cryptosporidium dose-response model

The dose-response model for *Cryptosporidium* applied in this QMRA is based on analysis for the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) (USEPA, 2006). In the experimental dose-response studies, human subjects challenged with the pathogen responded differently depending on the strain of *Cryptosporidium parvum* used for the challenge (Messner, Chappell, & Okhuysen, 2001; Okhuysen et al., 2002). Consequently, Messner et al. (2001) applied the LT2ESWTR *Cryptosporidium* dose-response model built on Bayesian analyses of individual and combined data sets for different isolates and outbreak data. The LT2ESWTR dose-response model is exponential with model parameter r = 0.09.

Giardia dose-response model

The *Giardia* dose-response model was informed by previous human challenge studies that involved introduction of the pathogen through an oral route into human volunteers. The dose of the pathogen administered ranged from 1 to 106 cysts (USEPA, 2010). The endpoint applied in the human challenge experiment was shedding cysts in faeces, and the data was successfully fit to an exponential dose-response model with parameter r = 0.0199 (Rose, Haas, & Regli, 1991).

Campylobacter spp. dose-response model

The dose-response models for *Campylobacter* used in this QMRA was based on a human challenge study reported by Black et al. (1988). Data from the response of individuals in the investigation were successfully fit to a beta- Poisson dose-response relationship with parameters $\alpha = 0.144$ and $\beta = 7.59$ (Medema et al., 1996).

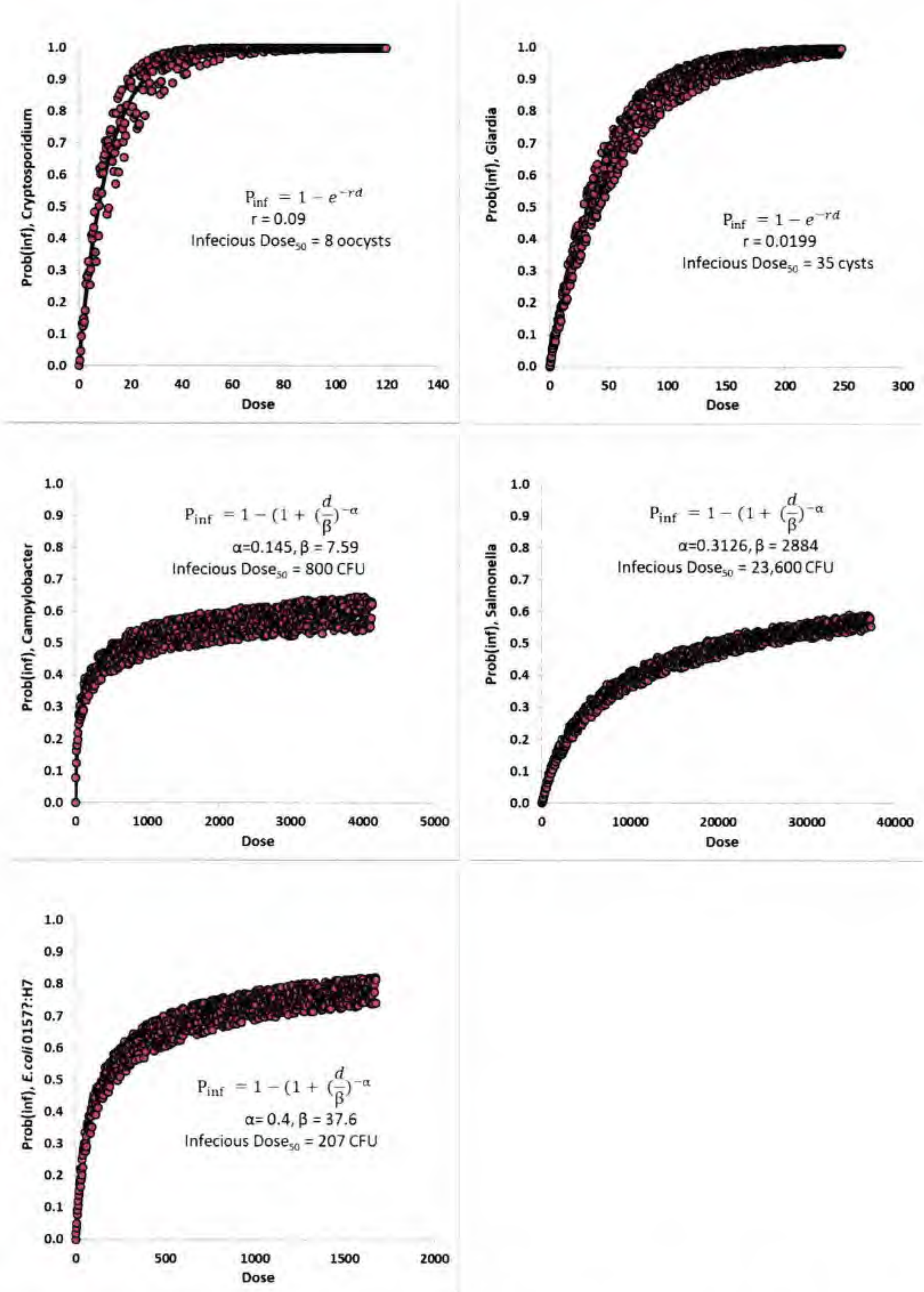
E. coli O157:H7 dose-response model

A total of eight outbreaks informed the *E. coli* O157:H7 dose-response model used in this QMRA. These data were based on the outbreaks data reported in Teunis et al., (2008b). A critical assumption in the investigation was that the pathogen doses ingested in the outbreaks were Poisson-gamma distributed. Teunis et al. (2008) thus explored several models among which the beta-Poisson dose-response model (infection endpoint) best fitted the data. While the Teunis et al., (2008b) study applied 10,000 pairs of dose response parameters to capture uncertainties in the model input, median values from those pairs were applied in this QMRA as point estimates ($\alpha = 0.4$ and $\beta = 37.6$).

Salmonella dose-response model

Salmonella occurrence and infectivity differs widely with serotype. Considering the range of serotypes that could reasonably occur in recreational water, it was thus necessary in this QMRA to select an appropriate dose-response model which apparently represents the overall incidence of infection among individuals who get exposed to them. For this purpose, two published *Salmonella* dose response models exists that are based on infection due to multiple serotypes of *Salmonella* (the beta-Poisson model, as in Haas et al., (1999b) and the Gompertz-log model, as in Olivieri and Seto (2007). In the beta-Poisson model, parameters $\alpha = 0.3126$ and $\beta = 2884$ were applied. In the log-Gompertz model (for an illness endpoint), a range of values for the model parameters were applied consistent with previous studies. These took on a range of values of dose response parameter ln (a) which are uniformly distributed between 29 and 50, and b = 2.148. This QMRA applied the beta-Poisson model, as in Haas et al., 1999 and USEPA (2010)

Appendix 9. Plots of individual dose response curve fitted for animal waste related pathogens in this QMRA.



Included in each plot is the dose-response model applied, the model parameters and the infectious $dose_{50}$ i.e. the amount of pathogen (measured in specified units of microorganisms) required to cause an infection in the 50% of exposed host population.

Appendix 10. Proportion of infections that progress to a symptomatic response (illness)

Based on data from the field studies that administer dose of the pathogens to volunteers, the progression from infection to symptomatic illness for *Campylobacter* is assumed to occur in the range of 0.1 to 0.6. Hence, the most conservative value of 0.6 was adopted.

The progression from infection to symptomatic illness for *E. coli* O157:H7 is assumed to be in the range of 0.2 to 0.6 based on outbreak data (Teunis et al., 2004); the percentage of symptomatic and asymptomatic individuals who were household contacts of hemolytic uremic syndrome patients (Werber et al., 2008); and the occurrence of anti-Stx2 IgG (Ludwig et al., 2002). Hence in this QMRA, the most conservative value of 0.6 was adopted.

The progression from infection to symptomatic illness for *Salmonella* ranged from zero to one in reported dose challenge investigations. However, these studies most commonly report a low morbidity (0%) in most cases (USEPA 2010). In this QMRA, a conservative point estimate of 100% was adopted.

The progression from infection to symptomatic illness for *Cryptosporidium* is based on the USEPA literature review of available data (USEPA, 2006). In that analysis, EPA analyzed available literature and identified studies with applicable data. The review showed that the progression from infection to symptomatic illness for *Cryptosporidium* typically range from 0.19 to 0.7. In this QMRA, a point estimate of 70% (0.7) was adopted.

Due to the highly asymptomatic nature of *Giardia* infections, only a small fraction of infected individuals report symptoms. Available data indicate that between 20 to 70% of individuals who had *Giardia* cysts in their faeces exhibited symptoms (USEPA 2010). In this QMRA, a point estimate of 70% (0.7) for the progression from infection to symptomatic illness was adopted.

Appendix 11. Individual's Illness Risk (%) and predicted number of illness cases per 100 swimmers who are exposed to Mataura River water that potentially contains *Cryptosporidium* following Alliance Plant WW discharge

Child

Statistics	50% Perc	60% Perc	70% Perc	80% Perc	90% Perc	95% Perc	IIR (%)
SummerSite1C_NormalDischarge_notreatment_ill	13	17	21	27	39	50	16.63
WinterSite1C_NormalDischarge_notreatment_ill	7	9	12	17	28	39	11.05
SummerSite1C_Worstcase_notreatment_ill	17	22	30	37	49	59	21.56
WinterSite1C_Worstcase_notreatment_ill	10	13	18	26	40	49	15.05
SummerSite1C_NormalDischarge_withtreatment_ill	-	-	-	1	1	2	0.33
WinterSite1C_NormalDischarge_withtreatment_ill	-	-	-	-	1	1	0.20
SummerSite1C_Worstcase_withtreatment_ill	-	-	-	1	2	2	0.54
WinterSite1C_Worstcase_withtreatment_ill	-	-	-	-	1	2	0.28

Adults

Statistics	50% Perc	60% Perc	70% Perc	80% Perc	90% Perc	95% Perc	IIR (%)
SummerSite1A_NormalDischarge_notreatment_ill	7	9	12	16	24	36	10.34
WinterSite1A_NormalDischarge_notreatment_ill	3	5	6	9	17	27	6.58
SummerSite1A_Worstcase_notreatment_ill	10	13	17	23	36	49	14.23
WinterSite1A_Worstcase_notreatment_ill	5	7	11	15	26	39	9.745
SummerSite1A_NormalDischarge_withtreatment_ill	0	0	0	0	1	1	0.16
WinterSite1A_NormalDischarge_withtreatment_ill	0	0	0	0	0	1	0.1
SummerSite1A_Worstcase_withtreatment_ill	0	0	0	0	1	1	0.24
WinterSite1A_Worstcase_withtreatment_ill	0	0	0	0	1	1	0.18

Appendix 12. Individual's Illness Risk (%) and predicted number of illness cases per 100 swimmers who are exposed to Mataura River water that potentially contains *Giardia* oocysts following Alliance Plant WW discharge

Child

Statistics	50% Perc	60% Perc	70% Perc	80% Perc	90% Perc	95% Perc	IIR (%)
SummerSite1C_NormalDischarge_notreatment_ill	1	1	1	2	4	6	1.41
WinterSite1C_NormalDischarge_notreatment_ill	0	0	1	1	2	4	0.93
SummerSite1C_Worstcase_notreatment_ill	1	1	2	3	6	10	2.33
WinterSite1C_Worstcase_notreatment_ill	0	1	1	2	4	7	1.46
SummerSite1C_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.02
WinterSite1C_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.01
SummerSite1C_Worstcase_withtreatment_ill	0	0	0	0	0	0	0.03
WinterSite1C_Worstcase_withtreatment_ill	0	0	0	0	0	0	0.02

Adult

Statistics	50% Perc	60% Perc	70% Perc	80% Perc	90% Perc	95% Perc	IIR (%)
SummerSite1A_NormalDischarge_notreatment_ill	0	0	1	1	2	3	0.70
WinterSite1A_NormalDischarge_notreatment_ill	0	0	0	1	1	2	0.47
SummerSite1A_Worstcase_notreatment_ill	0	1	1	2	3	5	1.23
WinterSite1A_Worstcase_notreatment_ill	0	0	1	1	2	4	0.75
SummerSite1A_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.01
WinterSite1A_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.01
SummerSite1A_Worstcase_withtreatment_ill	0	0	0	0	0	0	0.02
WinterSite1A_Worstcase_withtreatment_ill	0	0	0	0	0	0	0.01

Appendix 13. Individual's Illness Risk (%) and predicted number of illness cases per 100 swimmers who are exposed to Mataura River water that potentially contains *E. coli* 0157: H7 following Alliance Plant WW discharge

Child

Statistics	50% Perc	60% Perc	70% Perc	80% Perc	90% Perc	95% Perc	IIR (%)
SummerSite1C_NormalDischarge_notreatment_ill	2	2	3	4	7	9	2.73
WinterSite1C_NormalDischarge_notreatment_ill	1	2	2	3	5	7	1.92
SummerSite1C_Worstcase_notreatment_ill	2	3	5	6	10	13	4.03
WinterSite1C_Worstcase_notreatment_ill	2	2	3	5	7	11	2.90
SummerSite1C_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.00
WinterSite1C_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.00
SummerSite1C_Worstcase_withtreatment_ill	0	0	0	0	0	0	0.00
WinterSite1C_Worstcase_withtreatment_ill	0	0	0	0	0	0	0.00

Adult

Statistics	50% Perc	60% Perc	70% Perc	80% Perc	90% Perc	95% Perc	IIR (%)
SummerSite1A_NormalDischarge_notreatment_ill	1	1	2	3	4	6	1.50
WinterSite1A_NormalDischarge_notreatment_ill	0	1	1	2	3	4	1.06
SummerSite1A_Worstcase_notreatment_ill	1	2	3	4	6	9	2.34
WinterSite1A_Worstcase_notreatment_ill	1	1	2	3	4	7	1.61
SummerSite1A_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.00
WinterSite1A_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.00
SummerSite1A_Worstcase_withtreatment_ill	0	0	0	0	0	0	0.00
WinterSite1A_Worstcase_withtreatment_ill	0	0	0	0	0	0	0.00

Appendix 14. Individual's Illness Risk (%) and predicted number of illness cases per 100 swimmers who are exposed to Mataura River water that potentially contains *Salmonella* following Alliance Plant WW discharge

Child

Statistics	50% Perc	60% Perc	70% Perc	80% Perc	90% Perc	95% Perc	IIR (%)
SummerSite1C_NormalDischarge_notreatment_ill	10	12	16	21	26	36	12.66
WinterSite1C_NormalDischarge_notreatment_ill	6	7	10	13	20	27	8.56
SummerSite1C_Worstcase_notreatment_ill	13	17	22	27	38	46	16.67
WinterSite1C_Worstcase_notreatment_ill	8	11	14	19	29	37	11.63
SummerSite1C_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.03
WinterSite1C_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.02
SummerSite1C_Worstcase_withtreatment_ill	0	0	0	0	0	0	0.05
WinterSite1C_Worstcase_withtreatment_ill	0	0	0	0	0	0	0.03

Adult

Statistics	50% Perc	60% Perc	70% Perc	80% Perc	90% Perc	95% Perc	IIR (%)
SummerSite1A_NormalDischarge_notreatment_ill	6	7	9	13	19	25	8.11
WinterSite1A_NormalDischarge_notreatment_ill	3	4	6	8	14	20	5.49
SummerSite1A_Worstcase_notreatment_ill	8	10	13	18	25	35	11.07
WinterSite1A_Worstcase_notreatment_ill	4	6	9	13	19	27	7.64
SummerSite1A_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.02
WinterSite1A_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.01
SummerSite1A_Worstcase_withtreatment_ill	0	0	0	0	0	0	0.03
WinterSite1A_Worstcase_withtreatment_ill	0	0	0	0	0	0	0.01

Appendix 15. Individual's Illness Risk (%) and predicted number of illness cases per 100 swimmers who are exposed to Mataura River water that potentially contains *Campylobacter* following Alliance Plant WW discharge

Child

Statistics	50% Perc	60% Perc	70% Perc	80% Perc	90% Perc	95% Perc	IIR (%)
SummerSite1C_NormalDischarge_notreatment_ill	3	4	6	7	11	14	4.48
WinterSite1C_NormalDischarge_notreatment_ill	2	3	4	5	7	11	3.08
SummerSite1C_Worstcase_notreatment_ill	5	6	7	10	13	16	5.81
WinterSite1C_Worstcase_notreatment_ill	3	4	5	7	10	13	4.09
SummerSite1C_NormalDischarge_withtreatment_ill	0	0	0	0	0	1	0.11
WinterSite1C_NormalDischarge_withtreatment_ill	0	0	0	0	0	1	0.07
SummerSite1C_Worstcase_withtreatment_ill	0	0	0	0	1	1	0.18
WinterSite1C_Worstcase_withtreatment_ill	0	0	0	0	0	1	0.09

Adult

Statistics	50% Perc	60% Perc	70% Perc	80% Perc	90% Perc	95% Perc	IIR (%)
SummerSite1A_NormalDischarge_notreatment_ill	2	3	3	5	7	10	2.93
WinterSite1A_NormalDischarge_notreatment_ill	1	2	2	3	5	8	1.94
SummerSite1A_Worstcase_notreatment_ill	3	4	5	7	10	12	3.87
WinterSite1A_Worstcase_notreatment_ill	2	2	3	4	7	9	2.67
SummerSite1A_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.05
WinterSite1A_NormalDischarge_withtreatment_ill	0	0	0	0	0	0	0.04
SummerSite1A_Worstcase_withtreatment_ill	0	0	0	0	0	1	0.10
WinterSite1A_Worstcase_withtreatment_ill	0	0	0	0	0	0	0.04

4

APPENDIX 4

Determination of mixing zone of treated wastewater from Alliance Mataura discharged into the Mataura River: a mixing modelling approach using contaminant tracers,

Streamlined Environmental, 2019.

Determination of mixing zone of treated wastewater from Alliance Mataura discharged into the Mataura River: a mixing modelling approach using contaminant tracers

Action	Name	Date
Draft prepared by	Dr Christopher A. Dada	28 February
Draft reviewed by	Dr Tim Cox	1 March and 5 March
Final prepared by	Dr Christopher A. Dada	2 April

Report AES1803

Prepared for Alliance Group/ Aquatic Environmental Sciences Ltd

April 2019

© Streamlined Environmental Limited, 2019

Dada, A.C (2019)

Determination of mixing zone of treated wastewater from Alliance Mataura discharged into the Mataura River: a mixing modelling approach using contaminant tracers. Report AES1803, Streamlined Environmental, Hamilton, 18pp.

Streamlined Environmental Ltd,
Hamilton, New Zealand
www.streamlined.co.nz, info@streamlined.co.nz

Contents

Executive Summary

Alliance Group is seeking renewal of consents to continue discharging treated meatworks wastewater into the Mataura River. To support the new discharge consent application, Alliance Group, through Aquatic Environmental Sciences (AES) Ltd, has contracted Streamlined Environmental to model the mixing of contaminants following discharge of treated wastewater into the Mataura River.

The EFDC Explorer modelling suite was used to determine the spatial extent of the mixing zone. EFDC (Environmental Fluid Dynamics Code) is a general-purpose, state-of-the-art hydrodynamic modelling package for simulating three-dimensional flow, transport, and biogeochemical processes in surface water systems including rivers, lakes, estuaries, reservoirs, wetlands, and near-shore to shelf-scale coastal regions (Hamrick 1996). EFDC has been applied to several water bodies (including rivers, lakes, reservoirs, wetlands, estuaries, and coastal ocean regions) in support of environmental assessment and management and regulatory requirements. It has evolved over the past two decades to become one of the most widely used and technically defensible hydrodynamic models in the world. In addition to the far-field transport and fate simulation capability incorporated into the EFDC's water quality and toxic contaminant modules, the code includes a near-field discharge dilution and mixing zone module. The near-field model is based on a Lagrangian buoyant jet and plume model and allows representation of submerged single and multiple port diffusers (Frick 1984; Lee and Cheung 1990).

The model assumes that measured analyte concentrations in the site immediately upstream of the discharge are adequately representative of the conditions in the Mataura River.

Summary of results

To define the mixing zone extent, a hydrodynamic mixing model of the Alliance Plant discharge into the Mataura River was constructed and used to simulate river mixing of *E. coli*, which had previously (Dada, 2019) been shown to be present at elevated concentrations below the Alliance discharge. Over the 1 km distance below the discharge point, it was assumed that *E.coli* was conservative (i.e. no die-off).

The EFDC model dilution maps for the Alliance Plant discharge show, as expected, that when the treated effluent is discharged into the river, it does not instantaneously mix with the receiving water. Instead, what forms is an effluent plume starting at the outfall as effluent begins to mix with the Mataura River water. The mixing zone is thus a transitional area within the Mataura River in which the treated effluent discharge is gradually assimilated into the Mataura River.

Because of the high receiving water to Alliance Plant wastewater ratio, the hydrodynamics of the river and the bank-side discharge mechanism, the discharged water is well mixed in the receiving environment. The plume does not travel along the river bank or accumulate along the river bank regardless of the hydrological and wind conditions.

The effect of the discharge is felt at the opposite stream bank within a longitudinal distance of approximately 50 m from the discharge point, where concentrations gradually begin to increase as a result of the plume extension.

At a longitudinal distance of approximately 100m from the discharge point, no further analyte dilution takes place. At sites beyond this 100m distance, analyte concentrations downstream of the discharge remain the same (i.e. more or less the same concentrations downstream). This is the point of full mixing.

These results were verified using TP analyte concentrations from a longitudinal monitoring of downstream sites in 2017-2018 and similar results were obtained for the mixing zone - no further analyte dilution takes place at a longitudinal distance of approximately 100m from the discharge point.

Based on this mixing model, the mixing zone could be affirmed to be approximately 100m from the Alliance Plant discharge. Designating the site 100m downstream of the discharge as the mixing zone for compliance monitoring, is, however, impractical. This is because it is not possible to safely access the river at this point, at all times. The existing consent conditions set the mixing zone at a more accessible site, 'Mataura Bridge 200d/s', approximately 800 metres downstream of the outfall. If this site is maintained as a compliance monitoring site, the results of this modelling predict that contaminants from the discharge will be fully mixed.

1. Introduction

Alliance is New Zealand's only wholly farmer-owned red meat co-operative with plants located at varying locations in New Zealand, including Mataura, Southland. The Alliance Plant at Mataura produces several waste streams, including from the slaughter floor, boning room, edible by- products processing, stockyards and truckwash, water treatment plant backwash and domestic waste (which goes to the Mataura Wastewater Treatment Plant). Meat processing wastewater generated in the factory is treated onsite via physical treatments prior to being discharged to the Mataura River.

Alliance Group is seeking renewal of consents to continue discharging treated meatworks wastewater into the Mataura River. To support the new discharge consent application, Alliance Group, through Aquatic Environmental Sciences (AES), has contracted Streamlined Environmental Limited to model the mixing of treated discharge contaminants in the Mataura River. The focus of this study is to establish the mixing zone, beyond which full mixing is expected to have occurred.

Extensive literature exists that are related to the definitions of mixing zones for wastewater discharges to surface waters (see Cooke et al., 2010 for a review of New Zealand and international approaches). In New Zealand, the Resource Management Act (1991) and predecessor legislation refers to 'reasonable mixing zone'. This is the spatial extent of a river (in this case) below a discharge which is set aside for the mixing of contaminants, and that below which standards or guidelines must be met. For example, s107 RMA does not allow the grant of a discharge permit if "after reasonable mixing" the contaminant is likely to give rise to defined effects in the receiving waters (s107(1)(c- g).

Reasonable mixing zone may be defined by way of a plan, or by a decision-maker based on what is reasonable in the circumstances. The extent of full mixing needs to be known before such a decision can be made. The focus of this study, therefore, is on the determining the extent of full mixing.

A number of approaches are already documented in local and international literature on approaches to address mixing and dilution of analytes in receiving waters following discharge. For instance, in field-based studies, common tracers such as dyes (e.g. Rhodamine), salts, and stable isotopes are used as tracers to characterize river mixing. These tracers are typically mixed with the wastewater under consideration before discharge to the receiving water to determine mixing and flow paths of water within the receiving water, and to determine mixing and dilution of contaminants in the wastewater following discharge (see Cooke, 2014 for an example). The use of various tracers was also considered; however, this would require consent approval. Alternative tracers considered were potential analytes in the discharge; this was selected as the preferred option. In this case, the elevated and predictable concentrations of *E.coli* in the wastewater was utilised to fulfil the role of 'tracer'.

In this study, the EFDC Explorer modelling suite was applied as an effective approach to answer the question related to mixing in the Mataura River. EFDC (Environmental Fluid Dynamics Code) is a general-purpose, state-of-the-art hydrodynamic model modeling package for simulating three- dimensional flow, transport, and biogeochemical processes in surface water systems including rivers, lakes, estuaries, reservoirs, wetlands, and near-shore to shelf-scale coastal regions (Hamrick 1996). EFDC has been applied to many water bodies in support of environmental assessment and management and regulatory requirements. It is widely used and technically defensible (Torres- Bejarano et al 2015, USEPA 2017). In addition to far-field fate and transport simulation capability, EFDC includes a near-field discharge dilution and mixing zone module. The near-field model is based on a Lagrangian buoyant jet and plume model and allows representation of submerged single and multiple port diffusers (Frick 1984; Lee and Cheung 1990).

The EFDC Explorer modelling approach to mixing/dilution has number of advantages over an actual dye release study. For instance, while a dye study requires (a) intensive consideration for health and safety issues, (b) extensive post-processing and skill, and (c) higher costs magnified by need for significant field deployment, its output and value are limited to prevailing conditions. These issues are overcome by using a contaminant dispersal modelling approach, which simulates a dye release using a conservative natural tracer. It was noted in Dada (2019) that Alliance Plant discharge *E.coli* levels can be as high as 400 times the level in the receiving water. Hence, the discharge significantly raised *E.coli* levels in the Mataura River (but not pathogen levels or illness risks). This study therefore adopted *E.coli* as a preferred "tracer" and is interchangeably referred to as analyte in this report. Results were verified using TP as an alternate analyte. Analytes in the Alliance Plant discharge were treated as conservative parameters in the model, i.e. no die-off, uptake, or transformations. The model was validated with downstream *E.coli* and TP analyte concentrations at the Mataura Bridge (Alliance Plant weekly monitoring data, 2017-2018).

2. Model Construction and Parameterisation

2.1 Model Set-up

The 'Dye' transport module, which is part of the EFDC hydrodynamic model, was used in this study. The grid generation process, using a Cartesian Grid Type in the EFDC Model frame, was as described in the EFDC guidance document (Hamrick 1996). Coordinates for the lower left and upper right coordinates that covered the outline of the relevant section of the Mataura River were obtained from Google Earth. The land-boundary outlines of the relevant section of the Mataura River were produced using a combination of Google Earth and QGIS Desktop 2.18.12. A total of 390 active 15 by 20m grid cells that captured the Mataura River section 300m upstream and 1km downstream of the discharge were generated for the Mataura mixing study (Appendix 1).

Environment Southland data on geological surveys related to the depth characteristics of the Mataura River section (Appendix 1) were pre-processed with QGIS software (Quantum GIS, 2011) and applied as bathymetry data in the EFDC.

Boundary conditions were prepared and assigned to the model cell configuration. In this case there are three flow boundaries; one is inflow, i.e. upstream of the discharge, the second is the WWTP discharge into the Mataura River, while the third boundary is the outflow at the downstream end of the modelled reach, at a point in the Mataura River which is approximately 1.5km downstream of the discharge. The time series data for inflow and outflow boundaries applied in the model are presented in Section 2.2. Data for dye concentrations applied in the model, representing analyte concentrations for the inflow (receiving water, Mataura River@Gore) and the WWTP discharge, are presented in Section 2.3.

Model Calibration consisted of iterative adjustments to model parameters to match the measured water quality data. While most parameters in the model were kept at default values, the Manning's coefficient and Courant–Friedrichs–Lewy (CFL)[1] number was adjusted. The calibrated EFDC model parameters for the Mataura River included a Manning number[2] of 0.02 $s/[m^{1/3}]$ and a Courant–Friedrichs–Lewy (CFL) number of 0.4. A model simulation time of 365 days and a model time step of 2 secs were applied.

Residual Mean Square Error (RMSE[4]), Pearson correlation and R-squared metrics were used to measure the goodness-of-fit of the EFDC model predictions as shown in the following equations.

2.2 Flow rates

Discharge volumes of treated WWTP effluent:

The maximum daily treated wastewater discharge of 6,638 cubic metres per day (i.e. 0.08 m^3/s) was assumed in the EFDC model (Figure 1). While the discharge could be as high as 14,400 m^3/s,

[1] The CFL condition is a necessary condition for convergence while solving certain partial differential equations numerically as the inflow moves across the discrete spatial grid. A good rule for modelling applications with spatial and temporal varying advective fields is to use a time step on the order of 1/4 to 1/2 the limiting CFL time step (EFDC guidance document). In this study a time-step of 0.2 was applied

[2] The Manning constant forms part of the empirical formula used to estimate the average velocity of a liquid flowing in a conduit that does not completely enclose the liquid, i.e., open channel flow. This constant is generally lower for clean, straight channels and higher for streams with very weedy reaches, deep pools, or floodways with heavy underbrush

at full discharge, the results are not expected to be different[3].

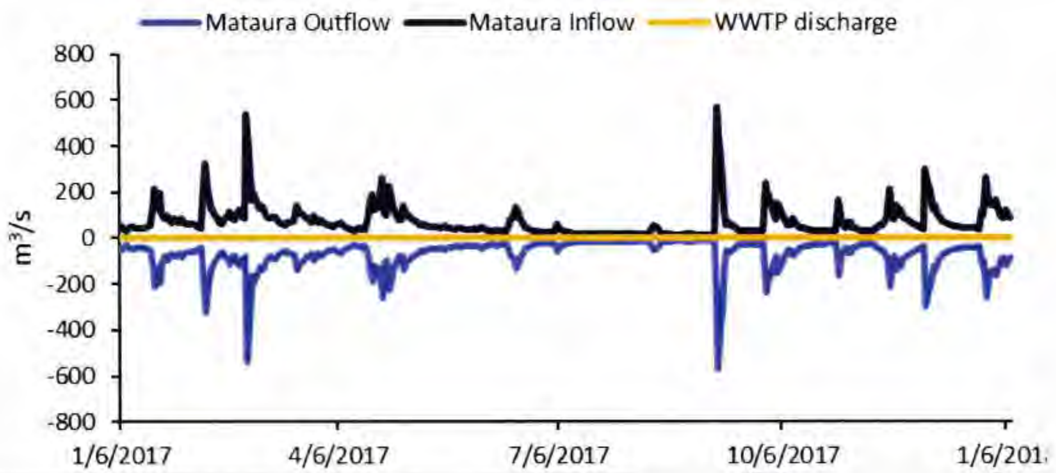


Figure 1 Mataura River upstream flow applied in the calibration of the EFDC mixing model

Receiving water flow conditions

Flow data were obtained from the Environment Southland (ES) continuous flow recorders via their website[4]. Observed daily flow rate upstream of the discharge for the modelling period ranged between 10.56 m^3/s and 570 m^3/s (2017-2018) (Figure 1).

2.3 Analyte concentrations

Mataura River background concentration

Variable background concentration data were applied during the model calibration stage to assess if the model will capture variabilities in daily analyte concentrations recorded at Mataura Bridge (downstream of the discharge). ES Monthly water quality data for Mataura River @ Gore[5] were applied in the model as baseline upstream concentrations.

Treated WWTP effluent quality

A 95th percentile *E.coli* concentration of 240,000 CFU/100mL for WWTP effluent, based on Alliance Plant Compliance Monitoring data, was used in the EFDC model.

[3] given that different scenarios of flow produced the same mixing distance, as will be seen in the results section.
[4] It is important to note that there is no continuous flow measurement recorded just upstream of the discharge. The closest upstream flow stations are Mataura River @ Gore and Waikaka Stream, a tributary which empties into the Mataura River at a location downstream of the Mataura River @ Gore flow recorder. Hence a reliable estimate of the upstream flow conditions was taken as of the combination of the daily flows at Mataura River @ Gore and Waikaka Stream.
[5] corrected for Waikaka stream @ Gore inflow

2.4 Mataura Mixing Model validation

The purpose of the model validation was to verify if the model reproduces the observed analyte concentrations recorded at Mataura Bridge (downstream of the discharge) during conditions of Alliance Plant discharge. To validate the model, a total time of 365 days was simulated. Depth averaged water column analyte concentrations at Mataura Bridge was thus predicted by the EFDC model. Alliance Plant weekly monitoring data collected from the Mataura bridge site (2017-2018) was compared to the model predicted concentrations (Table 1). Model performance was good, based on the low RSMEs, R-squared and Pearson Correlation matrixes associated with the predicted analyte concentrations

Figure 2 Mataura bridge, a site ~330m downstream of the discharge. Alliance Plant weekly monitoring data collected here was used to validate model.

Table 1 EFDC Mixing Model Validation: Comparison of simulated and measured data at Mataura Bridge.

Analyte	Sampling day	Observed Mataura Bridge concentration	EFDC Mataura Bridge concentration	Residual	Statistics
E.coli (LogCFU/100mL)	12	2.17	2.18	-0.01	RSME (LogCFU/100mL)=0.22
	47	3.30	2.85	0.45	Pearson Correlation = 0.79
	103	3.45	3.49	-0.04	R squared = 0.62
	131	3.04	2.17	0.88	
	221	1.95	2.18	-0.23	
	256	3.28	2.82	0.46	
	284	3.00	3.24	-0.24	
	319	4.11	3.70	0.41	
	346	3.28	2.56	0.72	
TP (mg/L)	303	0.02	0.04	0.018	RSME (mg/L) = 0.0003
	319	0.03	0.04	0.008	Correlation = 0.70
	327	0.02	0.04	0.017	R squared = 0.48
	331	0.02	0.04	0.019	
	339	0.03	0.04	0.007	
	355	0.05	0.05	-0.001	
	4	0.04	0.04	-0.003	
	8	0.04	0.04	-0.001	
	16	0.04	0.04	-0.003	
	24	0.04	0.04	-0.002	
	32	0.06	0.08	0.020	
	46	0.03	0.04	0.007	
	50	0.05	0.05	0.000	
	58	0.05	0.09	0.045	
	66	0.03	0.04	0.010	
	73	0.03	0.04	0.007	
	78	0.03	0.04	0.007	
	86	0.03	0.04	0.010	
	102	0.05	0.10	0.050	
	106	0.03	0.04	0.008	
	116	0.03	0.04	0.008	
	136	0.02	0.04	0.017	

DRAFT

2.5 Description of mixing scenarios

Three flow scenarios were considered in the study.

1. Typical flow conditions-median flow: In this scenario, the annual median flow rate (50.6 m^3/s) was applied in the model as the flow rate of the receiving Mataura River water.
2. Near worst-case flow: In this scenario, the summer median flow rate (19.28 m^3/s) was applied in the model as the flow rate of the receiving Mataura River water.
3. Worst-case flow: In this scenario, half of the summer median flow rate (9.64 m^3/s) was applied in the model as the flow rate of the receiving Mataura River water.

The reason for including these three flow scenarios is to inform whether the mixing length is approximately the same for higher flow rates as it is for the critical low flow rate.

2.6 Outputting of model results

Far-field dilution outputs:

Far-field sites in this study were taken as sites far away from the discharge point. Model output was generated by the model at one site upstream of the discharge and 14 sites downstream of the discharge (DS-Sites, see Figure 3). The first downstream site (DS-Site 1), the immediate receiving environment of the Mataura River, was approximately 20 m from the discharge point. Other subsequent downstream sites were spaced 100 m away from the previous downstream site (Figure 3). DS-Sites 6-11 were located in the part of the Mataura River where a small island, approximately 600 m downstream causes the river to split before coalescing further downstream. DS-Sites 12 and 13 were approximately 900 m and 1000 m away from the first site, DS-Site 1 (Figure 3).

Analyte concentrations generated at each of the 13 downstream sites were compared with each other and with the baseline concentration (upstream site) to inform whether the mixing length is approximately the same for higher flow rates as it is for the critical low flow rate at the various downstream sites.

Near-field dilution outputs:

Near-field sites in this study were taken as sites near the discharge point. In order to capture near-field dilutions, a finer scale resolution of the model analyte risk map was made for the first 250 metres downstream of the discharge site (Figure 3).

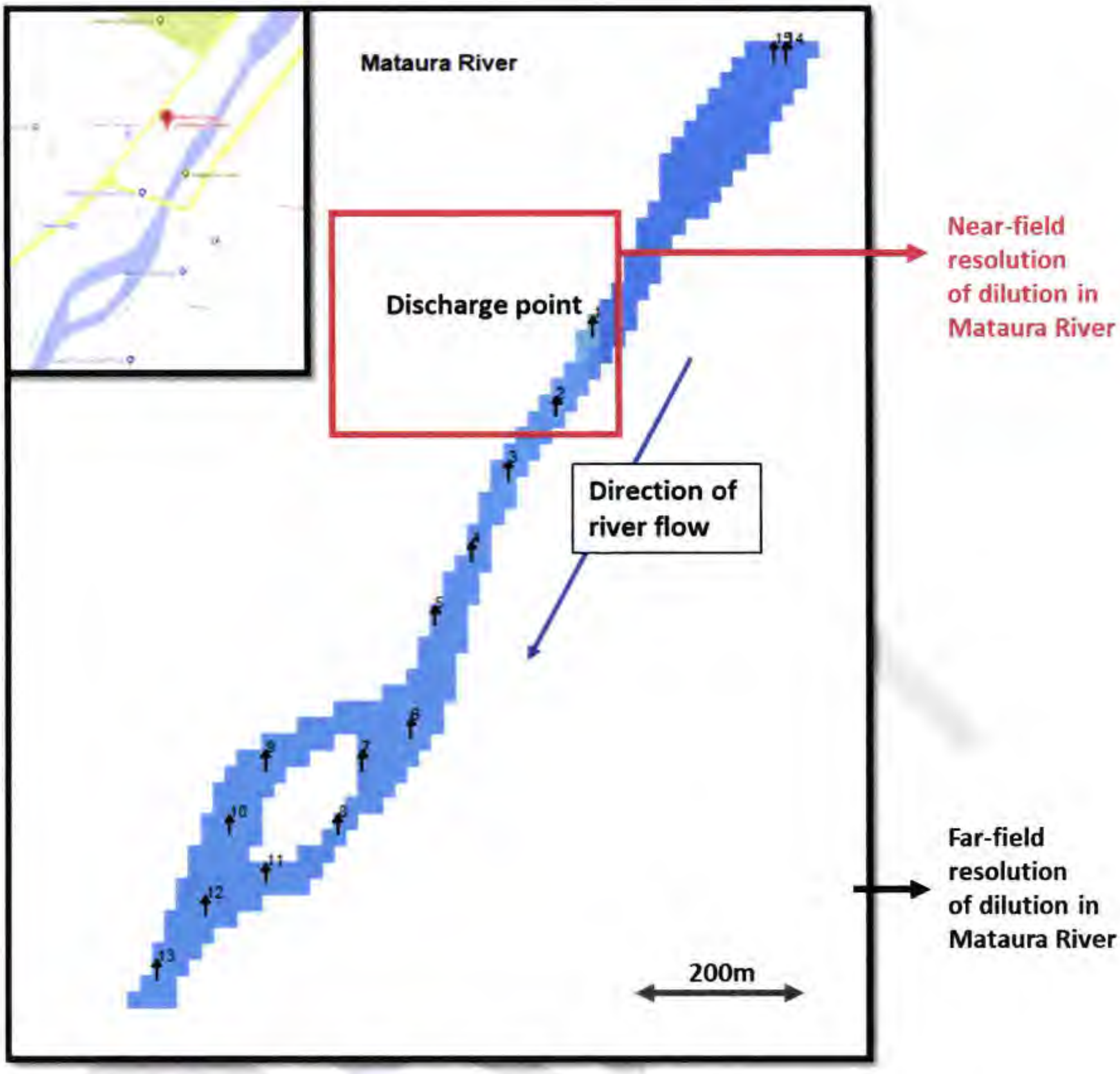


Figure 3 Sites where model output was generated by the model after mixing. The modelled section commences 500m before the discharge and extends 1km downstream from the discharge.

3. Modeling Results

To determine the size of the mixing zone, a plot of near-field dilution of continuous Alliance Plant discharge in the worst-case scenario with respect to dilution (i.e. 0.5*summer flow) is presented in Figure 4. The contour lines of concentrations following dilution in the receiving water show that the Alliance Plant discharge is progressively diluted by the Mataura River inflow between the point of discharge and approximately 100m downstream. Because of the high receiving water to Alliance Plant wastewater ratio, the hydrodynamics of the river and the bank-side discharge mechanism, the discharged water is well mixed in the receiving environment. The plume does not travel along the river bank or accumulate along the river bank regardless of the hydrological and wind conditions (Figure 4).

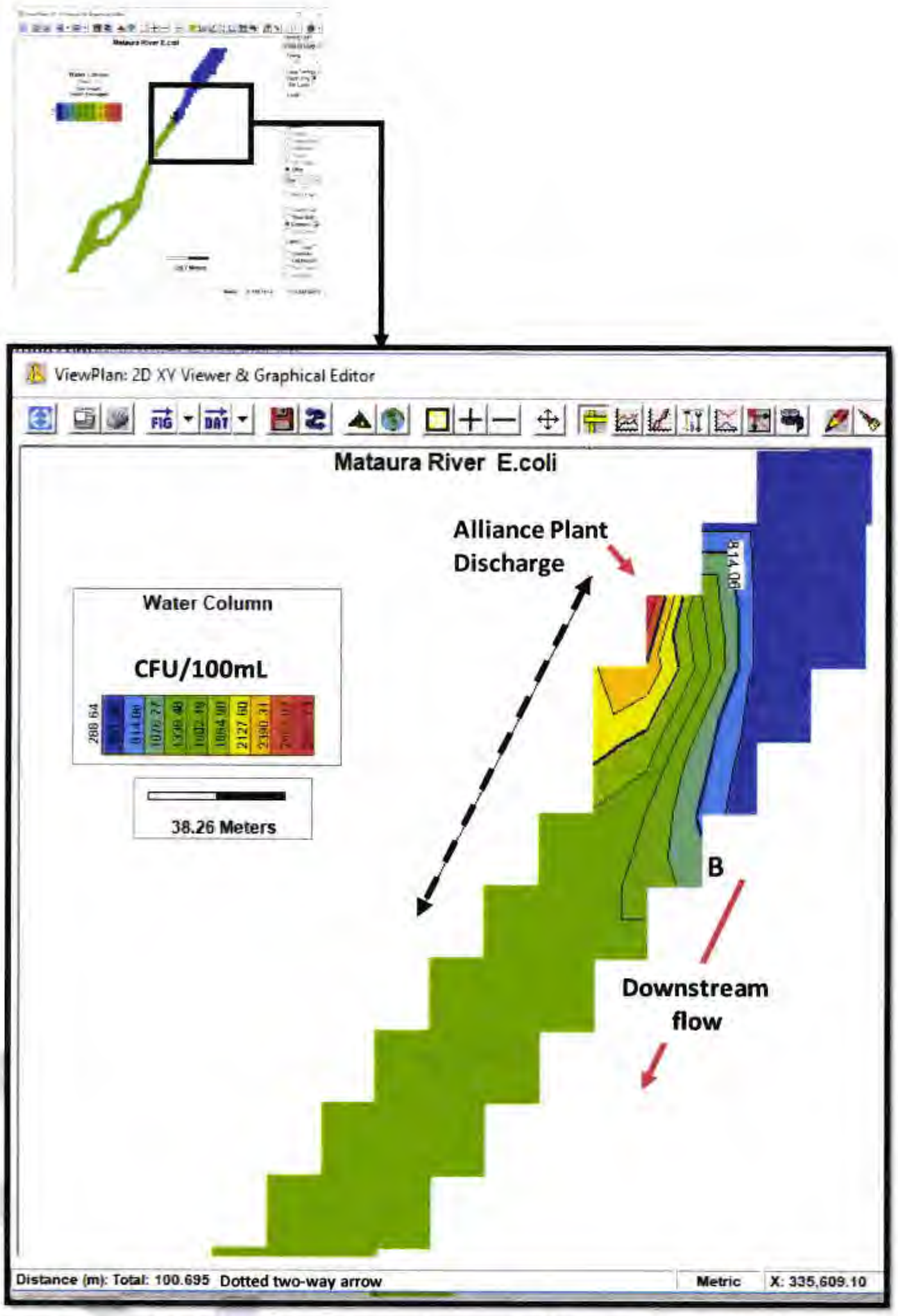


Figure 4 Plot of near-field dilution of continuous Alliance Plant discharge containing 240, 000CFU/100mL *E.coli* during worst-case Mataura River flow scenario (i.e. 0.5*summer flow). Dotted two-way arrow: distance beyond which no further analyte dilution takes place

In Figure 4, Alliance Plant wastewater containing 240,000 CFU/100mL *E.coli* (95th percentile concentrations) at a maximum discharge rate of 0.08 m^3/s was released daily into a critically low flowing (9.64 m^3/s) Mataura River containing a baseline concentration of 470 CFU/100mL. At the site of the discharge, in-stream concentrations increase to 2,441 CFU/100mL within 20m from the discharge (i.e. red colour at the core of the plume in Figure 4). The plume of Alliance Plant discharge is gradually diluted with corresponding reductions in the in-stream *E.coli* concentration to 1602 CFU/100mL as the plume extends its reach to other parts of the river (red–

orange–light green–deep green colour of the plume extension in Figure 4.

The effect of the discharge is felt at the opposite stream bank (B) within a longitudinal distance of approximately 50 m from the discharge point, where concentrations gradually begin to increase as a result of the plume extension. At a longitudinal distance of approximately 100m from the discharge point (see dotted two-way arrow in Figure 4) no further analyte dilution takes place across the width of the river and *E.coli* concentrations remain at 1602 CFU/100mL. At any site beyond this 100m distance, analyte concentrations downstream of the discharge remain the same (i.e. more or less the same concentrations downstream). This is the point of full mixing.

A similar plot was made for TP[6]. At a longitudinal distance of approximately 100m from the discharge point (see dotted two-way arrow in Figure 5), no further analyte dilution takes place. This is the point of full mixing.

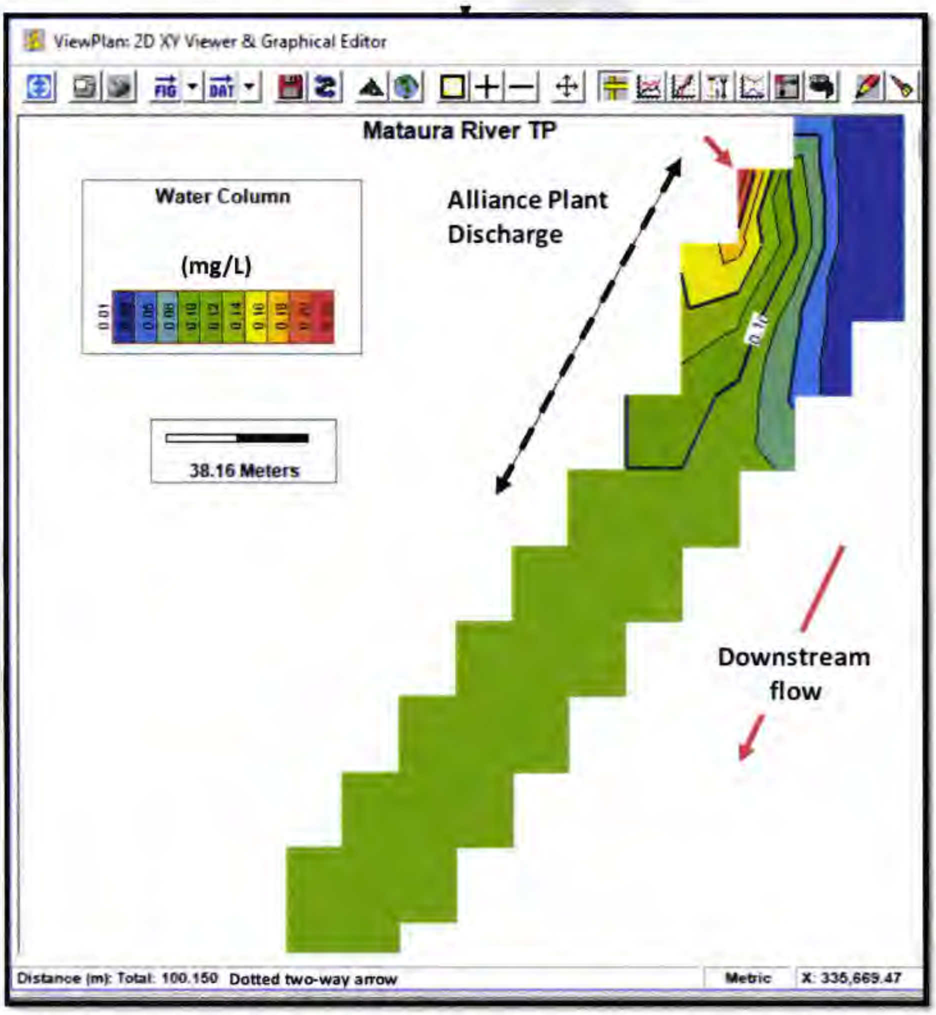


Figure 5 Plot of near-field dilution of continuous Alliance Plant discharge containing 10 mg/L TP during worst-case Mataura River flow scenario (i.e. 0.5*summer flow). Dotted two-way arrow: distance beyond which no further analyte dilution takes place

[6] Alliance Plant TP concentration = 10mg/L, Mataura River TP concentration = 0.03 mg/L

To establish whether the mixing length is approximately the same for higher flow rates as it is for the critical low flow rates, analyte concentrations at different downstream sites were plotted (Figure 6). Results show that regardless of the Mataura River flow condition, no further dilutions occur beyond DS-Site 2 (100m downstream of the discharge, Figure 6).

The results were further verified using TP concentrations[7]. The same pattern of results was obtained when *E.coli* concentrations were replaced with TP concentrations. No further dilutions occur beyond DS-Site 2

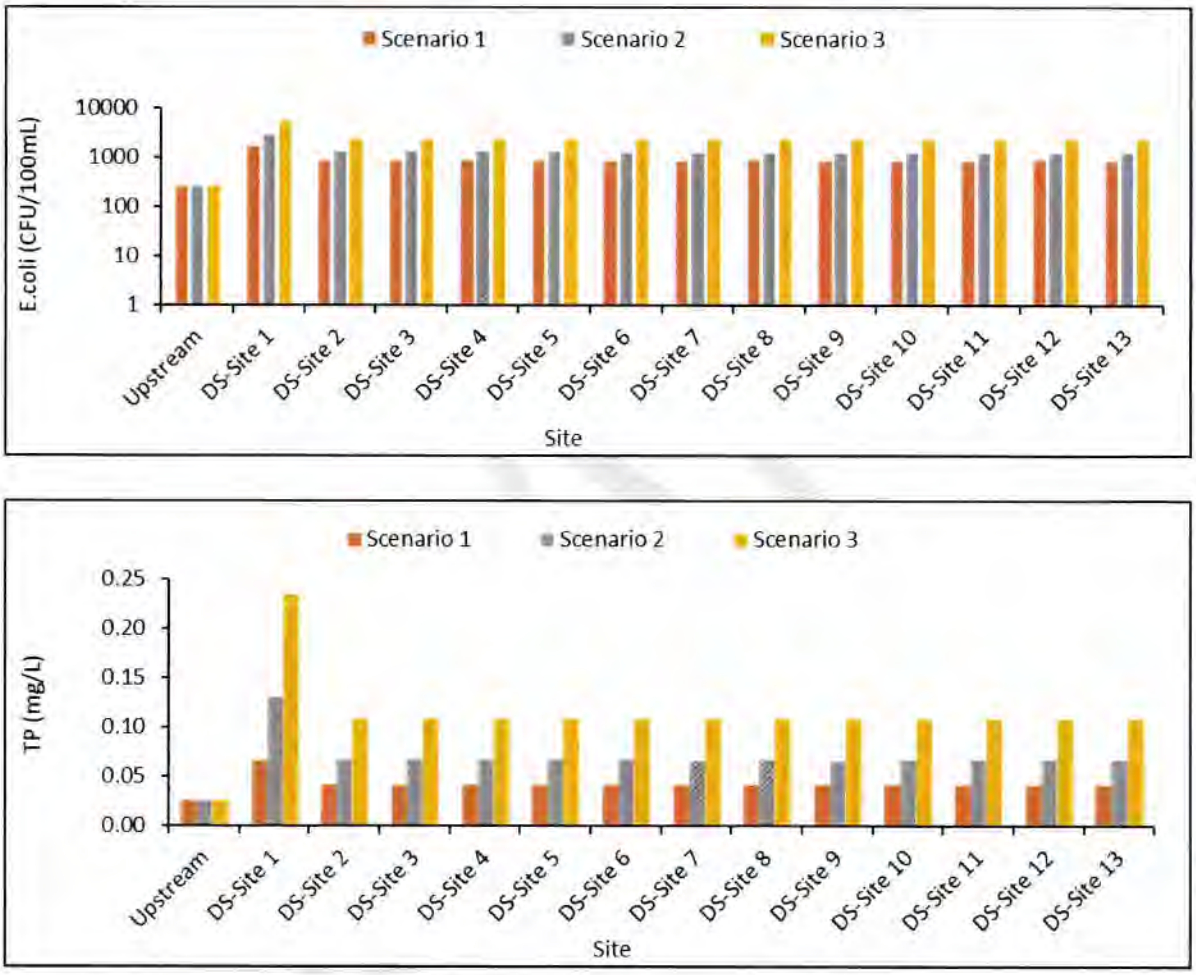


Figure 6 Mataura River median *E.coli* and TP concentrations (upstream and downstream of the Alliance Plant discharge) DS-Site 1 is approximately 20 m from the discharge point. Other subsequent downstream sites are spaced 100 m away from the previous downstream site. DS- Sites 6-11 are located in the part of the Mataura River where a small island, approximately 600 m downstream causes the river to split before coalescing further downstream. DS-Sites 12 and 13 is approximately 900 m and 1000 m away from the first site, DS-Site 1 (See Section 2.6).

[7] Alliance Plant TP concentration = 10mg/L, Mataura River TP concentration = 0.03 mg/L were applied, although the Alliance Plant discharge had an average of 4.1 mg/L and a 95th of 6.4 mg/L of TP for the 17/18 season

4. Discussion and Conclusions

Results from a constructed EFDC mixing model for the Alliance Plant discharge released into the Mataura River (Section 3) confirms that when effluent is discharged into the river, the treated wastewater does not completely and instantaneously mix with the receiving water. Instead, what forms is an effluent plume starting at the outfall as effluent begins to mix with the Mataura River water. The mixing zone is thus a transitional area within the Mataura River, in which the treated effluent discharge is gradually assimilated into the Mataura River.

During all Mataura flow scenarios considered in this modelling study, at a longitudinal distance of approximately 100m downstream of the discharge point, no further analyte (TP and *E.coli*) dilution takes place. At any site beyond this 100m distance, analyte concentrations do not significantly change with distance downstream. Based on this mixing model, the mixing zone could be affirmed to be approximately 100m from the Alliance Plant discharge.

Designating the site 100m downstream of the discharge as the mixing zone for compliance monitoring however is impractical. This is because it is not practically possible to access this site at all times. The existing consent conditions set the compliance point at Mataura Bridge, approximately 330 metres downstream of the outfall, which provides access for sampling Mataura River water. It therefore seems reasonable in the circumstances, to retain this site as the compliance point for the purposes of defining reasonable mixing under s107(1) RMA. The results of this modelling thus affirm that the analyte is fully mixed at this site.

5. References

Cooke, J., Milne, P., & Rutherford, K. (2010). A review of definitions of "mixing zones" and "reasonable mixing" in receiving waters. A report prepared for Auckland Regional Council. Auckland Regional Council Technical Report 2010/045, August 2010. ISSN 1179-0512 (Online) ISBN 978-1-927135-01, 3.

Cooke, J. (2014) Mixing and dilution in the Ruamahanga River: Verification of diffuser performance at the Masterton WWTP. Report prepared for Masterton District Council. Streamlined Environmental Ltd 23 pp.

Frick, W.E. 1984. Non-empirical closure of the plume equations, Atmos. Environ. 18:653-662.

Hamrick, J.M. 1996. A User's Manual for the Environmental Fluid Dynamics Computer Code (EFDC), Special Report 331. The College of William and Mary, Virginia Institute of Marine Science. 234 pp.

Lee, J.H.W., and V. Cheung. 1990. Generalized Lagrangian model for buoyant jets in a current. J. Environ. Engrg. 116:653-662.

Rutherford, K.; Zuur, R.; Race, P. (1994). Resource Management Ideas. No. 10. A. discussion on reasonable mixing in water quality management. Ministry for the Environment.

Torres-Bejarano, Franklin & Padilla, J & Rodríguez-Cuevas, C & Cantero, R. (2015). Hydrodynamics modelling utilizing the EFDC Explorer model for the sustainable management of Canal del

Dique-Guajaro hydrosystem, Colombia. 10.2495/SD150371.

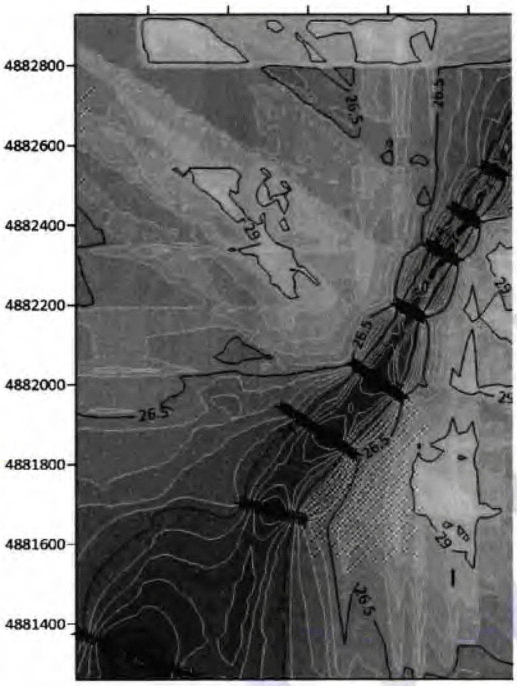
USEPA (1994) EPA Region VIII Mixing Zones and Dilution Policy. Denver, CO, U.S. Environmental Protection Agency, Region VIII, Water Management Division.

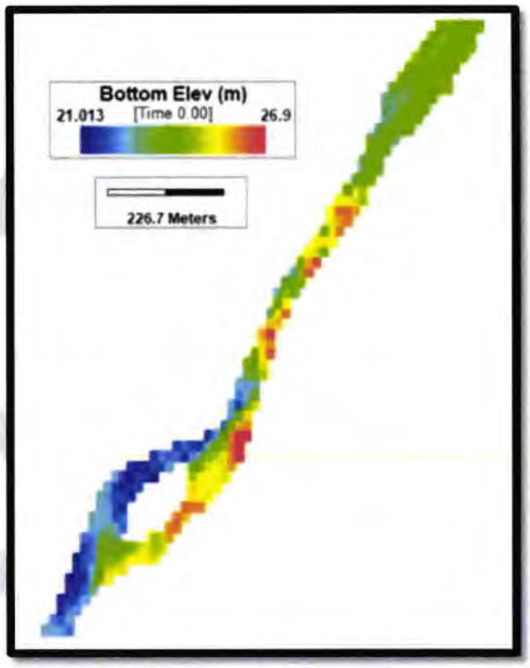
USEPA 2017 Introduction to EFDC: Water Quality Modeling Basics and Beyond https://www.epa.gov/sites/production/files/2018-01/documents/flyer_webinar_11_efdc_508_.pdf

DRAFT

Appendices

Appendix 1 Topographic-bathymetric characteristics for the Mataura River section (NZTM projection, vertical elevation in m a.s.l.).





5

APPENDIX 5

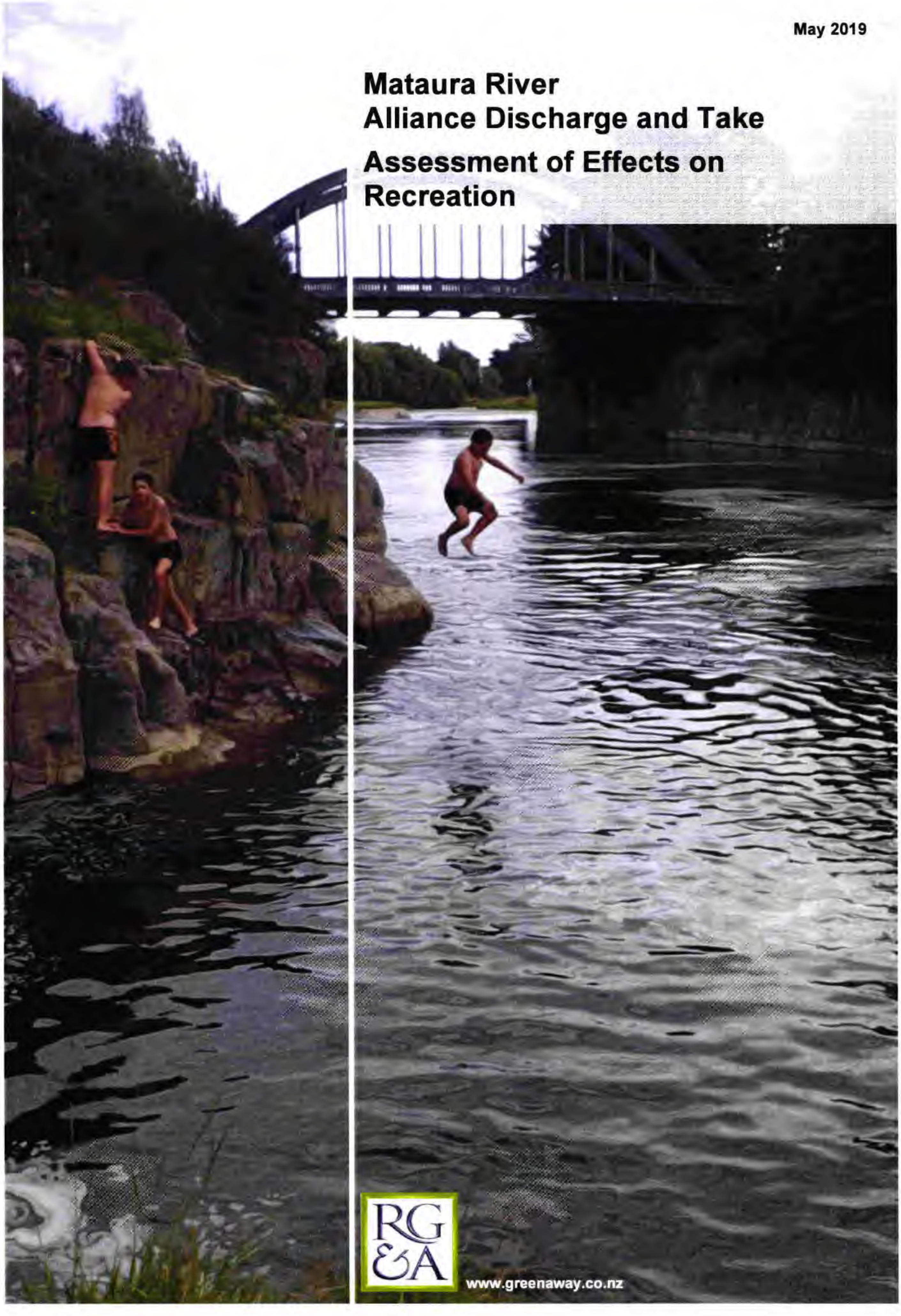
Mataura River Alliance Discharge: Identification of in-river recreation values,

Rob Greenaway & Associates, 2019.

May 2019

Mataura River
Alliance Discharge and Take

Assessment of Effects on Recreation



www.greenaway.co.nz

Mataura River
Alliance Discharge and Take

Assessment of Effects on Recreation

May 2019

Prepared for

Mitchell Daysh

By

Rob Greenaway & Associates
www.greenaway.co.nz

Version status

Final

Mataura River
Alliance Discharge and Take
Assessment of Effects on Recreation

Contents

Figures

Tables

1 Executive Summary

The Alliance Group Ltd (Alliance) is in the process of applying to reconsent its treated wastewater discharge and take and return of cooling water at its Mataura plant. This report identifies and locates the in-river recreational activities (those associated with water-contact) carried out on the Mataura River which may be affected by the take and discharge, and reviews potential effects on recreation. This assessment is based on:

- A review of the plans and strategies implemented by relevant planning authorities, including regional and district councils and the Department of Conservation, and the Water Conservation Order (section 2);
- Popular, published and online literature which describe recreation opportunities on the River (sections 3 and 4);
- An observational count of recreational activity on the River between Gore and Seaward Downs (section 5.1);
- Counts made from 10-minute interval camera records of use of the River near the Mataura Bridge (section 5.2); and
- Fifteen informal interviews with recreational users of the Mataura River. Interview records appear in Appendix 1, and where relevant, were emailed to the interviewee to confirm (not all wished to be quoted, but their comments are incorporated in the interview summary below and in section 6).

While the available data do not provide a full quantification of in-river recreational use of the Mataura River – which would require a significant research programme – they do indicate the main recreational values and where they occur. These are:

- The outstanding nature of the Mataura River for brown trout fishing, but a large reduction in fishing activity in the River downstream of Gore over the past decade;
- Its relatively high use for swimming, both up and downstream of Mataura;
- A very popular whitebait fishery in the lower reaches;
- Use of the riverbanks, berms, reserves and angler access points for a variety of terrestrial activities, mostly around settlements, and with relatively high activity levels at the Coal Pit Road angler access point;
- A low level of use of the River for salmon fishing;
- Some use of the River for kayaking, but with no relevant data to quantify activity;
- Very little other boating activity, such as jet boating – largely as a result of navigation rules which restrict jet boating on the River.

Water quality is identified in several publications, including Environment Southland's Recreational Bathing Survey (Ward 2015) as an issue of interest generally in Southland rivers, and a determinant for not using regional rivers for recreation; but its effect on recreation participation on the Mataura specifically has not been quantified. In a 2013 survey of whitebaiters on the Mataura River carried out by Environment Southland (ES 2013), excessive weed, water odour, stinky sediment and oily slicks were identified as occurring 'always' or 'often' by few respondents, with the majority noting they were observed either 'sometimes' or never.

Public Health South carried out an investigation into three cases of suspected cyanobacterial toxin poisoning in three people who swam in the River approximately 400 m above the Mataura Falls in late 2017, concluding that, "the causative agent remains unknown, however it can be presumed that cyanobacterial toxins being the most likely source of illness based on the clinical presentation of the three cases and reported water condition of the Mataura River at the time of swimming" (Marshall 2019). Southland and Gore Districts are otherwise regionally unremarkable in their reported incidence of Campylobacteriosis, Cryptosporidiosis and Giardiasis from water contact recreation (Public Health Southland 2019).

Interviewees indicated a variety of perceptions about changes to recreation values over time, with regard to water quality. Key points include:

- A variety of perceptions about water quality and the safety of contact recreation. While no-one interviewed would drink from the Mataura River below Cattle Flat, and many would not swim in it, responses included opinions ranging from 'possibly too clean' (by an angler) to 'horrendous' (a kayaker, describing the river-setting at Mataura generally, including the proximity of the Alliance plant to the River). All agreed that the River's water quality was far better than in the 1980s when there were a variety of untreated discharges, including municipal wastewater and outfalls from the pulp and paper mill, Alliance plant and Edendale dairy factory (these resulted in some very large trout and eels being caught); and that the latest upgrade at the Alliance plant had also had a positive effect. Several respondents – mostly anglers – considered the water quality now to be quite good, but potentially of decreasing quality due to farming intensification. Others considered the water quality to be poor. Many noted a variety of sources of contamination, including farming and treated municipal wastewater, particularly at Gore. The Alliance discharge did not feature as a major issue for most respondents but was noted by some kayakers. Most interviewees considered foam on the River to be a natural phenomenon, considering it occurs well above Gore.
- Opinions about the quality of the fishery also varied. Most agreed that the mayfly rise on the Mataura River had declined in frequency and intensity, with several theories as to the cause. The most experienced angler on the River downstream of Mataura – with detailed angling diaries – considered the insect life in the River to be quite healthy, but that warmer summer temperatures (climate change) were confining the rise to evenings and night, were less frequent generally, and were occurring later in the 'summer' season ('May is the new April'). Warmer temperatures were also considered a cause in the change in the patterns of the hatch by other anglers, but nutrification and sedimentation and (therefore) fewer insects were also identified. The Southland Fish and Game manager noted a lack of good data to define the scale of change and any specific causes, while noting that the fishery itself (the number and condition of fish) was still in a good state.
- Opinions about the number and quality of trout varied, with some considering the numbers and quality to be consistent, and others considering size, quality and numbers to have all declined. Some considered a reduction in trout size to be the result of a cleaner river. The change in the frequency, timing and duration of the mayfly hatch has influenced a change in fishing technique, with more nymphing over dry fly fishing.
- Swimming appears to be, in the main, a very local activity with a small number of regular users – also influenced by the recent closure of the community swimming pool at Mataura. There appears to be no common local conversation about illnesses from contact with the River water, and bathing water quality reports issued by Environment Southland do not appear to affect many swimmers' choices. One kayaker reported an illness after coming out of his kayak immediately below the Mataura Falls, and reported an odour from the Alliance discharge.

The key finding of this assessment is that while the contribution of the discharge and water take to adverse effects on recreation in the Mataura River are very slight and subsumed by the many other sources of nutrification and contamination, the Plant will need to reduce its levels of key contaminants as part of catchment wide initiatives to improve water quality.

Based on the findings of Dada (2018) and Montgomerie *et al* (2019), there appears to be no causal relationship between the discharge and levels of periphyton, macroinvertebrates, colour, clarity or the generation of foams or scums – and hence trout and whitebait habitat and the ability to catch them. Odour was reported as a potential issue by two interviewees, but appears to be confined to the area in the immediate vicinity of the Plant and within the discharge mixing zone (and so could be from the treatment plant rather than the discharge or River). Dada (2018) found elevated levels of *E.coli* associated with the discharge, but very low and variable levels of human pathogens, and therefore low human health risk. Nevertheless, options to further reduce these *E.coli* and nutrient outputs are recommended, and while not urgent considering the existing low scale of effect on recreation amenity (and ecological values), it is recommended that they be implemented during the life of a renewed consent.

Public Health South has noted a lack of warning signs about water contact recreation along the Mataura River; and the only swimming warning signs located beside the River in January 2019 between Gore and the coast were at Fortrose (erected by Environment Southland) and 'no diving' signs at either end of the Mataura Bridge. Alliance is not responsible for regional signage of this type, and there is no requirement to include sign installation as a consent condition (also considering the discharge has very little influence on water quality for contact recreation). However, as recommended by Public Health South, their installation needs consideration at the regional and district levels.

2 Plans and Strategies

This section considers regional recreation planning material in relation to recreation values on the Mataura River. National plans and strategies – such as the National Policy Statement for Freshwater Management – are reviewed in the summary Assessment of Environmental Effects accompanying the consent application and in other parallel assessments – such as Dada (2018) and Montgomerie *et al* (2019).

2.1 Water Conservation Order

The Water Conservation (Mataura River) Order 1997 relates to the Mataura River from source to sea, as well as the Waikaia River and its tributaries, the Otamita Stream, and all other tributaries of the Mataura River upstream of its confluence with the Otamita Stream and the Mimihau Stream and the Mokoreta River and each of their tributaries. The waterways' protected 'outstanding features' "include outstanding fisheries and angling amenity features". The Order controls the opportunity to dam the River and its tributaries, as well as defining standards for water quality and quantity.

The relevant Report and Recommendation of The Planning Tribunal (July 1989, Decision C32/90) focused – in line with the application – on the River's amenity for brown trout angling, finding (pp39-40):

> *We have very carefully reviewed all the evidence given by the local anglers and the scientists, including those whose specialties are concerned more with river flora and invertebrate populations. Having done so, we have concluded that the Mataura River system does contain an outstanding fishery and an outstanding angling amenity.*
>
> *As we said earlier there is really little dispute about the angling amenity, and in this regard we think it is right to give somewhat more weight to the so-called anecdotal evidence than the objectors would have us do. After all it goes back for nearly 100 years and we think weight should be given to the fact that for practically the whole of that time, this river system has enjoyed a reputation both within New Zealand and overseas for high quality brown trout angling. Then we take into account that for some years now, the system has not been artificially stocked and yet it has continued to provide a high catch rate by both national and international standards. We think, as indeed all the fisheries scientists agreed, that this is evidence that the river system supports a significantly large fish population. We think it right to say too that the outstanding angling amenity is a consequence of the outstanding fishery, for without this high quality fishery one of the important features of the angling amenity, namely the high catch rate, would not exist. It is this feature in particular that distinguishes the Mataura River fishing and angling amenity from, for example, the Ahuriri River, a distinction referred to specifically by Mr Witherow.*
>
> *We also give weight to the fact that the river system provides for the full range of angling experiences.*[1] *This too, is associated with the fishery and the changes in it that are evident in different parts of the river system, including the tributaries.*

Further detail was provided by witnesses for the applicant (pp13-14):

> *As we said earlier, Mr Weddell confirmed the presence of sea run trout from Mataura Island to the sea. He spoke about the importance of maintaining the quality of the fisheries in the tributaries so that the mainstem does not come under increasing angling pressure. He said that there were several reasons for the Mataura River being a quality fishery. There is a reliable flow of clean water, a relatively shallow gradient, and inaccessible areas to provide the fish with a haven to grow. He pointed out too that Gore markets itself as the brown trout*

[1] "... including bait fishing, spinning and fly fishing." (p11)

capital of the world. He said the Mataura River system is the best brown trout fishery of its kind that he knows of. He told. us in cross-examination that the Ahuriri River, about which we have recently made a report and recommendations. is a totally different fishing experience. In the Ahuriri River the angler looks for large individual fish. In the Mataura the angler is looking for large numbers of fish. In the opinion of this witness it is impossible to compare the two directly. One of the principal reasons for the difference is that the Ahuriri River is a snow fed river, whereas the Mataura River is a rain fed river, and is consequently more fertile and has more insects, and therefore more trout. Snow fed rivers have less trout. Mr Weddell agreed that the mayfly population is decreasing downstream of Gore, due to the effects of discharges, either from point sources or from agricultural run off. Consequently, fly fishing is best in the upper reaches. ...

Mr Witherow pointed out that the Mataura River has enjoyed a high reputation amongst anglers for a long time. He said that it is the most heavily fished brown trout river in New Zealand. No other brown trout river in New Zealand approaches this level of usage. It is of some importance to record however, that the majority of users, some 80% according to his evidence, live in the Mataura Valley and the nearby city of Invercargill. Of the remaining visitors to the river, some 15% live elsewhere in New Zealand and 5% come from overseas.

Mr Witherow went on to say that one of the most valuable attributes of the river as a fishery is that it is nonspecialist. In other words, it provides a full range of fishing experiences - a matter referred to earlier by other witnesses. He spoke about the effects of a major flood in the Mataura River in 1978 and how this constituted a temporary setback for the fishery. However, because new stock was readily available from sidestreams which had not been so affected by the flood, the fishery rapidly recovered and this demonstrates the resilience of the river system as a whole. In the opinion of this witness, the system is one ecological unit and protection of the fishery requires protection of all major parts of it.

The most concentrated angling occurs downstream of the Otamita Bridge. In particular, one stretch from Mataura downstream to Mataura Island - some 35 kilometres, being 16% of the mainstem - supports 41% of the angling and provides 37% of the annual trout harvest. The stretch from Mataura Island to the sea supports some 11% of angling and provides 10% of the harvest. From the Otamita Bridge, which is upstream of Gore to Mataura itself, the river supports an additional 15% of the angling and provides 15% of the harvest. In terms of angling usage, the stretch of river from Mataura to Mataura Island is the most valuable. Overall, the stretch from Mataura to the sea supports more than half the angling.

And in relation to water quality:

The most significant effect of a lowering in water quality below Gore is the effect on invertebrate fauna, and this has resulted in changes in feeding habits of the trout population in that part of the river. Dr Scott said that it is difficult to isolate particular detriments caused by any one water quality factor, because the various water quality components are not isolated. They occur together and interact in their effects on both invertebrates and fish. In terms of the measurable parameters involved in the Class D classification, it can be said that the river above Gore does not offer any problems and could probably meet a higher classification. Below Gore, the pH. temperature and clarity are not in dispute, but the dissolved oxygen levels do offer some difficulty. Dr Scott considers it is important that on a continuous basis the dissolved oxygen standard is maintained, since dissolved oxygen normally drops in concentrations during darkness. If compliance was required with the Class D classification standards continuously, the measured values would have more significance than they do at present. Dr Scott also gave evidence about the importance of the sub-catchments in the various tributaries, and in particular the fact that they provide an insurance against problems in the mainstem.

Little information about other recreational uses of the Mataura River besides evidence presented by the then chair of the Hokanui Runaka, Naina Russell (p35):

> *The Mataura River plays a large part in the lives of Mrs Russell and her people who support a managed approach and community use of the River. The River is used for gathering food and for recreation. The waters of the River also play a spiritual role in the lives of Mrs Russell and her people. The inanga or whitebait fishery, is a traditional one, as is the eel fishery. Eel numbers have fallen off but the members of the runaka do not know why.*

2.2 Department of Conservation

The Southland Murihiku Conservation Management Strategy (CMS) 2016 references the Mataura River, below Ardlussa, only in relation to the application of the Water Conservation (Mataura River) Order 1997 (discussed above) and restoration works at the freshwater Mātaitai Reserve at Mataura (discussed below). There are no other recreation data in the CMS relating to recreation on the Mataura River.

2.3 Mātaitai Reserve

A map of the 9 km length of the Mātaitai Reserve at Mataura is provided by the Ministry for Primary Industry's *National Aquatic Biodiversity Information System* (NABIS) (Figure 1, in blue with the Reserve's northern and southern extents indicated).

Figure 1: Mātaitai Reserve at Mataura. Source: NABIS

The status of the Mātaitai Reserve is defined by the Fisheries (Declaration of Mātaitai Reserve at Mataura River and Appointment of Tangata Tiaki/Kaitiaki) Notice 2005 (No. F329).

The notice appoints a member of Ngai Tahu as the Tangata Tiaki/Kaitiaki for the Reserve, bans commercial fishing and controls customary harvesting. The objectives of the Hokonui Rūnanga for their management of the Mataura River Mataitai Reserve are detailed online.[2]

The Fisheries (Mataura River Mataitai Reserve Bylaws) Notice 2009 (No. F485) further controls fishing activity:

> *3 (a) No person may:*
>
> *(i) take any of the following species within the Mataura River Mataitai Reserve; or*
>
> *(ii) possess any of the following species within that area; or*
>
> *(iii) possess any of the following species taken from within that area: Lamprey, Shortfin eel and Longfin eel.*
>
> *(b) No person may use, set or possess any fyke net within the Mataura River Mataitai Reserve.*

National amateur fishing regulations otherwise apply, including those maintained by the NZ Fish and Game Council.

---

[2] https://www.hokonuirunanga.org.nz/projects/environment/mataura-mataitai/

Cultural practices such as the harvesting of lamprey can have recreation components, but as their management is primarily within a cultural context, this recreation assessment does not apply. There is otherwise little available published data about recreational eel and lamprey fishing on the Mataura River.

2.4 Southland District Council

The Southland District Plan 2018 does not describe any particular recreation values on the Mataura River, but defines it as a river 'requiring esplanade mechanisms'. Section 5.4 defines the rationale for this requirement, based on a schedule "prepared by the Southland Fish & Game Council – 2012" (Table 1).

Table 1: Mataura River esplanade requirements, Southland District Plan 2018 Table 16 section 5.4		
Waterway	Location	Comments
Mataura River	Nokomai River confluence to DOC estate	Water Conservation Order applies
Mataura River	Nokomai River confluence to Tomogalak Stream confluence	Water Conservation Order applies
Mataura River	Tomogalak Stream confluence to Gore District boundary	Access points limited, Water Conservation Order applies
Mataura River	Gore District boundary to the sea	Legal access insecure, Water Conservation Order applies

Policy SUB.10 of the Plan notes (although the referenced schedule does not define the preferred esplanade type):

> *Esplanade mechanisms provide for the protection of conservation values of riparian margins, the maintenance of water quality and aquatic habitats and the enhancement of public access and recreational opportunities. In addition, esplanade reserves can provide access for waterway maintenance or bank stability works.*
>
> *Esplanade requirements vary, but generally reflect the nature and width of the waterway, its value for public access and recreation, its conservation value and the nature of adjoining land use. Schedule 5.4 of the District Plan lists the areas of coastline, lakes and rivers where esplanade mechanisms are required and the nature of that esplanade.*

The Southland District Council *Parks and Reserves (Open Spaces) Activity Management Plan 2018-2028* (2018) identifies one Council reserve on the banks of the Mataura River: the Wyndham Wildlife Refuge, noting its purpose for 'casual recreation and wildlife reserve', and the general description: "This reserve is located on the outskirts of the town adjacent to the eastern bank of the Mataura River. Provides a habitat for a large number of bird species." 'Utilisation' is described as 'unknown'.

The Council's *Open Spaces Strategy 2014-2024* is generic in nature and does not identify any specific activities in any setting.

2.5 Gore District Council

The Gore District Plan 2014 notes that the Mataura River is (section 2.21) "a significant waterway, of cultural and recreational importance. Most notably, it provides the habitat for the brown trout fishery for which the District is well known," and that it is one of only two outstanding natural features in the District. The Plan notes (2.2.2 (2)),

> *The Mataura River is a significant natural feature, however, that is best protected through the provisions of a regional plan. A non-regulatory role can be adopted by the Gore District*

Council in order to ensure that people are aware of its significance and the positive actions they can take to protect the values of the river.

The Plan also notes the status of the WCO (e.g. 2.2.6, 2.4.1).

Section 2.4.2 (Margins of Rivers and Streams, Issues) states that, "The Mataura River is a significant natural feature and some management of activities taking place on its margins is appropriate." With the objectives (2.4.3):

(1) To preserve the natural character of the margins of the Mataura River.

(2) To provide public access along the margins of the Mataura River where this is practical and can be safely undertaken without adversely affecting the use of adjoining land.

With the principal reasons (2.4.6):

(1) The Mataura River is a significant natural feature and land use activities on the margins of the River could give rise to significant adverse effects.

(2) To enable the provision of public access to the Mataura River for the enjoyment of the recreational, cultural and landscape values, except where this will affect public health or safety, or where site security would be compromised.

"Public access to the Mataura River and access for licensed sports fishers to the Waikaka Stream and their margins is considered important" is described as one of five issues to be addressed in the Plan's section 8, Subdivision of Land; with the relevant policy 8.4 (6): "Provide public access to and along the Mataura River by way of esplanade strips."

The *Gore District Council Parks, Recreation and Facilities Strategy 2013* does not identify any specific recreation activities on the Mataura River, but notes its role in providing the opportunity for riparian 'Linkage Parks' with development standards (2.4.3) "to provide corridors of land to provide access to and along waterways, and to provide for pedestrian and cycle activities". No formed or surfaced tracks or paths are proposed within the development standard for these areas ('grass only').

The *Gore District Council Reserve Management Plan 2016,* while identifying several river-side reserves all upstream of Mataura (Richmond Street Community Centre, Richmond Street Recreation Reserve, Woolwich Street Walnut Plantation), identifies only terrestrial recreation uses, including: dog exercising, freedom camping, Remotely Piloted Aircraft Systems (drones etc), picnicking, events, walking and cycling.

The *Gore District Physical Activity Strategy 2007* identifies the Mataura River, within a review of facilities and opportunities in the District as a, "world renowned brown trout fishing river. It also offers water sport opportunities such as kayaking and opportunities for walking and picnicking on the river bank." A survey of residents' levels and types of recreation participation was undertaken to support the development of the strategy, with a 6% response rate (310 completed questionnaires from 5200 ratepayer households, with a 1% response rate for Mataura). The results should be considered as only indicative. Swimming was the most popular activity amongst respondents (n=66), but the questionnaire did not identify if this was in a pool or natural setting. Only 6 respondents named fishing as an existing activity, and 2 for kayaking. Twenty-one percent of respondents stated they participated in 'water based outdoor recreation', although this was not defined further. Reasons for not participating in more physical activity were largely personal, with no environmental issues noted (i.e. time, cost, ability, no one to do it with, transport, don't want to, facilities and skills / knowledge). Swimming was the main activity respondents wanted to do more of, although the preferred setting (pool or natural setting) was not identified.

2.6 Southland Regional Council

The *Southland Regional Policy Statement 2017* references the WCO on the Mataura River ("National Water Conservation Orders on the Mataura and Ōreti Rivers also reflect the national significance of these water bodies, particularly as brown trout fisheries" (1.2)), but otherwise only references recreation values in general terms, for example (1.2):

> *The national parks, rivers and lakes and wilderness areas in Southland attract local residents as well as national and international tourists. The recreational and tourism opportunities provided by the trout fisheries, tramping tracks, wildlife and other natural resources benefit both the health and wellbeing of the community and the local economy.*

The *Regional Water Plan for Southland 2010* defines the Mataura River as (5.1.1 (3)) a surface water body "other than in Natural State Waters", with the objective:

> *To maintain and enhance the quality of surface water bodies so that the following values are protected where water quality is already suitable for them, and where water quality is currently not suitable, measurable progress is achieved towards making it suitable for them.*
>
> *In surface water bodies classified as mountain, hill, lake-fed, spring-fed, lowland (hard bed), lowland (soft bed) and Mataura 1, Mataura 2 and Mataura 3:*
>
> *(a) bathing, in those sites where bathing is popular;*
>
> *(b) trout where present, otherwise native fish;...*

The Water Plan notes the potential for toxic cyanobacteria and nuisance algal growths to (5.2.1 Policy 6), "make the surface water body undesirable for swimming, clog water intakes, clog whitebait nets, degrade benthic invertebrate communities or impair spawning habitat for native fish" with specific reference to the Mataura River for cyanobacteria.

Policy 8 (5.2.1) in reference to discharges to water states that:

> *...it should also be noted that some rivers are used for example by certain fish species i.e. long fin eels during migration and by recreationists for kayaking at high flows, especially the Upper Mararoa, lower Waihōpai, parts of the Mataura and parts of the Waiau. Discharges at high flows may therefore conflict with some recreation and habitat values and may not always be appropriate.*

Appendix K of the Water Plan identifies 'popular bathing sites' to which various policies and standards are applied to ensure (3.1 (4)):

> *The water quality of surface water bodies will be maintained and enhanced so that it is suitable for bathing in popular bathing sites, trout and native fish, stock drinking water and Ngāi Tahu cultural values, including mahinga kai.*

Each of the sites is defined as encompassing the waters immediately under the relevant bridge and 100 metres upstream and downstream, and includes only the Gore Bridge on the Mataura River.

The *Regional Water Plan* controls the placement, use and maintenance of whitebait stands via its Rule 34. This is reviewed in section 3.6 of this report.

The *Proposed Southland Water and Land Plan (Decisions Version, 4 April 2018)* does not provide additional detail about specific recreational activities on the Mataura River, but does expand the list of popular bathing sites (in Appendix G) to include:

- Mataura River at Gore Bridge
- Mataura River at Riversdale
- Mataura River at Mataura River Bridge

- Mataura River at Woolwich Street Reserve

The *Mataura Catchment Strategic Water Study* (Hughes *et al* 2011) refers only to angling on the Mataura River, in accordance with the Water Conservation Order, and contact recreation standards in general terms; and refers to studies on other waterbodies which sought to assess the market value of freshwater fishing. No additional research into other recreation values on the Mataura River was undertaken.

3 Activity specific data

3.1 Public access

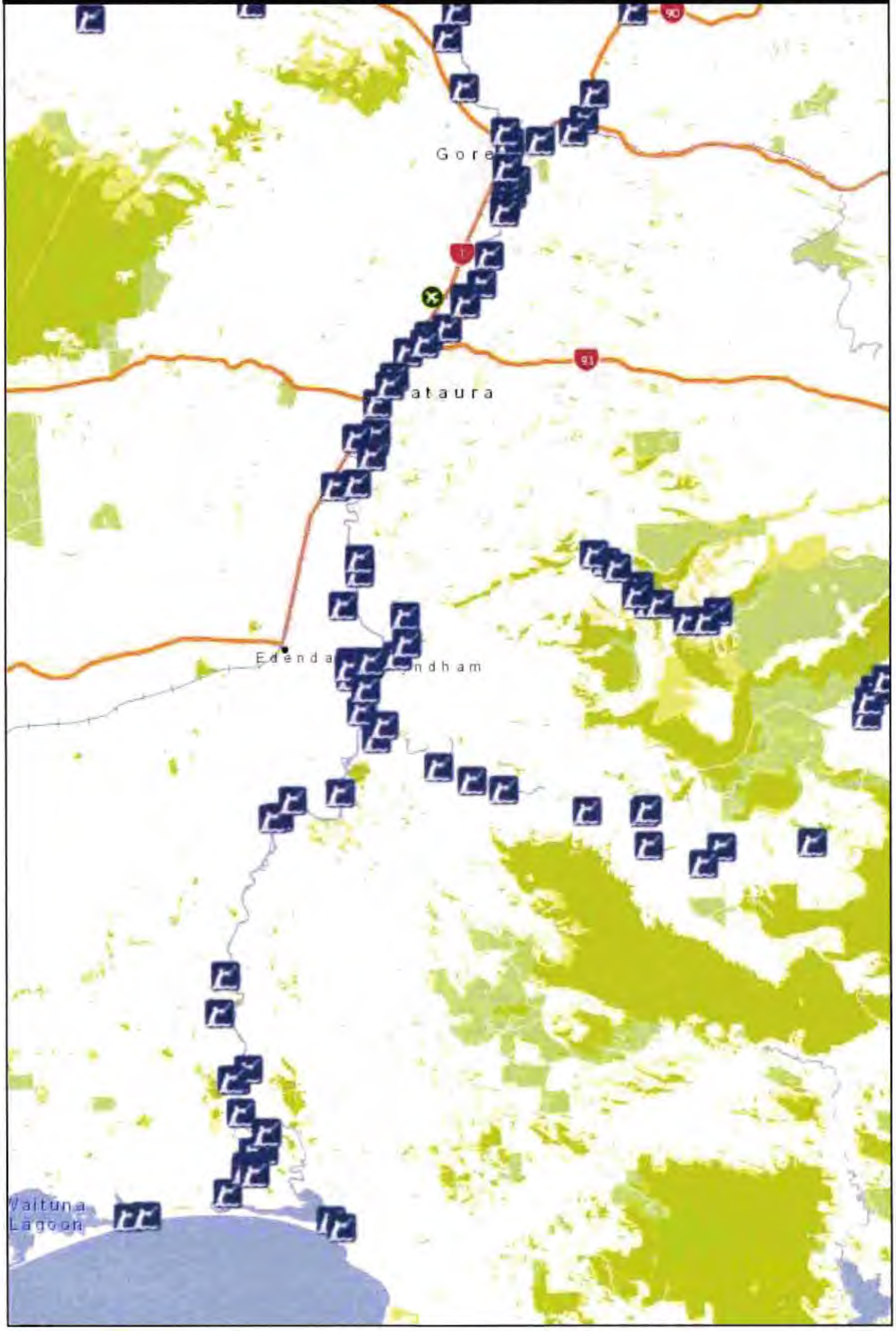
Figure 2 shows an example of the forms of public access available adjacent to the Mataura River, and the degree to which the location of the River has, in places, deviated from contact with these. Figure 2 is sourced from the Walking Access Commission's online Walking Access Mapping system (WAMS), which is derived from an algorithm-based query of Land Access New Zealand property database. This results in an incomplete data-set since publicly accessible land can be held via a variety of different mechanisms – including unencumbered freehold Council land – which are not picked up by the query. There is also – at the national level – very little compiled data about the location and access opportunities provided by easements in favour of the public over private land. Perambulatory esplanade strips are also not shown. The WAMS data are therefore only a starting point for any review of access options.

The Southland Fish & Game Council has compiled the most comprehensive analysis of access opportunities on the Mataura River, and these are presented in the Council's Mataura River access map, attached as Appendix 2 to this report, and which are replicated in a WAMS mapping layer provided by Fish & Game (Figure 3). The Mataura River is described as having 'insecure' legal access between Gore and the sea by the Southland Fish & Game Council in the Southland District Plan (see section 2.4 of this report).

In summary, public access to and along much of the Mataura River is based on, mostly, legal road – formed and unformed – with bankside access up and downstream from those points; with riverside reserve areas in most settlements and at several points between. Downstream of Mataura there is a handful of developed reserve or picnic areas: the managed berms and banks in Mataura; the riverside and Wyndham Scenic Reserve on the true left at the end of Pollock Road; the angler access area on the true right off McCall Road; and the Fortrose parking and boat launching areas. There appears to be very few areas of esplanade reserve adjacent to the River.

Figure 2: Mataura River public access example – Winton. Source: WAMS

Figure 3: Lower Mataura River angler access. Source WAMS / Southland Fish and Game



3.2 Trout and salmon fishing

Fish & Game Southland briefly describes the Mataura River on its website, and the fishing rules (Table 2):3

> *The Mataura is New Zealand's most fished brown trout river. It is a large long river with hundreds of places that provide excellent trout fishing.*
>
> *Like all Southland rivers, perhaps even more so, its trout are difficult to catch for the newcomer, and even for the experienced angler catching trout on this river requires skill and local knowledge. The skill has to be learned but local knowledge can be gained from Southland Anglers who are usually willing to provide advice.*
>
> *Fish and Game and local sports are good places to start. Many locals use worms to fish for Mataura trout but visitors prefer fly fishing. On the Mataura there is room for all.*

Table 2: Mataura River and relevant Southland fishing regulations 2018/19

Section	Open Season	Method	Daily bag limit
Mataura River and tributaries upstream of Hume's Road Bridge, Garston	1 Oct – 30 Apr	Fly, spinner	1
Mataura River– Garston Bridge to the Gore Bridge	1 Oct – 30 Apr	Fly, spinner, bait	4
Mataura River – the Gore Bridge to the Gorge Road Bridge	1 Oct – 31 May, excluding 4 and 5 May 2019	Fly, spinner, bait	4
Mataura River – the Gorge Road Bridge to sea	All year	Fly, spinner, bait	4
A person must not fish from any boat or any form of flotation device in the Mataura River upstream from the Mataura Island Bridge			
A person must not take (or attempt to take) salmon from any river during the months of April and May			
Fishing for coarse fish in all waters in Southland region is prohibited			
No person shall in any one day take, kill or be in possession of more than 1 salmon from any waters of the region			

Unwin (2013) is a survey of relative national angling river values based on an update of the survey methodology used in the national angler surveys of the 1979/81 season (Richardson *et al* 1984, for example) and a pilot survey undertaken in the Otago and Nelson/Marlborough F&G regions (Unwin 2009). The survey was distributed online to a random sample of 11,923 whole-season and family licence holders for the 2011/2012 angling season. Parallel telephone surveys on non-respondents in the Southland, Wellington, and Hawkes Bay regions were completed to test for sample bias.[4]

Respondents were asked to identify rivers they had fished over the last 3-5 years, to rate their enjoyment of the fishery on a scale from 1 (least enjoyable) to 5 (most enjoyable), and to identify up to three reasons, from a list of ten, why they fished each river. These were: Close to home, Close to holiday home, Easy access to river, Plenty of fishable water, Scenic beauty, Wilderness feeling, Angling challenge, Expect good catch rate, Chance to catch trophy fish, Other (including a brief description).

[3] https://fishandgame.org.nz/southland/freshwater-fishing-in-new-zealand/fishing-locations-and-access/

[4] Unwin (2013) reported: "Online respondents were more active than telephone respondents, fishing more rivers (11.9 vs. 4.2 rivers per respondent, respectively), in more regions (2.4 vs. 1.5 regions per respondent, respectively), but were more conservative when ranking rivers according to their level of enjoyment. A likely explanation is that respondents who took the effort to respond to the online survey, who represent only 14.9% of the recipients, were more committed anglers than telephone respondents, who represented 71% - 92% of those interviewed. The pooled online responses therefore provide comparative data on New Zealand rivers as assessed by a large pool (1,650) of experienced river anglers, akin to the views of an expert panel."

Summary scores for enjoyment level, and for nine of the ten reasons why respondents fished each river (excluding "Other"), were generated for all rivers. The enjoyment level was calculated as the numerical average of the individual 1-5 ratings. Scores for each reason (or attribute) were generated by expressing the number of respondents who had nominated that reason as a fraction of the total number of respondents who had fished each river, yielding an attribute score from 0-1.

The Mataura River above Gore was ranked (out of 38 popular rivers in Southland):

- 1st for level of use,
- 5th equal for enjoyment,
- 19th for close to home,
- 24th equal for close to holiday home,
- 6th equal for ease of access,
- 1st for area fishable,
- 29th equal for scenic beauty,
- 27th equal for wilderness feeling,
- 25th equal for angling challenge,
- 3rd equal for anticipated catch rate,
- 10th for anticipate large fish.

The Mataura River below Gore was ranked (out of 38 popular rivers in Southland):

- 2nd for level of use,
- 13th equal for enjoyment,
- 15th equal for close to home,
- 24th equal for close to holiday home,
- 10th equal for ease of access,
- 2nd for area fishable,
- 36th equal for scenic beauty,
- 31st for wilderness feeling,
- 32nd equal for angling challenge
- 2nd for anticipated catch rate,
- 20th equal for anticipate large fish.

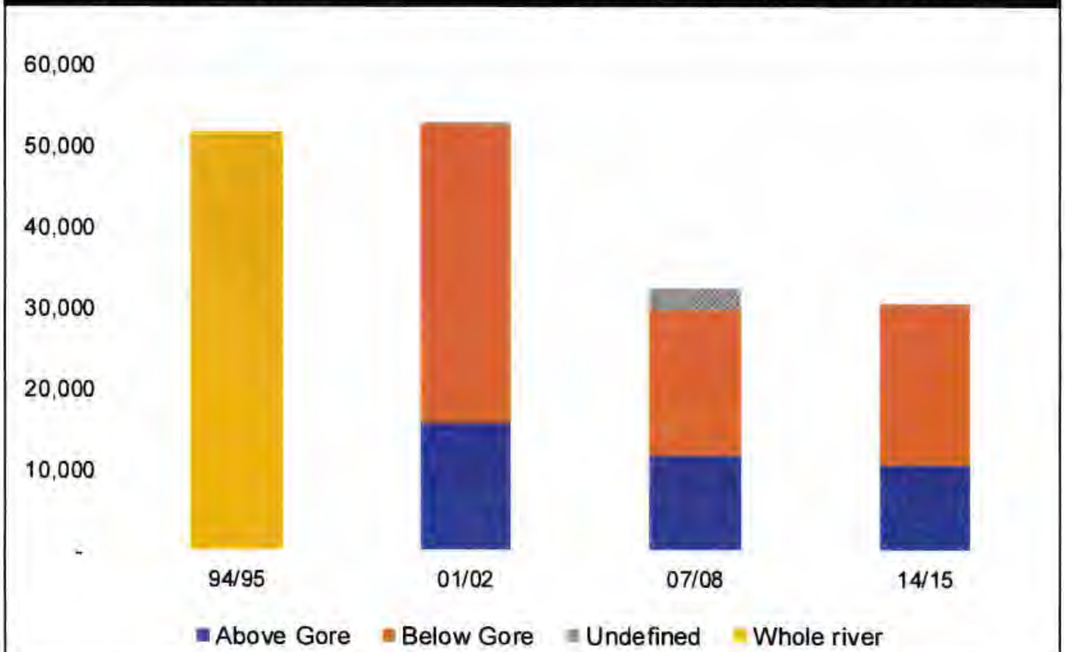
Table 3: Values of New Zealand angling rivers - Otago. Source: Unwin (2013).	Total responses	Mean Enjoyment Score	Close to home	Close to holiday home	Ease of access	Area of fishable water	Scenic beauty	Wilderness feeling	Angling challenge	Anticipate good catch rate	Anticipate large fish	Other
Mataura River above Gore	188	3.03	23%	7%	50%	60%	9%	5%	25%	40%	10%	3%
Mataura River below Gore	171	2.71	27%	7%	47%	58%	4%	1%	19%	42%	6%	2%
Mean (all Southland Rivers)	40	2.58	24%	10%	31%	27%	34%	28%	35%	20%	8%	4%
Mean (all NZ rivers)	**41**	**2.38**	**27%**	**10%**	**33%**	**29%**	**32%**	**25%**	**32%**	**16%**	**8%**	**4%**

Unwin (2016) reports on multiple years of angling data for the Mataura River, based on the periodic and comprehensive national angler surveys carried out by NIWA for the NZ Fish & Game Council. Figure 4 shows the survey results for the Mataura River for four national surveys since the 1994/95 angling season for New Zealand resident anglers, in angler days (any period fishing on one day – be it 10 minutes or 10 hours – is considered an 'angler day'). This shows a significant decrease in the level of angler activity on the River since the 2001/02 season, particularly on the River downstream of Gore. Anglers were not asked which section of the River they fished in the 1994/95 survey, and some responses in the 2001/02 and 2007/08 were not assigned to one reach (shown in grey). Overseas anglers were not canvassed effectively prior to the 2014/15 season.

Unwin reports (2016), for the 2014/15 season:

> *Total effort for the Southland region in 2014/15 was 122,660 ± 6,010 angler days, distributed over 57 river fisheries and 14 lake fisheries in 14 catchments. The fishery was dominated by the four main catchments which traverse the Southland region from north to south: the Mataura (44,270 ± 3,610 angler-days; 36% of the regional total); the Waiau*

Figure 4: NZ Angler days on the Mataura River by section, 1994/95 to 2014/15

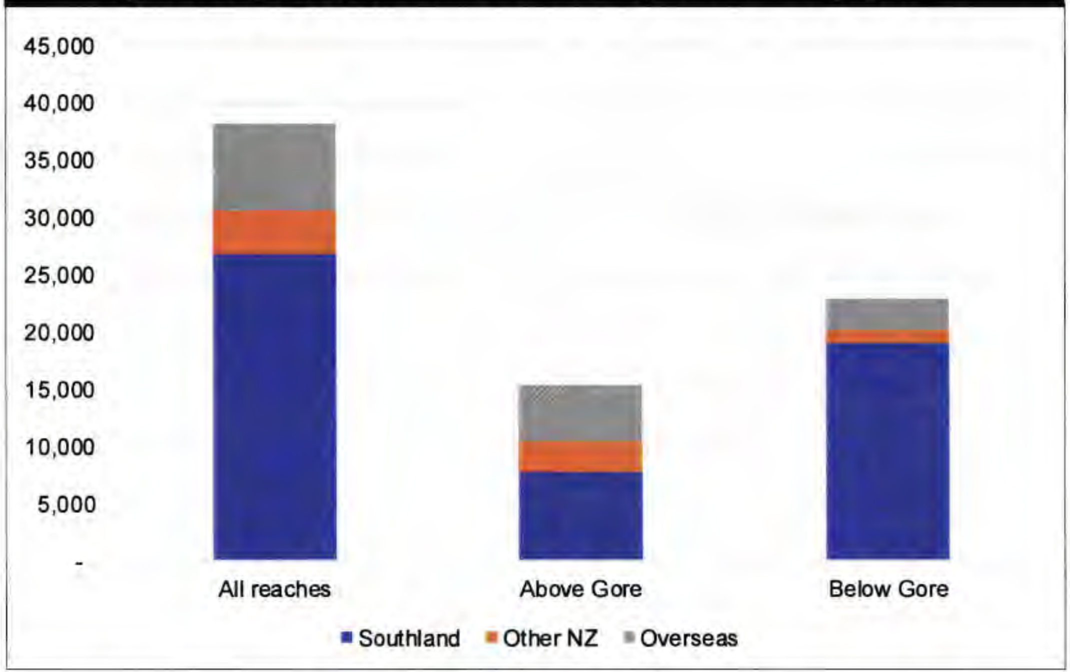


(43,120 ± 3,170 angler-days; 35%); the Oreti (18,110 ± 2,090 angler-days; 15%); and the Aparima (10,160 ± 2,220 angler-days; 8%). River fisheries accounted for 90,990 ± 5,310 angler-days (74% of the regional total), and lake fisheries for 31,670 ± 2,830 angler-days (26% of the total)....

On the Mataura River, visitors (overseas anglers and Kiwis from regions other than Southland) accounted for 49% of total effort above Gore (7,560 ± 1,040 of 15,280 ± 1,580 angler-days), compared to 17% of total effort below Gore (3,880 ± 750 of 22,980 ± 3,090 angler-days) (Figure 5). Unwin (2016) reports:

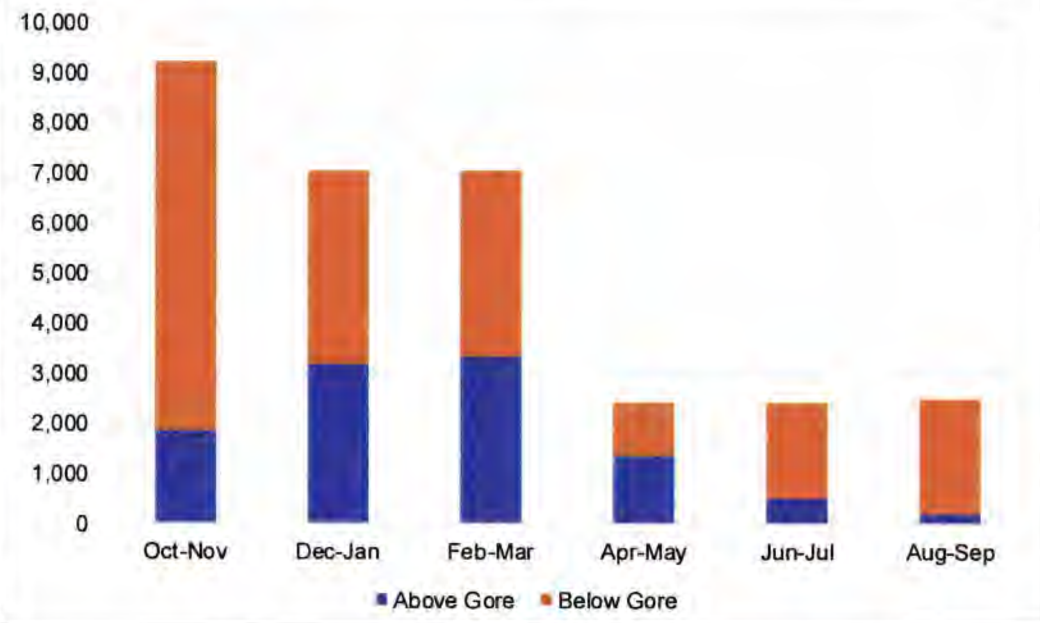
Data for visiting anglers from other New Zealand regions also help to illuminate the longitudinal distribution of usage on the three Southland rivers – the Mataura, Oreti, and Waiau – which were subdivided into multiple reaches for survey purposes. On both the Mataura and Oreti most effort (60% and 81%, respectively) was recorded on the lower reaches. However, whereas Southland anglers tended to favour the lower reaches of both rivers, visiting anglers tended to focus on the upper reaches. On the Mataura River, visitors accounted for 49% of total effort above Gore (7,560 ± 1,040 of 15,280 ± 1,580 angler-days), compared to 17% of total effort below Gore (3,880 ± 750 of 22,980 ± 3,090 angler-days).

Figure 5: Angler days on the Mataura River by reach and origin, 2014/15



Angling occurs throughout the year, with a peak late in the year and over the warmer months (Unwin 2016) (Figure 6).

Figure 6: NZ Angler days on the Mataura River by period and reach, 2014/15



Kent (2009) describes the Mataura River in his comprehensive angling guide to the South Island in three sections: above Cattle Flat, from Cattle Flat to Gore and from Gore to the sea. The latter two descriptions are given here:

Middle reaches (Cattle Flat down to Gore)

This is the most popular stretch of river, although the water quality deteriorates and sight fishing is no longer an option. Overseas anglers, especially those from the US, enjoy this section as, like many American rivers, the water itself must be fished, unless of course trout are rising. The riverbed is still predominantly gravel, the mud banks are covered with grass and willows, and there is a healthy stock of browns that average around 1 kg. However, there is the occasional fish up to 4 kg. Above the Waikaia confluence the river can be waded and crossed in normal conditions, but below this confluence it swells to the point where crossings become more hazardous. Trout can be more selective from this point down and there are some interesting backwaters to explore that often remain clear when the main river is discoloured. Use the same flies as suggested for the upper Mataura, with the addition of midge pupa and corixa, especially in the backwaters. During the 'mad Mataura rise', try a small, unweighted, dark-bodied nymph or a soft hackle wet fished dead drift. Use a small indicator or even a small Parachute Adams that is easily visible. When the trout are unresponsive, try seining the river to determine the food source then operating on a fly with a pair of scissors to match the hatch.

Lower reaches (Gore to the mouth)

The best water lies upstream from Mataura Island, as below this point the river becomes channelled and unattractive. The river is much larger and deeper in this section, with an occasional coal reef altering the character of the riverbed. There are long glides and willows, with very high numbers of trout present. Some of these are large but they often remain difficult to catch. Use the same mayfly, caddis, midge pupa and corixa imitations as above with even a Black and Peacock for snails. Spin and live bait anglers enjoy good success in these lower reaches, especially when whitebait are running.

Kent & Madsen (2003) include the Mataura River in their book *New Zealand's Top Trout Fishing Waters*, with very similar text to Kent (2009).

The Southland Fish & Game Council angler access map for the Mataura River (see Appendix 2, no date) describes the River:

The Mataura is one of New Zealand's most famous fishing rivers. Some claim it is the best fly fishing river in the world, others would beg to differ.

The most famous feature of the Mataura is its hatches of mayfly. Whilst other New Zealand rivers trend to have sporadic hatches in the evenings the Mataura often produces consistent hatches that can start at 10am and last through until nightfall!

Millichamp (2013) in his comprehensive and authoritative guide to salmon angling in New Zealand describes the salmon fishing resource on the Mataura:

MATAURA RIVER
Median flow: 71 cumecs
Recent runs: 20-100 fish
Historical maximum run: 100 fish
Angler days/year: 40 260
Best fishing: January-March

The Mataura is one of New Zealand's best trout fisheries but has only a small salmon run, which attracts interest from local anglers. Most of the targeted salmon fishing takes place immediately below the Mataura Falls at the Mataura township, which restrict fish passage when the river is low. When the river rises, the fish run past the falls and seem to disappear. Some are caught as by-catch by trout spin anglers, which is not surprising given the huge number of angler days spent on the river each season.

3.3 Kayaking and rafting

The 5th edition of *New Zealand Whitewater: 180 Great Kayaking Runs* (Charles 2013) - the only published current popular guide for kayaking – does not reference kayaking on the Mataura River.

Egarr (1995) in an earlier and more comprehensive kayaking guide describes limited kayaking options on the Mataura:

There are three significant rivers flowing into Foveaux Strait from the Southland countryside - the Aparima, the Oreti, and the Mataura. None of the tributaries of these three rivers are of sufficient size to attract whitewater paddlers. The Aparima and Oreti are the smaller rivers, and are much alike in that they flow in shallow beds over alluvial shingle, bordered by willows and man-made flood protection works, flood banks and groynes. Their channels have been straightened. In summer the countryside is dry and the rivers nearly reduced to a trickle. With rain they flood quickly with very fast currents, and will spread out into the willows. Gradients are low and rapids almost non-existent.

The Mataura River also lies in a shingle bed for most of its length, but being larger than either the Aparima or the Oreti, contains a reasonable flow of water for the whole year. It is best known as an excellent trout-fishing river. Between Athol and Tomogalak (the Waikaia Plains), the Mataura Gorge is without significant rapids. From the Tomogalak River confluence the Mataura spreads over a wide shallow shingle bed. It does not regain sufficient depth for river trips until near Gore, where occasional outcrops of rock appear in the river bed. At high flows, these have the potential to create some rapids of around grade II difficulty.

Near the meat processing plant and papermill at Mataura there are two notable rock outcrops. The first creates a rather nasty weir across the river, with a drop of around a metre. Some 200m downstream is another rock outcrop, which creates a small waterfall. These falls were used in the past for water supply and energy generation and there are *man-modified intakes on both banks. Some building debris makes these falls potentially dangerous. There are no other notable rapids on the river. Immediately below Gore, the Mataura has been used by canoeists and is considered to be an ideal trip for the less experienced. The water is, however, rather polluted below Mataura.*

The Southland Canoe Club describes the 'Mataura River Run' online (one of only four runs listed by the Club):[5]

Get in is at the Tuturau Reserve about 5km south of Mataura on the east or river left. Get out is at an anglers access at the southern boundary of the Gore District Council.

The Mataura run is a fun, social flat grade 2.

The run should take a couple of hours allowing you to play on fun waves along the way.

Rafting on the Mataura River does not appear in any literature or online.

3.4 Swimming

There are no published data to indicate the scale and location of swimming on the Mataura River. The *Proposed Southland Water and Land Plan* (Decisions Version, 4 April 2018) lists 'popular bathing sites' (in its Appendix G) including, on the Mataura River:

- Gore Bridge
- Riversdale
- Mataura River Bridge
- Woolwich Street Reserve

The Regional Council monitors bathing water quality at Riversdale and Gore, with the standard reported as 'unsuitable for swimming' at late March 2019 (Figure 7). Ward (2015) (see section 4.1) indicates that swimming is a popular activity regionally, but does not indicate where swimming occurs.

A review of bathing water standards in the Mataura River over time is provided by Dada (2018) and is discussed in section 7 of this report.

Figure 7: Bathing quality monitoring sites and state (LAWA, April 2019)

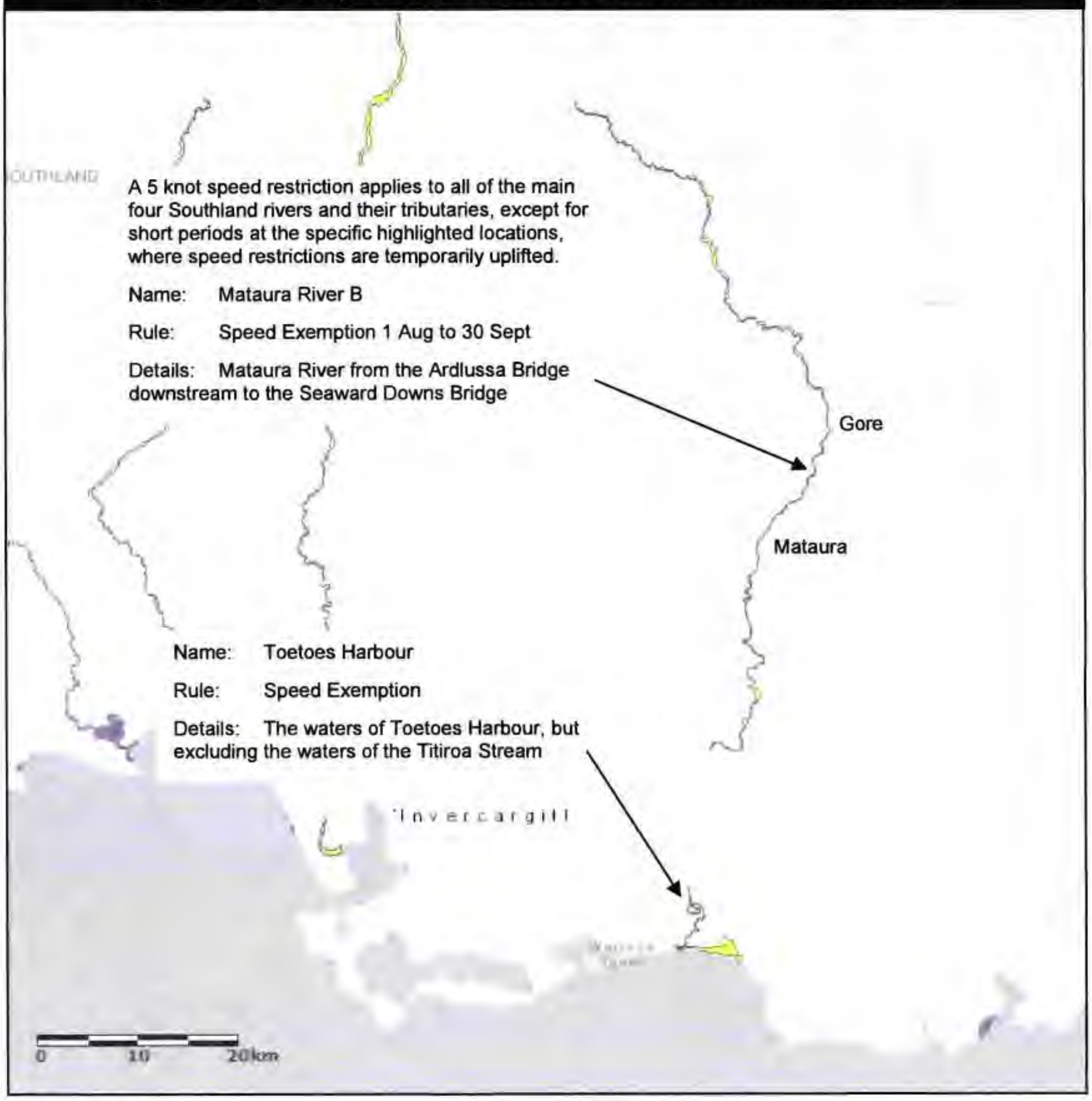
[5] https://sites.google.com/site/southlandcanoeclub/mataura-river-run

3.5 Jet boating

Jet boating is only possible on rivers where vessels are permitted to travel at more than 5 knots (just over 9.2 kph) within defined areas. Regional navigation safety bylaws generally restrict speeds to less than 5 knots within 200 metres of the shore or any structure (amongst other things), which means jet boats would never be able to get to planing speed without an 'uplift' of this restriction. The *Southland Regional Council Navigation Safety Bylaws 2009 (revised 2015)* enables jet boating on the Mataura River for a two-month winter period between the Ardlussa and Seaward Downs Bridges, all year in the Toetoes Harbour, and all year within a 300m section of the River south of Gore:

> *Vessels navigating the waters of the Mataura River shall be exempted from the Operating Requirements with regard to Speed of Vessels (clause 3.2.1 (a) and (b)) for the areas and duration detailed below:*
>
> *(a) all the area of the Mataura River downstream of the* [former] *State Highway 92 road bridge to the sea, including all the waters of Toetoes Harbour, but excluding the waters of the Titiroa Stream as shown in Schedule 11, Map 3;*
>
> *(b) for the period of 1 August to 30 September inclusive of each year all the area of the*

Figure 8: Speed uplifts on the Mataura River. Beacon online GIS (SRC)

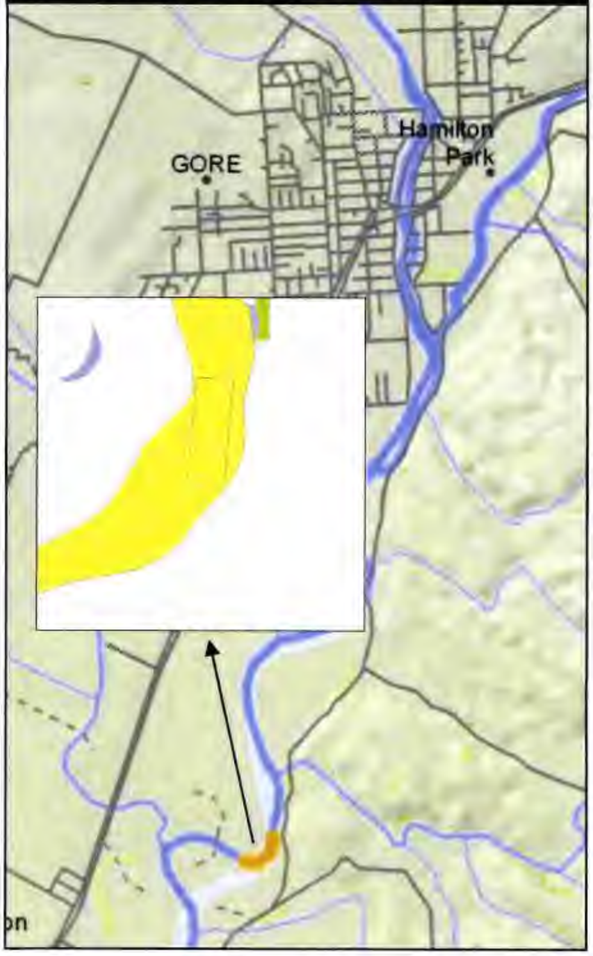


Mataura River from the Ardlussa Bridge downstream to the Seaward Downs Bridge as shown in Schedule 11, Map 3;

(c) within the area of water 300 m long and 100 m wide, 4.8 kilometres downstream from Gore at Beattie's Beach as shown in Schedule 11, Map 4.

Map 3 in the Navigation Safety Bylaw erroneously shows an uplift on the entire River downstream of the Ardlussa Bridge, while the Environment Southland online Beacon GIS service shows the relevant section accurately (Figure 8).[6] Map 4 of the bylaw vaguely shows the relevant uplift section south of Gore at Beattie's Beach in orange, and is more clearly defined by the GIS as a rectangle (or perhaps a rhombus) within the River (Figure 9).

Figure 9: Map 4 detail, GIS inset



The Jet Boating New Zealand *Safety/Year Book* (2013) notes the uplift rules and notes:

> *The Falls at Mataura Freezing Works are not boatable. Gore Bridge to Mataura Falls not recommended due to obstructions except within the area 300m long, 4.8 kilometres downstream of Gore at Beattie's Beach. Classes 2 – 3* [more advanced boating/comfortable after 1 season – difficult/adventure/skill required/families not recommended] – *shingle / boulders / willows / coal. Launch sites: Ardlussa Bridge, and Gore*

[6] http://gis.es.govt.nz/index.aspx?app=navigational-safety-bylaws

3.6 Whitebaiting

The whitebait fishing season for Southland (and most of New Zealand) opens on 15 August and runs until 30 November. Fishing is only permitted between 5:00 am and 8:00 pm, or between 6:00 am and 9:00 pm when New Zealand Daylight Saving is being observed.[7]

Recreational whitebaiting is generally a poorly researched activity. Environment Southland completed a survey of 600 registered whitebait stand holders in 2013, but this only considered consented stand holders (with a 17% response rate) and did not include those using other methods such as hand-held nets. The only comprehensive review of whitebaiting in the South Island was carried out in 1988 for MAFFish (Kelly 1988) – although those findings are likely to still hold in general terms. Kelly described whitebaiting in Southland generally:

> *There is no doubt that the rivers of Southland support a recreational whitebait fishery and a significant commercial whitebait fishery. Commercial whitebaiters are mostly seasonal workers and retired people who seek to augment their income from their catch. They usually live in a caravan or bach close to their fishing site, so can fish every day. A notable feature of the fishery is the use of platforms or stands from which whitebaiters fish. The stands are now registered with the Department of Conservation* [now the Regional Council]. *The majority of Southland whitebaiters could be classed as recreational fishermen, although many sell their excess catch.*
>
> *Competition for a good fishing site is fierce. The commercial operators work the best sites on the lower river, with the result that the recreational fishermen who don't live on site tend to get pushed up-river. Whitebaiters may also be found fishing beaches, river mouths and bars. Using scoop nets, they commence fishing just after low tide and continue till high tide.*

Kelly described the Mataura River as having a large commercial component with 222 registered stands at the time:

> *This river is also* [in addition to its 'more famous' trout fishery] *the most important whitebaiting river Southland. An average number of 200 whitebaiters per day is usual (R.A. Johnson pers. comm.), but on the first day of the 1984 season, 300 nets were being fished on the Mataura, with 500 people in attendance.*
>
> *The majority of whitebaiters fishing the lower reaches of Mataura could be classed as commercial operators. Many camp on site the whole season and fish from private stands. Large conical set nets are used, together with screens, and are set into the current. The catch rates are generally good, with lifts of up to 2.5 kg of whitebait being common.*

Environment Southland controls the placement, use and maintenance of whitebait stands via its Rule 34. The Plan notes that, "Policy 13.17 of the Regional Policy Statement for Southland restricts the allocation of space for whitebait stands to those stands lawfully established as of 1 October 1993. The existing number of whitebait stands is considered to be sufficient to achieve the needs of present and future users. Therefore, the number of existing whitebait stands will not be allowed to increase." And:

> *Most whitebait stands in Southland are located within the coastal marine area and are controlled through the provisions in the Regional Coastal Plan. Only twenty one stands are located outside the coastal marine area as at 1 November 2003. These stands are located within the Aparima and Pourakino Rivers and are controlled through the provisions of the Regional Water Plan, which is consistent with the Regional Coastal Plan….*

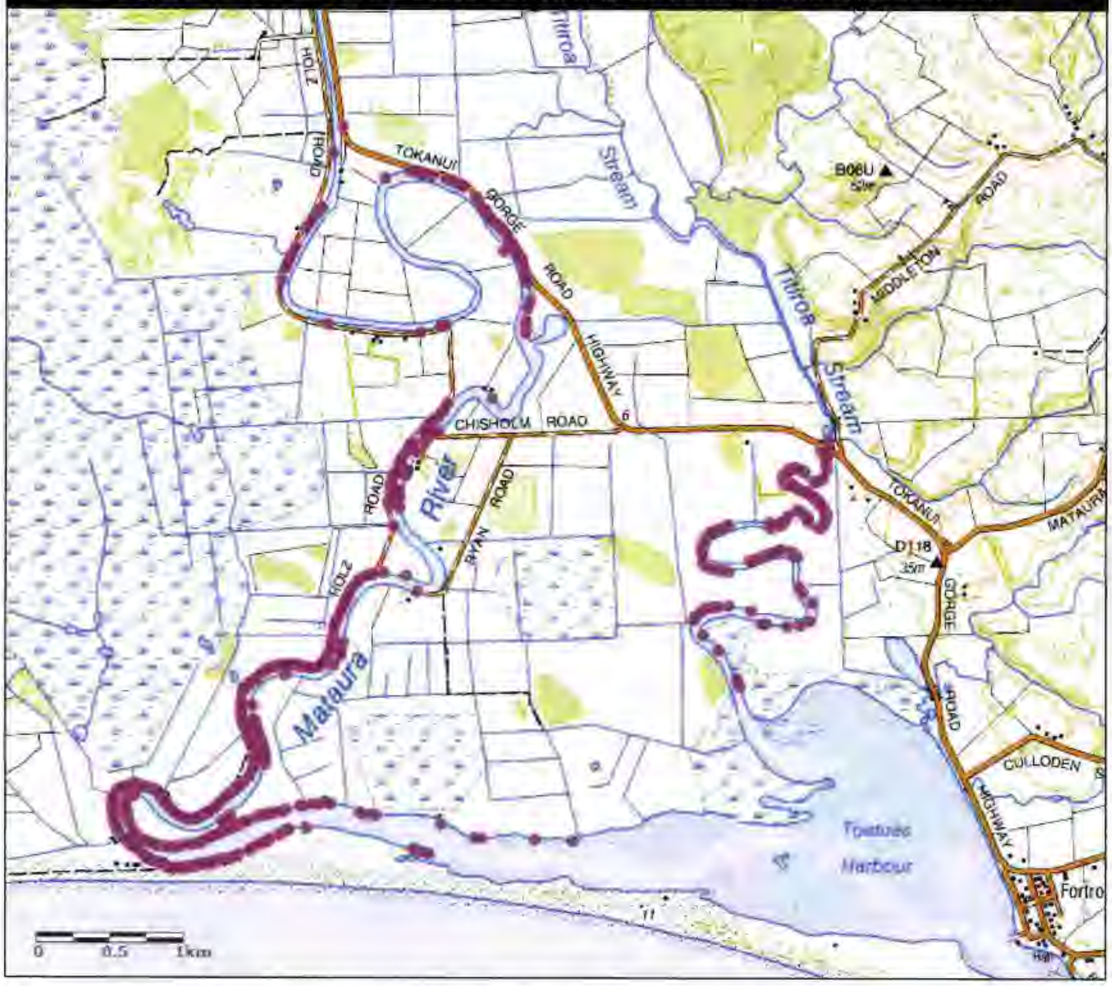
---

[7] https://www.doc.govt.nz/parks-and-recreation/things-to-do/fishing/whitebaiting/whitebait-regulations-all-nz-except-west-coast/

Where an existing whitebait stand needs to be relocated or replaced because it has been endangered or destroyed by changes to river bed or bank morphology, this may be allowed on a case-by-case basis through the resource consent process. The rule is not intended, however, to provide for the moving of stands to obtain a better fishing site, where it is still physically possible to use the old site. The replacement stand should be as close as practicable to the former site.

The Proposed Southland Land and Water Plan restricts the number of stands to those existing as of 1 June 2003. Consented stand locations are shown on the Regional Council's Beacon online GIS portal and all are more than 40 km downstream of Mataura (Figure 10).

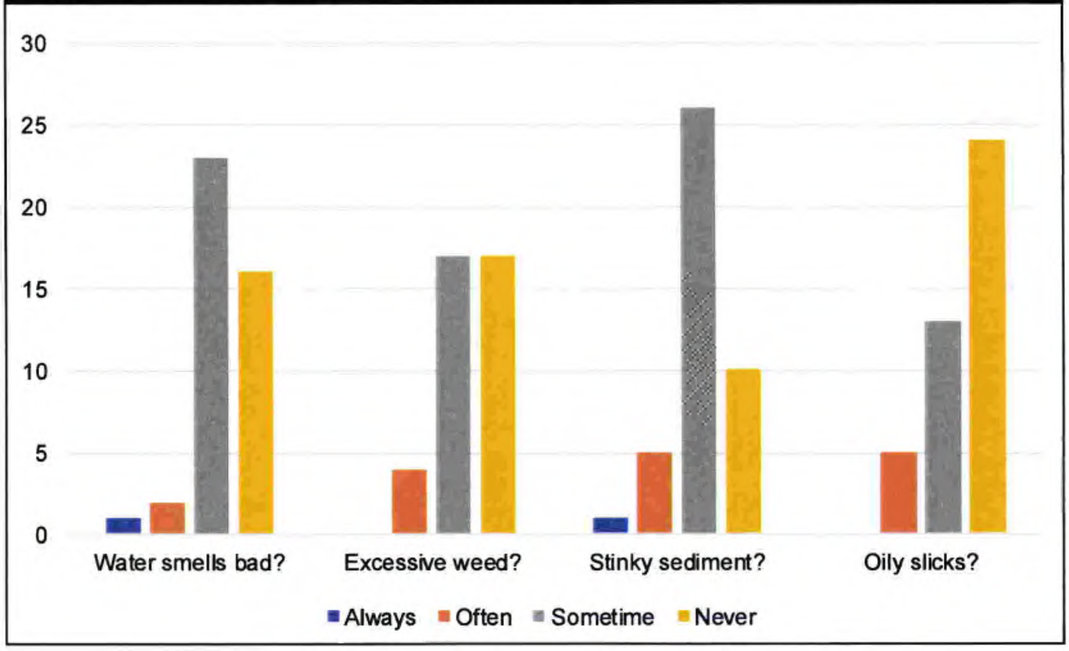
Figure 10: Consented whitebait stands, Mataura River and Titiroa Stream



Environment Southland completed a survey of 600 registered whitebait stand holders in 2013 with a response rate of 17%, 45 of whom had stands on the Mataura River (Environment Southland 2013). The questions aimed to establish, "an understanding of the time people spent whitebaiting, whether symptoms of poor water quality were being observed by whitebaiters, whether fishing diaries were being kept, and whether people were happy with access to whitebait stands."

Most respondents (62%) fished for between 3 and 6 hours per day, and between 100 and 200 hours per year. Figure 11 shows respondents' opinions about the frequency that they notice water quality issues. 'More whitebait' (55% of respondents) and 'better water quality' (50%) were the top two things which would improve the whitebaiting experience regionally. Satisfaction with the activity on the Mataura River was higher than for the Aparima River, and similar to the Titiroa Stream.

Figure 11: Mataura River whitebaiter perceptions of water quality (count). ES 2013



4 Other recreation research

4.1 Public Health South

Public Health South was contacted to identify any research that could indicate any issues with public health resulting from recreational contact with Mataura River water (Renee Cubitt, Health Protection Officer Public Health South, pers. comm.). Two reports were located.

The first was an investigation into three cases of suspected cyanobacterial toxin poisoning contracted by three people who swam in the Mataura River in early December 2017 approximately 400 m upstream of the Mataura Falls (Marshall 2018). All three men reported full submersion and ingestion of river water and one suffered renal failure and liver impairment. The investigation found:

> *The microbial monitoring result taken Monday 4th December for the Mataura River at Gore (approx. 15km upstream of site) by Environment Southland as part of their summer recreational water monitoring programme was within acceptable standards for bathing at 140 E.coli / 100mL. The result shared by the Alliance Mataura group from Tuesday 5th December nearby the site was also acceptable at 110 E.coli / 100mL.*
>
> *Upon discussion with Environment Southland, it was noted that recent flood waters from the Central Otago floods that severely affected Roxburgh around the 26th November may have been still flushing debris down tributaries flowing into the Mataura River. Both case A and B described seeing large amounts of 'dark brown clumps' of material floating past in the water and reduced water clarity when swimming on the 3rd of December....*
>
> *This common source outbreak appears to have been caused due to ingestion of contaminated water in the Mataura River over the weekend period of 2nd-3rd December, 2017. Unfortunately, the causative agent remains unknown, however it can be presumed that cyanobacterial toxins being the most likely source of illness based on the clinical presentation of the three cases and reported water condition of the Mataura River at the time of swimming.*

And

> *The Mataura River has a current SFRG (Swimming for Recreation Grade) 'D' rating and is rated 'totally unsuitable for recreation' at a monitoring site 22km downstream of Mataura township in a NIWA technical report. Recent studies by the Cawthron Institute show the Mataura River to have extremely high anatoxin concentrations when compared to other rivers nationally. Mataura also has no public swimming pool to provide a safe swimming alternative to the river.*
>
> *Despite the state of water quality in the Mataura River and lack of swimming options for its population, there are no warning signs erected at popular swimming spots within the township unlike other recognised recreational bathing sites in Southland. This lack of communication may have occurred due to Gore District Council not having an Environmental Health team to raise this issue, unlike other councils around Southland, who actively maintain recreational bathing warning signage.*[8]

The second reviewed the incidence and potential sources of Campylobacteriosis, Cryptosporidiosis and Giardiasis throughout the Southern DHB region from 2013 to 2017 (Public Health South, 2019). The report does not specify the rivers where recreational water contact could be attributed to the incidence of waterborne diseases; and in the data set used (EpiSurv), more than one risk factor could be attributed to each notified disease case – such as recreational water contact as well as

[8] The only swimming warning signs located on the River in January 2019 were at Fortrose (erected by Environment Southland) and 'no diving' signs at either end of the Mataura Bridge.

contact with diseased animals. The review also noted that only approximately 0.4% of acute gastroenteritis community cases result in a notification, which is a common statistic internationally.

The review suggests that the incidence of the three diseases are not unusually different across the territorial authorities in the Region (Figure 12) and that water contact recreation is one source of infection of many (Figure 13). Figure 14 (over-page) indicates that the Gore and Southland Districts have similar – and relatively unremarkable – disease incidence profiles for water contact recreation. The review indicates that the water source for contact recreation for all relevant data is based on rivers, beaches and lakes located anywhere in New Zealand (reporting occurs in the Region, but not necessarily the activity which caused the event).

Figure 12: Public Health South (2019) disease incidence by local authority

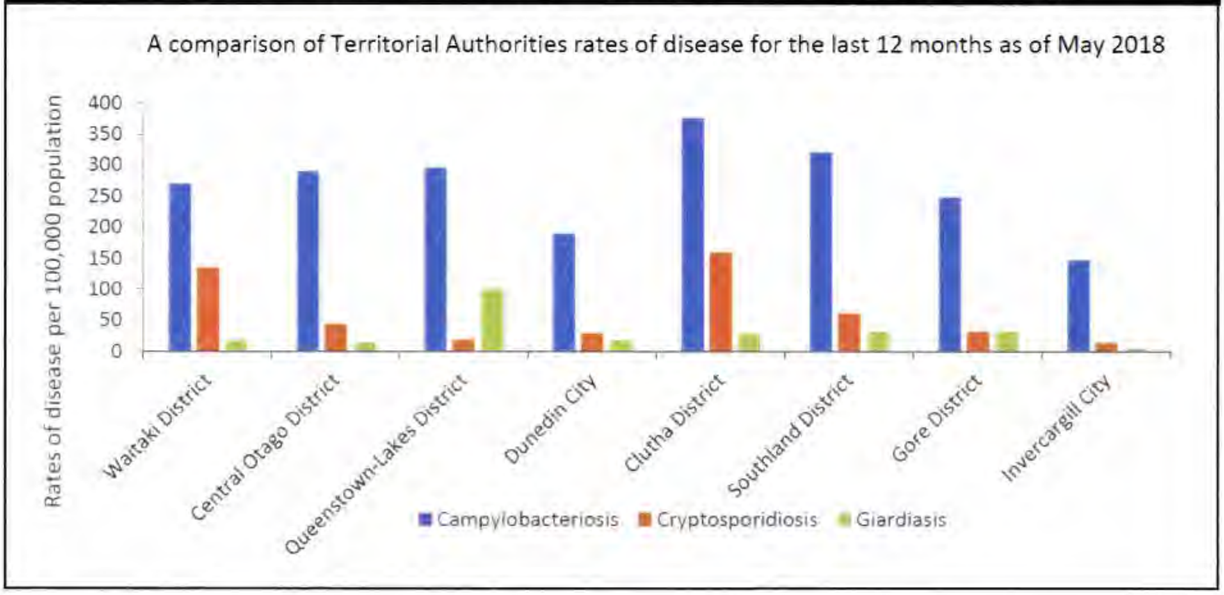


Figure 13: Public Health South (2019) disease incidence by risk factor

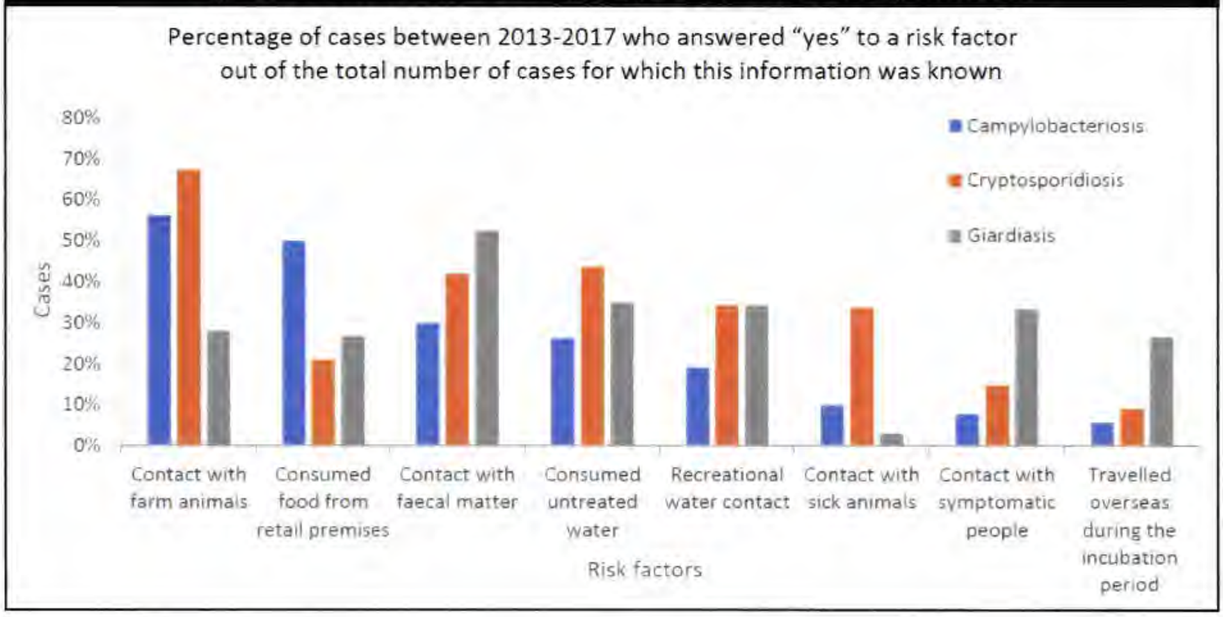
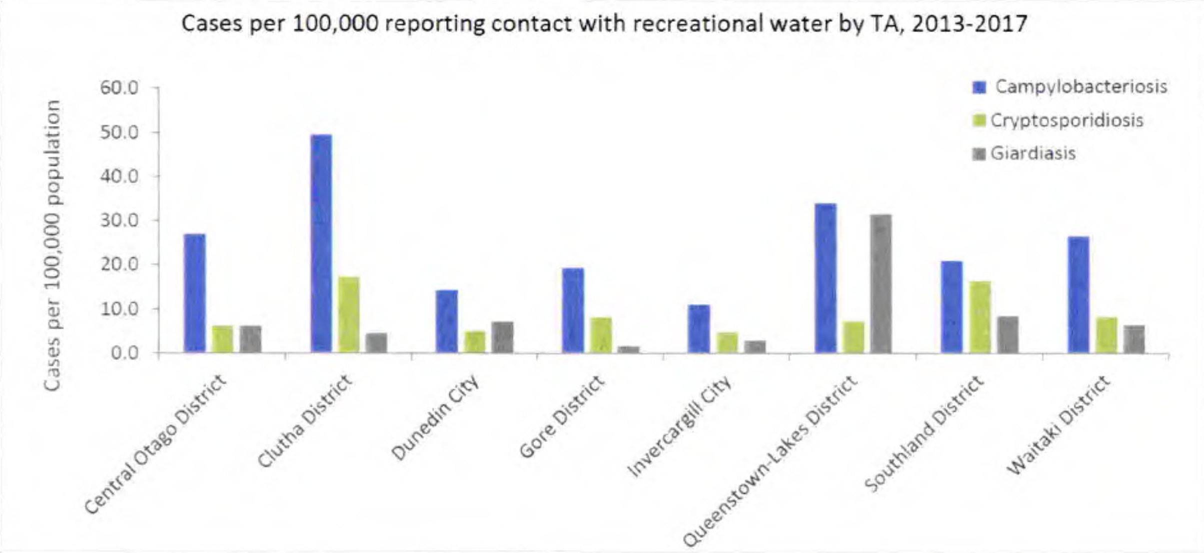


Figure 14: Public Health South (2019) water contact disease by local authority



4.2 Environment Southland Recreational Bathing Survey

The Environment Southland Recreational Bathing Survey (Ward 2015) was carried out to "try and find where people recreate, what activities are being carried out, what kai is being collected, what problems are being experienced and whether the recreational bathing programme is delivering to the public needs." The 197 respondents were self-selected and therefore are unlikely to be representative. The Mataura River was identified as one of the more popular recreation destinations within the scope of lake, marine and river settings (Figure 15 - yellow bars indicate coastal; green lakes, and blue freshwater areas. An asterisk indicates areas with bathing and/or shellfish gathering water quality monitoring locations – in the case of the Mataura River these are located at Riversdale and Gore (for bathing) and at Fortrose (for shellfish)).

Figure 15: Most popular Southland river, lake and marine settings (Ward 2015)

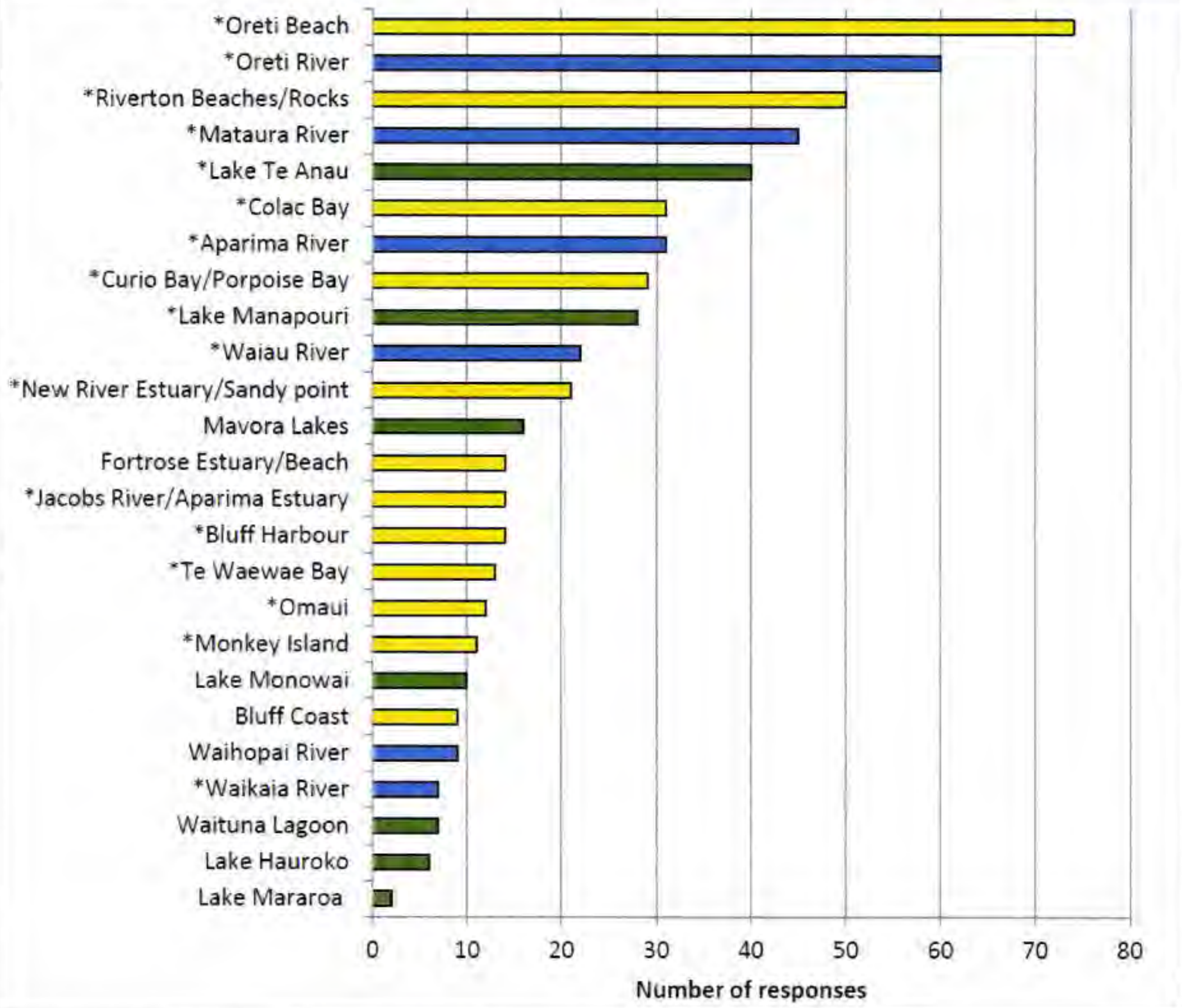


Figure 16 shows the activities undertaken by respondents. Due to the structure of the questionnaire, the activities cannot be correlated to a particular setting, so there is no indication of which activities occur on the Mataura River. Respondents could name more than one activity.[9]

[9] The data shown in Figure 16 and Figure 17 have been generated from the original data provided by Environment Southland rather than the bathing survey report. The report uses pie charts for these data which do not accurately show the popularity of each activity. A pie chart based on percentages suggests 30% of respondents swim, whereas 83% of respondents named this activity.

Figure 16: Recreation activities by number of responses (count) (Ward 2015)

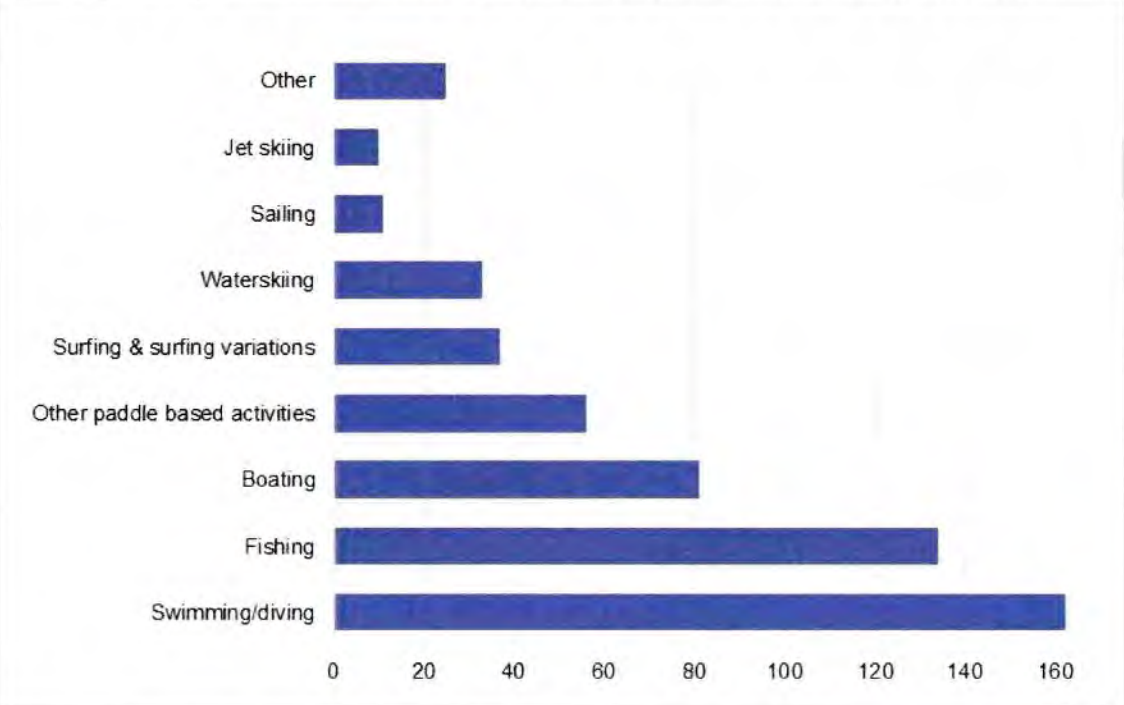
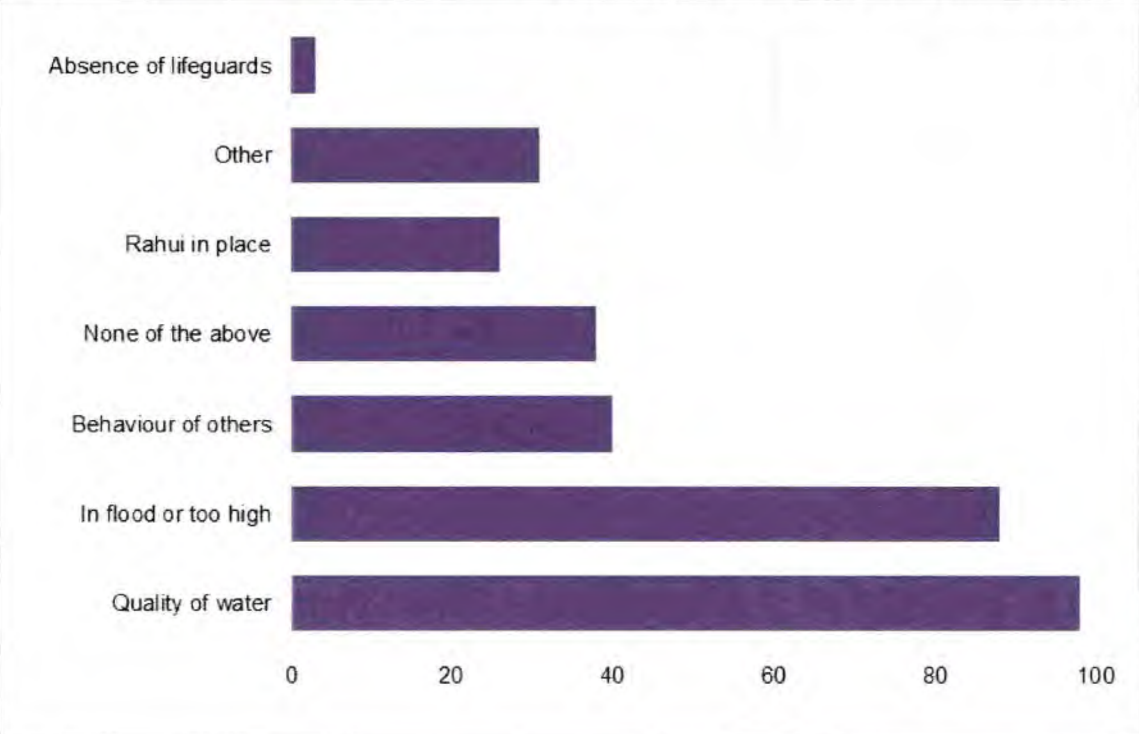


Figure 17 shows the 'factors which prevent you or your whanau from participating in water based activities'. Water quality is a key issue, but again the data cannot be correlated with a specific setting.

Figure 17: Reasons for non-participation by number of responses (count) (Ward 2015)



4.3 New Zealand Recreational River Use Study: specialisation, motivation and site preference

Galloway (2008) reported on the findings of a survey of individuals who recreate on and around rivers in New Zealand (*New Zealand Recreational River Use Study*). Individuals were invited to participate in an internet survey via direct contact at river recreation-related events and electronically via a range of related web sites, group membership, internet bulletin boards, magazines and newspapers. Just over 1300 respondents completed the survey which ran from October 2007 to March 2008. Although the survey results cannot be considered representative of the recreation population, as the sample was self-selected and not randomly generated, they give an impression of the opinions and preferences of what is probably the more active and aware end of the recreation participation spectrum.

Twenty-three activities were represented in the data. The dominant respondents were white water kayakers, anglers and multisport participants. Respondents were grouped into four broad activity groups: boating (non-motorised) (55.4%), fishing (21%), boating (motorised) (2.4%), and shore-based (21.2%).

The survey was designed to evaluate respondents' motivations and site preferences about their level of specialisation in their activity. It was not designed to ascribe values to defined reaches of rivers throughout New Zealand so, in that sense, its results must be treated conservatively.

A list of 1043 rivers was compiled and respondents were asked to indicate up to ten rivers that they had last visited, and the next ten that they wished to visit. This provides a snapshot, rather than a complete picture of the respondents' experiences and views. A total of 4921 rankings were provided for 513 rivers. Rivers ranked more than 100 times included the Waimakariri (227), Tongariro (191), Buller (154), Hurunui (128), Kaituna (118), Mohaka (116), and Clutha (113) Rivers. The Mataura was rated by 36 respondents out of 1300 (Galloway 2008: Table B1). Table B2 (Galloway 2008) identifies the recreation group of those respondents and, for the Mataura, shows: 1 were 'boating (non-motorised)', 17 were 'fishing', none was 'boating (motorised) and 1 was 'shore-based'. There appears to be data missing in this analysis, and response rates for any one activity are too low to place much reliance on the findings.

The Mataura River was not subdivided, and so no comparison can be made between the upper and lower reaches.

For each visited river, respondents were asked to rate its scenic beauty, wilderness feeling, degree of challenge, and opportunity to develop Whanaungatanga / companionship, on a 9-point Likert scale (a scale of response options ranging from full (9) to no (0) agreement, with 5 a neutral response). The question was phrased generally, and therefore is not able to take into account the different values supported by different reaches of each river. At best, it provides a general, broad brush impression of the values ascribed to the whole river, compared to the general values ascribed to other rivers.

Of 71 rivers nationally the Mataura River was ranked:

- 48th for scenic beauty (a mean of 6.05 within a range of 3.05 for the Avon River to 8.6 for the Arahura River),
- 53rd for wilderness feeling (a mean of 5.11 within a range of 2.0 for the Avon River to 8.38 for the Whataroa River),
- 18th for challenge (a mean of 6.33 with a range of 2.1 for the Avon River to 7.8 for the Ruakituri River),
- 59th for companionship (a mean of 4.39 with a range from 3.25 for the Hinemaiaia River to 6.82 for the Waitaha River), and

- 47th overall (the 'grand mean' of 5.49 with a range of 3.22 for the Avon River to 7.69 for the Arahura River).

4.4 Water Bodies of National Importance

As part of the Government's assessment of Water Bodies of National Importance, work has been undertaken to identify water bodies of value for recreation and tourism. The recreation report, titled *Potential Water Bodies of National Importance for Recreation Value* (MfE, 2004), lists 105 freshwater bodies including lakes, river and wetlands that are potentially important for recreation. Six water bodies are identified in Southland including the Mataura River. The list was derived from an internet survey of recreationists, a telephone survey of the public, a literature review and discussion with selected representatives of recreational groups. The report has many inconsistencies and the base research has significant weaknesses.

The internet survey – which was based on a self-selected sample with an apparent bias to kayakers and canoeists – had the following count of activity respondents for the Mataura River:

- 1: Fishing
- 1: Walking

It was also identified as a whitebaiting river with more than 200 users.

The equivalent report for tourism (Ministry of Tourism, 2004) used activity data from the International Visitor Survey and Domestic Travel Study to identify trips associated with freshwater bodies and included the following 'activities': scenic cruises, beaches, jet boating, glow worm caves, swimming, caving, white water rafting, black water rafting, lake fishing, river fishing, sailing, river kayaking, water skiing and punting. The dataset identified the top eight freshwater destinations (which, in Southland, included only waterbodies near Te Anau[10]) and the top ten freshwater activities. There were no data relevant to other Southland waterbodies. A separate listing was also given of freshwater bodies important for their scenic appeal rather than use value – none in Southland.

4.5 New Zealand recreational river survey

The only comprehensive assessment of recreation potential of inland waterways was undertaken over three decades ago (Egarr & Egarr 1981). The Mataura was described in five sections: The Upper Mataura River to Athol (with 'Low' recreation value); Mataura Gorge - Athol to Tomogalak (with 'Intermediate' recreation value); Tomogalak to Gore (with 'Low' recreation value); Gore to Wyndham (with 'Intermediate' recreation value); and Wyndham to the Sea (with 'Intermediate' recreation value). Fishing and hunting were not considered in the analysis.

The Egarrs' descriptions of the lower three reaches are (noting again that fishing was not part of the scope):

> *TOMOGALAK TO GORE*
>
> *Length: 66km. Average gradient: 1:770 1.3m/ km.*
>
> *Recreational use and scenic description: From the confluence with the Tomogalak Stream the Mataura River spreads out onto the Waimea Plains, becoming wider and shallower. Willows continue to line the banks and sweep the water with their branches for most of the distance to Gore. In the 10km above the Waikaia River confluence the river becomes braided and splits around grass-covered islands. The river, in summer, becomes hopelessly shallow for boating and is not often used for recreation. There are no rapids other than shingle shallows until almost to Gore, where there are the first signs of hard bedrock that*

[10] Lake Te Anau, Tunnelburn River, Arthur River, Clinton River, Hollyford River, Lake Hauroko, Wairarahiri River, Waiau River, Mavora Lakes, Lake Manapouri

creates rock ledges throwing up small rapids. Such rapids are more common in the lower river.

GORE TO WYNDHAM

Length: 36km. Average gradient: 1:700 1.4m/ km.

Recreational use and scenic description: Below Gore the essential nature of the Mataura, a wide shingle bed river flanked by willows, does not alter except that the shingle beaches on either side of the river are smaller and there are periodic outcrops of a hard, smooth rock which creates some mild rapids. Between the paper mill and the freezing works at Mataura there is a weir about 1.5 metres in height; 200 metres downstream there is a natural rock weir or small waterfall. These obstructions effectively prevent the upstream navigation of jet boats and are not run by canoeists, rafters or other craft. Possibly the waterfall could be run but the presence of the weir, which creates a powerful and dangerous stopper wave close beneath the sill of the weir, convinces most boaters to portage this section. Below Gore extensive willow clearing has been carried out and this may eventually extend downstream. However, the river is wide enough so that small craft can avoid running into the willows. Gravel and sandy beaches flank the river channel but they are not as extensive as in the upper river. Beneath the Wyndham Bridge lie old wooden bridge piles cut off just below normal summer water level. These can be hazardous. Jet boats use the river up to Mataura and this section is also a popular, easy trip for canoeists. Other craft seldom use the river.

WYNDHAM TO THE SEA

Length: 57km. Average gradient: Slight.

Recreational use and scenic description: The river below Wyndham tends to flow quietly between low beaches and grassy banks. Large willows line the banks draping their branches into the water. They become smaller and occur only occasionally below the Seaward Downs. The river becomes tidal and swampy, the shingle bed giving way to mud. The river is jet boated along this section and sometimes canoed and navigated by power boats.

The Egarrs' report provides rankings of rivers/reaches for recreational and scenic value and goes on to select the most important that deserve protection for their recreational value at a variety of priority levels. The Mataura below Tomogalak was not identified.

4.6 National Inventory of Wild and Scenic Rivers

In 1982 the National Water and Soil Conservation Authority released a draft inventory of wild and scenic rivers and sought submissions. A resulting document was published in 1984 (Grindel 1984), and provides a list of what were considered to be "nationally important wild and scenic rivers." The final list excluded lakes because the Committee responsible for compiling the list decided that its terms of reference did not include them. Thirteen rivers were identified in the North Island and 40 in the South. The Mataura River was in the draft list, but not in the final (possibly because it was not considered 'wild'), but this significance assessment is now redundant considering the existing Water Conservation Order.

The Ministry of Agriculture and Fisheries made a substantial submission to the draft inventory in relation to freshwater angling values (Tierney *et al* 1982). The authors recommended that the Mataura River be considered as nationally important due to the value as a brown trout fishery (p88):

The Mataura River, from source to sea, is identified in the draft inventory as a nationally important brown trout fishery. Fisheries Research Division fully supports its inclusion in the inventory, but suggests that in addition to the comments should note that there is a significant whitebait fishery at the river mouth.

In 1986 the Protected Waters Assessment Committee released its recommendations for a, "*list of those lakes and rivers which the committee commends as suitable for inclusion in a Schedule of Protected Waters*" (Grindell and Guest 1986). The intention of the study was to advise the then Ministers of Works and Development and Conservation of, "*those waters deserving inclusion in a schedule of Protected Waters that can be attached to the Water and Soil Conservation Bill.*"

The committee's analysis built on the *National Inventory of Wild and Scenic Rivers* (Grindell 1984), but expanded the scope of assessment from that study's limit of wild, scenic, recreational and scientific values to include, in addition: fisheries, wildlife habitat, flora, tourism and cultural values.

In terms of recreational values, the relevant assessment procedure for identifying an outstanding waterbody was well outlined (p7). This process was drawn, in the main, from the approach used in the *National Inventory of Wild and Scenic Rivers*:

> *"This category includes those rivers where the existing water regime plays an essential and dominant role in providing an outstanding recreational experience or range of experiences. An area which has an unrealised potential for providing an outstanding amenity may be considered. While the surrounding landscape may contribute significantly to those experiences the water, the river or lake bed and possibly a narrow riparian strip are the crucial elements for the recreational value. The recreations are mainly instream use (angling, jet boating, canoeing, packfloating, etc) but this committee recognised that picnickers, etc, also went there because of the water, not in spite of the water. An area may be considered outstanding because of one or more of a number of characteristics. It may provide a wide variety of recreational experiences and be used often by people within and, to an extent, outside its region. Or its present level of use may be low but provide an exceptional type of recreational experience, possibly requiring advanced skills so that people from other regions or overseas travel to the area to use it.*
>
> *"Summary of characteristics*
>
> a *The characteristics vary and largely reflect the recreational uses for which the river is outstanding.*
>
> b *The river satisfies the recreational needs of a large number of people, or constitutes an amenity for a wide variety of recreational activities, or provides an outstanding recreational experience.*
>
> c *A river in this category may be under-utilised at present but have potential for varied, intensive or specialised use.*
>
> d *The area may be readily accessible, frequently by road. The surrounding land may show signs of human activity and settlement.*
>
> e *The water may be subject to some minor diversions and there may be some development such as bank protection works, but not to the extent that the river regime is controlled.*
>
> f *While there may be some waste discharges, the water will usually be of a quality compatible with the recreation activities.*
>
> *"Rivers are the focus of a great variety of recreational activities. A range of recreational facilities for present and future recreationists must be protected throughout the country.*
>
> a *Wilderness and expedition type facilities: generally wild and scenic rivers of sufficient size to permit a range of recreational values.*
>
> b *White water: essential for whitewater rafting, canoeing, jet boating.*
>
> c *Placid water: essential for boating activities where coastal waters unsuited to boating.*

d *Small urban streams: close to populated areas for general recreation and picnicking.*

e *Routes as access and as a form of recreation."*

The committee developed a three-tier classification (groups one, two and three) to define an order of importance for the waters identified as outstanding. In terms of including the waters in a schedule of protection (p12), "*anything less than the first group would provide an inadequate representation. If the Schedule should be bigger, then the second group should be used for making a selection. If the two together are insufficient then the third group should be used for making a selection.*"

The Mataura River was not listed, which is rather surprising considering its listing in the 1982 National Water and Soil Conservation Authority draft inventory and the Ministry of Agriculture and Fisheries submission (Tierney *et al* 1982).

5 2019 Observations

Two counts of recreational use of sections of the Mataura River were carried out in early 2019: an observational count of activity between Gore and Seaward Downs; and 24hr counts of recreation activity immediately below the Mataura Falls relying on a camera.

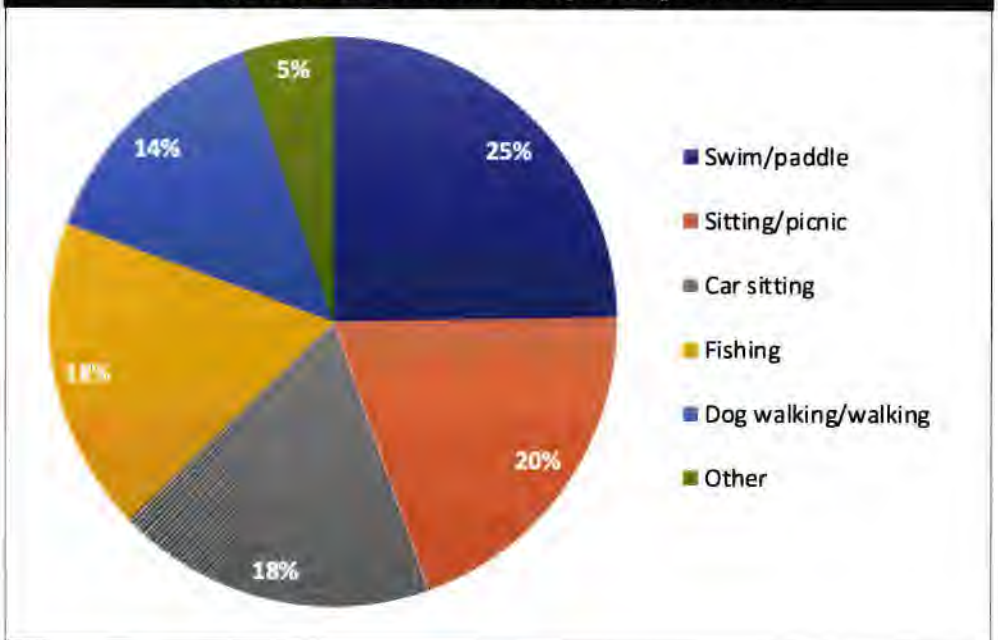
5.1 Observational count

To give some quantification of the main recreational uses of the Mataura River, an observational count of the location and types of recreation occurring between Gore and Seaward Downs was carried out between 16 January and 6 February 2019. Ten days of counts were carried out over three weekdays during the school holidays, three weekdays outside the holidays, three weekend days and Waitangi Day. One observer drove a circuit between Gore and Seaward Downs daily, starting at a different point and time each day (so each site was visited at different times of the day), and visiting each of 27 publicly accessible riverside locations within the study area, including all angler access point identified by Fish & Game's Mataura River Angler Access map (Appendix 2).

The study area was chosen to allow a comparison of activity up and downstream of Mataura, and to fit within an 8-hour survey period. The study results are indicative only – in terms of showing actual use patterns – and are intended to show relativity between activities and locations. Very early and very late angler activity is likely to have been undercounted, although the Mataura River is reputed to fish well all day. Early morning walks, for example, are also likely to be under-counted, as the observer could only visit a small number of sites in the morning period. Swimming may be over-represented, since this is likely to occur during a longer period from the middle of the day into the late afternoon (it was very warm weather during the study, and observations only occurred on fine days). This use pattern is supported by the data captured by camera as described in the following section.

Figure 18 shows the observation count data for all sites. A total of 247 activity observations were made, with swimming or paddling a quarter of all observations. This included, mostly, teenagers fully swimming in the River, or young children paddling on the edge. 'Other' included horse riding and several workers taking time out. Car sitting – at 18% – included individuals or groups basing their activity within or immediately beside a vehicle, including, mostly, looking at phones, as well as

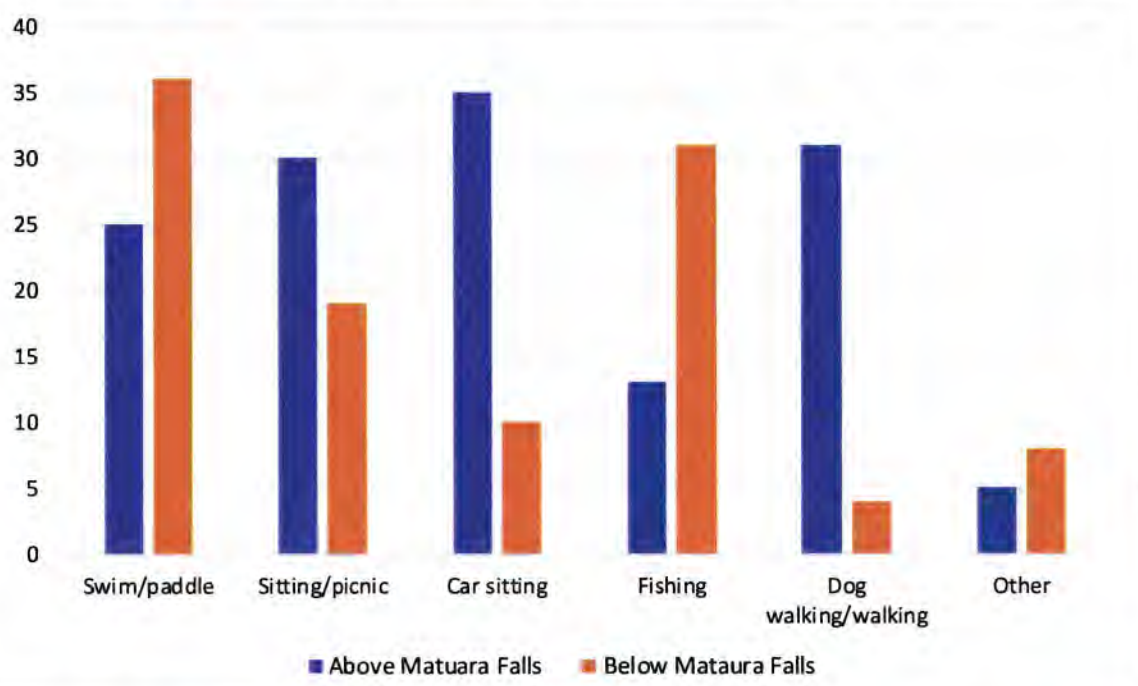
Figure 18: Observation data by activity – all sites



eating lunch, watching the water or monitoring others at play.

Figure 19 shows activity records for above and below the Mataura Falls. Twelve sites were above and 15 below the Falls. Terrestrial activities tended to dominate upstream while swimming and fishing were more recorded more often below.

Figure 19: Observation data by activity and above or below Mataura Falls (counts)



Most records came from eight sites, shown in Table 4. Notably, fishing tended to be dispersed through the study area, with the 44 records spread reasonably evenly over 14 sites, although the very pleasant and accessible angler access off Coal Pit Road accounted for a quarter of all angler records, with users more likely to be in family groups.

Table 4: Main observation record sites (counts)

	Swim / paddle	Sitting / picnic	Car sitting	Fishing	Dog walking / walking	Other	Total count
Maitland Street, Gore	4	2	2		1		**9**
Woolwich Street, Gore	12	21	9	2	8	1	**53**
River Terrace, Gore		5	6	1	8		**20**
River Street, Gore	9	2	18		11	4	**44**
Angler access above Mataura Bridge	9	3		2			**14**
Angler access Wyndham Rd Nth of Chalmer Rd		10	4	7		1	**22**
Wyndham Racecourse	11		2		4	4	**21**
Coal Pit Road angler access	11	5	4	11			**31**
Other	5	1		21	3	3	**33**
All	**61**	**49**	**45**	**44**	**35**	**13**	**247**

5.2 Camera record

A camera was mounted upstream of the Mataura Bridge to give an estimate of recreational activity immediately below the Alliance plant, and at a site identified in the *Proposed Southland Water and Land Plan (Decisions Version, 4 April 2018)* as a 'popular bathing site' (see section 2.6) (and at a site where a camera could be easily mounted). An image was recorded every 10 minutes, and Figure 20 gives an example showing an angler. As with the observation count, the intention was to give a relative estimate of activity and not to complete a census of activity over a wide area.

Figure 20: Camera image example (angler) at Mataura Bridge

The camera operated from 5 February to 25 March 2019. Eight days within this period were lost due to camera malfunctions, giving 48 days of data, over a mostly sunny and warm period. A total of 139 people was recorded (some possibly the same people on different days or times): 22% were angling, 39% swimming and 39% sitting or standing or accompanying others swimming and fishing.

Figure 21 shows the counts of activity by hour of day, with swimming occurring only after 1pm, and angling occurring throughout the day.

Figure 22 shows activity records by day of the week. While Saturday appears relatively busy, activities are well-dispersed; and for swimming this makes sense since most of this activity was recorded after school-hours.

Figure 21: Camera data records at Mataura Bridge by hour (counts)

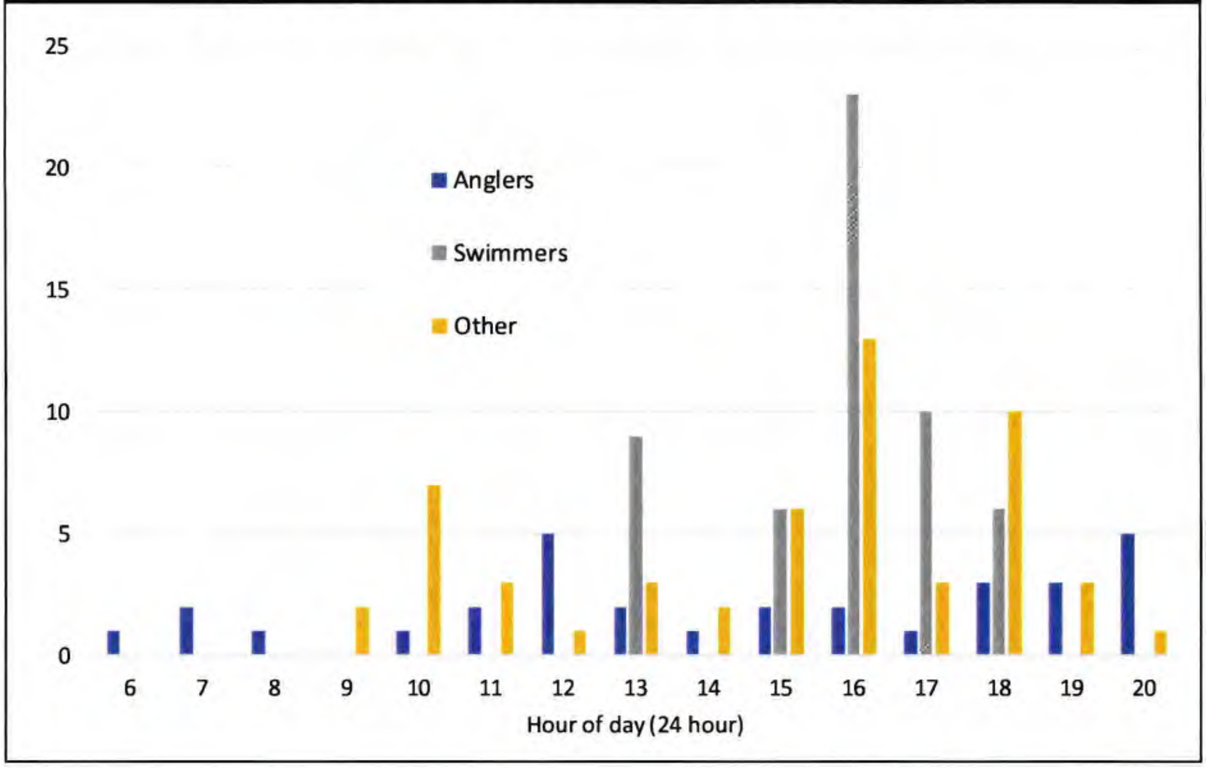
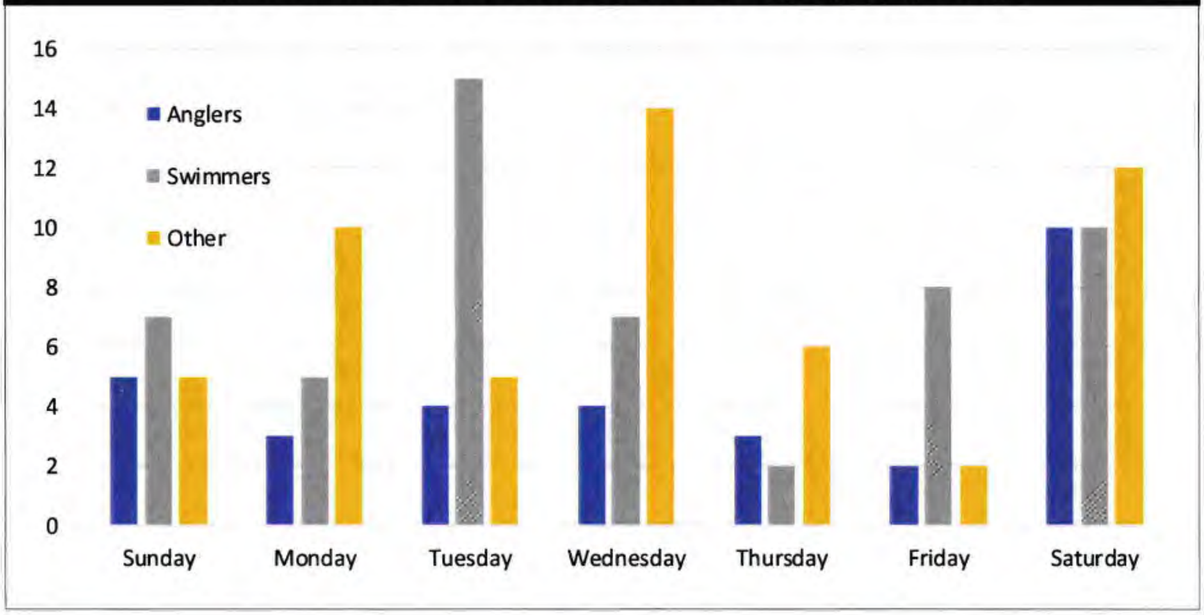


Figure 22: Camera data records at Mataura Bridge by day (counts)



6 Interview summaries

A selection of recreational users was interviewed or contacted via email to gain an understanding of users' perceptions of the quality and nature of the recreational experience on the Mataura River, and the perceived effect of water quality on the experience.

Full interview summaries are provided in Appendix 1 (not all wished to be quoted). Interviewees indicated a variety of perceptions about changes to recreation values over time, with regard to water quality. Key points include:

- A variety of perceptions about water quality and the safety of contact recreation. While no-one interviewed would drink from the Mataura River below Cattle Flat, and many would no swim in it, responses included opinions ranging from 'possibly too clean' (by an angler) to 'horrendous' (a kayaker, describing the river-setting at Mataura generally, including the proximity of the Alliance plant to the River). All agreed that the River's water quality was far better than in the 1980s when there were a variety of untreated discharges, including municipal wastewater and outfalls from the pulp and paper mill, Alliance plant and Edendale dairy factory (these resulted in some very large trout and eels being caught); and that the latest upgrade at the Alliance plant had also had a positive effect. Several respondents – mostly anglers – considered the water quality now to be quite good, but potentially of decreasing quality due to farming intensification. Others considered the water quality to be poor. Many noted a variety of sources of contamination, including farming and treated municipal wastewater, particularly at Gore. The Alliance discharge did not feature as a major issue for most respondents but was noted by some kayakers. Most interviewees considered foam on the River to be a natural phenomenon, considering it occurs well above Gore.
- Opinions about the quality of the fishery also varied. Most agreed that the mayfly rise on the Mataura River had declined in frequency and intensity, with several theories as to the cause. The most experienced angler on the River downstream of Mataura – with detailed angling diaries – considered the insect life in the River to be quite healthy, but that warmer summer temperatures (climate change) were confining the rise to evenings and night, were less frequent generally, and were occurring later in the 'summer' season ('May is the new April'). Warmer temperatures were also considered a cause in the change in the patterns of the hatch by other anglers, but nutrification and sedimentation and (therefore) fewer insects were also identified. The Southland Fish and Game manager noted a lack of good data to define the scale of change and any specific causes, while noting that the fishery itself (the number and condition of fish) was still in a good state.
- Opinions about the number and quality of trout varied, with some considering the numbers and quality to be consistent, and others considering size, quality and numbers to have all declined. Some considered a reduction in trout size to be the result of a cleaner river. The change in the frequency, timing and duration of the mayfly hatch has influenced a change in fishing technique, with more nymphing over dry fly fishing.
- Swimming appears to be, in the main, a very local activity with a small number of regular users – also influenced by the recent closure of the community swimming pool at Mataura. There appears to be no common local conversation about illnesses from contact with the River water, and bathing water quality reports issued by Environment Southland do not appear to affect many swimmers' choices. One kayaker reported an illness after coming out of his kayak immediately below the Mataura Falls, and reported an odour from the Alliance discharge.

7 Effects of Alliance discharge and take

Four potential issues with the Alliance discharge and take are of interest to recreation, considering the recreation values identified in this assessment:

- The degree to which it increases the risk of contracting a waterborne disease from water contact recreation, including swimming, paddling and trout and whitebait fishing;
- The effect of the discharge on trout and whitebait abundance and quality, associated with water quality and other habitat parameters, such as the health of the in-river macroinvertebrate community and water temperature;
- The degree to which the discharge exacerbates nuisance periphyton growths, affecting bathing quality and the risk of anglers slipping; and
- Odour from the discharge, alterations of water colour and clarity and the generation of foams and scums, affecting water contact recreation as well as visual amenity, angling and whitebaiting.

Each of these issues is discussed below.

7.1.1 Waterborne disease

Dada (2018) reviews the risk of contracting a microbial disease from contact with water affected by the Alliance discharge. The review finds:

- That although the Alliance discharge often contains a high concentration of *E.coli* bacteria – which are used in water testing to indicate the likelihood of the presence of pathogenic organisms in a waterbody – the discharge contains relatively few human pathogens, including Salmonella, Campylobacter, Cryptosporidium and Giardia. So, while the discharge often contributes significantly to the exceedance of national standards for contact recreation in the River, the increase in the real risk of disease is relatively slight.
- The Mataura River, above and below the discharge, normally fails the bathing water standards for contact recreation, particularly when water clarity is poor or when river flows are elevated. Dada (2018) suggests that a combination of faecal loadings from pastoral catchment overland flows, birds (particularly for Campylobacter) and in-stream processes account for much of the bacterial load; although the Alliance discharge is also a contributor and its effects on *E.coli* levels are most evident at low River flows (when there is less dilution).
- Considering the relatively low pathogenic loading in the discharge, Dada (2018) concludes that, "the current wastewater treatment applied at Alliance Plant is sufficient to reduce health risks associated with swimming at the study site (Mataura Bridge) to levels below 'the NZ threshold for tolerable risk', even at maximum discharge of 14,400 m^3/d."

This does not, of course, mean that the River is always suitable for swimming downstream of Mataura, due to the many other sources of contamination in the catchment. Relevantly, the National Policy Statement for Freshwater Management includes provisions which place an obligation on Environment Southland to set policy and methods to improve water quality in the Mataura Catchment so that it is suitable for primary contact more often, and the key indicator for how that is being achieved is also instream *E.coli* concentrations

It is suggested that the Plant's should contribute to catchment-wide improvements in water quality in the Mataura River with regard to its high *E.coli* output – despite its low pathogen loading.

7.1.2 *Trout and whitebait abundance and quality*

Montgomerie *et al* (2019) report that changes in: the benthic invertebrate community; the chemical composition of the water; periphyton levels; and water temperature, all have the potential to affect trout and whitebait habitat, and therefore their abundance and condition. Montgomerie *et al,* in their assessment of in-river ecological values and the effects of the Alliance discharge, reach similar conclusions to Dada (2018): while the contribution of the discharge to adverse environmental effects are slight and subsumed by the many other sources of nutrification, the Plant will need to reduce its levels of key contaminants as part of catchment wide initiatives to improve water quality.

With regard to the benthic invertebrate community, Montgomerie *et al* found mayfly (*Deleatidium* sp) abundance varied above and below the discharge and showed no relationship with it; but rather was closely aligned with variations in water temperature, associated with low flows and long, warm summer periods. This aligns with comments made by several anglers during interviews for this assessment (Appendix 1). Discharge water temperature – from both treated wastewater and plant cooling water – had no relevant effect on in-river water temperature; and in January 2018 river water temperature upstream and below the discharge exceeded the upper lethal temperature for mayfly over a period of days.

Similarly, periphyton surveys showed variability above and below the discharge, with no causative relationship with it (which accounts in part for the lack of effect on macroinvertebrates in the River). Interestingly, while mean monthly dissolved inorganic nitrogen and dissolved reactive phosphorus concentrations at biological monitoring sites upstream and downstream of the discharge exceeded the Ministry for the Environment (MfE) periphyton guideline for protecting benthic biodiversity, no nuisance periphyton growths were identified in surveys carried out since 2013, suggesting, according to Montgomerie *et al*, that either dissolved inorganic nitrogen or dissolved reactive phosphorus concentrations need to be higher than the MfE (2000) guidelines, or other factors are controlling periphyton growth in the River.

Montgomerie *et al* also found that the total nitrogen discharge contribution to the Toetoes Estuary load from the discharge is 1.1 – 1.7%, and the estimated total phosphorus discharge contribution is 0.7 – 1.3%, with most of the total nitrogen and total phosphorus load derived from other catchment inputs, particularly diffuse sources. Even a marked reduction in the discharge of total nitrogen and phosphorus loads would have little, if any, detectable effect on the Estuary's nutrient status.

Accordingly, Montgomerie *et al* concluded that the take and discharge are very unlikely to have any detectable effects on ecological communities.

7.1.3 *Periphyton growths*

Periphyton growths in the River were reviewed by Montgomerie *et al* (2019), as discussed above, with no relationship with the discharge identified.

7.1.4 *Odour and other water quality issues*

Odour was reported, via the interviews summarised in section 6 by one kayaker as having been noted immediately at the Alliance discharge site, and was considered a potential issue by one angler – although not necessarily a determinant of participation in that case. It is also not clear if the reported odour came from Alliance's wastewater treatment plant or the discharge itself.

The consent conditions for the discharge set a mixing zone 250 m downstream, although Montgomerie *et al* (2019) estimate that the zone, in practice, extends 100 m from the discharge. It appears, from interviews, that there are no reports of odour beyond the mixing zone, and the swimming site approximately 50 m upstream of the Mataura Bridge remains popular.

Montgomerie *et al* (2019) find that the discharge does not adversely affect pH, turbidity, total suspended solids, colour, clarity or the generation of foams or scums. Foam – which is particularly conspicuous at the Mataura Falls – occurs equally when the discharge is in operation or is closed.

7.2 Effects summary

The key finding of this assessment is that while the contribution of the discharge and water take to adverse effects on recreation in the Mataura River are very slight and subsumed by the many other sources of nutrification and contamination, the Plant will need to reduce its levels of key contaminants as part of catchment wide initiatives to improve water quality.

Based on the findings of Dada (2018) and Montgomerie *et al* (2019), there appears to be no causal relationship between the discharge and levels of periphyton, macroinvertebrates, colour, clarity or the generation of foams or scums – and hence trout and whitebait habitat and the ability to catch them. Odour was reported as a potential issue by two interviewees, but appears to be confined to the discharge mixing zone. Dada (2018) found elevated levels of *E.coli* associated with the discharge, but very low and variable levels of human pathogens, and therefore low human health risk. Nevertheless, options to further reduce these *E.coli* and nutrient outputs are recommended, and while not urgent considering the existing low scale of effect on recreation amenity (and ecological values), it is recommended they be implemented during the life of a renewed consent.

8 Conclusion

The data – from popular literature, published research and primary research in the form of observation and camera counts – indicate:

- The outstanding nature of the Mataura River for brown trout fishing;
- Its relatively high use for swimming, both up and downstream of Mataura;
- A very popular whitebait fishery in the lower reaches;
- Use of the riverbanks, berms, reserves and angler access points for a variety of terrestrial activities, mostly around settlements, and with relatively high activity levels at the Coal Pit Road angler access point;
- A low level of use of the River for salmon fishing;
- Some use of the River for jet boating and kayaking, but with no relevant data to quantify these uses;
- Water quality is of interest when assessing recreation values on the Mataura River.

Public Health South has noted a lack of warning signs about water contact recreation along the Mataura River (see section 4.1); and the only swimming warning signs located beside the River in January 2019 between Gore and the coast were at Fortrose (erected by Environment Southland) and 'no diving' signs at either end of the Mataura Bridge. Alliance is not responsible for regional signage of this type, and there is no requirement to include sign installation as a consent condition (also considering the discharge has very little influence on water quality for contact recreation). However, as recommended by Public Health South, their installation needs consideration at the regional and district levels.

9 References

Charles, G. 2013. *New Zealand Whitewater 5. 180 Great Kayaking Runs.* (5th edition) Graham Charles.

Cressey, P., Hodson, R., Ward, R., & Moriarty, E. 2017. *Use of Quantitative Microbial Risk Assessment to Assess the Human Health Risk of the Mataura River, Southland.* Report prepared for Alliance Group Ltd.

Dada, A.C. 2018 *Quantitative Microbial Risk Assessment for the discharge of treated meat processing factory wastewater into the Mataura River.* Report AES1704, Streamlined Environmental, Hamilton. Prepared for Alliance Group / Aquatic Environmental Sciences Ltd

Department of Conservation. 2016. *Southland Murihiku Conservation Management Strategy.* 2 vols. Department of Conservation Southland.

Egarr, G. Egarr, J. Mackay, J. 1979. *64 New Zealand Rivers.* NZ Canoeing Association.

Egarr, G. 1995. *New Zealand's South Island Rivers: A Guide for Canoeists, Kayakers and Rafters.* Nikau Press, Nelson.

Egarr, G.D. and Egarr, J.H. 1981a. *New Zealand Recreational River Survey: An Investigation into the Recreational Potential of New Zealand's Inland Waterways. Part 1: Methods and Conclusions.* Water and Soil Miscellaneous Publication no. 13. Published for the New Zealand Canoeing Association by the National Water and Soil Conservation Organisation, Wellington.

Egarr, G.D. and Egarr, J.H. 1981b. *New Zealand Recreational River Survey: An Investigation into the Recreational Potential of New Zealand's Inland Waterways. Part II: Summaries of North Island Rivers.* Water and Soil Miscellaneous Publication no. 14. Published for the New Zealand Canoeing Association by the National Water and Soil Conservation Organisation, Wellington.

Environment Southland, 2013. *Whitebait Survey Summary of results.* Environment Southland Invercargill.

Fink-Jensen, K. Johnson, M. Simpson-Edwards, M. 2004a. *Freshwater recreational users. Survey of freshwater use in New Zealand.* BRC Marketing & Social Research for MfE.

Fink-Jensen, K. Johnson, M. Simpson-Edwards, M. 2004b. *Freshwater recreational users. Internet survey of freshwater use in New Zealand.* BRC Marketing & Social Research for MfE.

Fish & Game Hawke's Bay Region, 2005. *2005 Sports Fish & Game Bird Management Plan for the Hawkes' Bay Region*

Freshwater Solutions Ltd. 2019. *Assessment of the Effects of Alliance Mataura's Discharges and Water Take on Mataura River and Toetoes Estuary.* Report prepared for the Alliance Group Ltd.

Galloway, S. 2008. *New Zealand Recreational River Use Study: Specialization, Motivation and Site Preference.* School of Physical Education University of Otago.

Greenaway, R. 2016. *Outstanding freshwater body assessment criteria and assessment methodology: Recreation values.* Prepared for Golder Associates as part of the Outstanding Freshwater Body Project.

Grindell and Guest (eds). 1986. *A list of rivers and lakes deserving inclusion in a schedule of protected waters.* Water and soil miscellaneous publications No.97

Grindell, D.S. (ed). 1984. *A national inventory of wild and scenic rivers.* Water and Soil Directorate, Ministry of Works and Development.

Hughes, B. Harris, S. Brown, P. 2011. *Mataura Catchment Strategic Water Study.* Liquid Earth, Aqualinc Research and Harris Consulting report prepared for Environment Southland.

Jet Boating New Zealand (JBNZ). 2013. *Safety / year book for the subscription year 1st July 2013 to June 2014.* JBNZ Inc.

Kelly, G.R. 1988. *An inventory of whitebaiting rivers in the South Island.* NZ Freshwater Fisheries Report No. 101. Freshwater Fisheries Centre, MAFFish, Christchurch.

Kent, J. 2009. *South Island Trout Fishing Guide.* Reed Publishing, Auckland.

Kent, J. Magnano Madsen, P. 2003. *New Zealand's Top Trout Fishing Waters.* Reed Publishing (NZ) Ltd.

Marshall, K. 2018. *Mataura River Cluster – an investigation of suspected cyanobacterial toxin poisoning in Southland, New Zealand.* Southern District Health Board, Public Health South. Kate Marshall, Health Protection Officer.

Millichamp, R. 2013. *Salmon Fever.* Ross Millichamp Environmental, Christchurch

Ministry for the Environment. 2004. *Water Bodies of National Importance: Potential Water Bodies of National Importance for Recreation Value.* Ministry for the Environment, Wellington.

Ministry of Tourism. 2004. *Waters of National Importance for Tourism.* The Ministry of Tourism, Wellington.

Montgomerie, R., Carter, N., and Fitzpatrick, M. 2019. *Assessment of the Effects of Alliance Mataura's Discharges and Water Take on Mataura River and Toetoes Estuary.* Freshwater Solutions client report for Alliance Group Ltd.

Public Health South. 2019. *Surveillance Report: Risk factors that may contribute to enteric diseases (Campylobacteriosis, Cryptosporidiosis and Giardiasis) 1 January 2013 – 31 December 2017.* Public Health South – Southern District Health Board, Southern DHB region.

Teirney, L.D., Unwin, M.J., Rowe, D.K., McDowall, R.M., Graynoth, E. 1982. *Submission on the draft inventory of wild and scenic rivers of national importance.* Ministry of Agriculture and Fisheries. Fisheries Environmental Report No. 28.

Unwin, M.J. 2016. *Angler usage of lake and river fisheries managed by Fish & Game New Zealand: results from the 2014/15 National Angling Survey.* NIWA Christchurch

Unwin, M.J. 2013. *Values of New Zealand angling rivers Results of the 2013 National Angling Survey.* NIWA Christchurch Prepared for Fish & Game New Zealand

Unwin, M.J. 2009. *Angler usage of lake and river fisheries managed by Fish & Game New Zealand: results from the 2007/08 National Angling Survey.* NIWA Christchurch Prepared for Fish & Game New Zealand

Unwin, M. and Brown, S. 1998. *The Geography of Freshwater Angling in New Zealand: A summary of results from the 1994/96 National Angling Survey.* Prepared by NIWA for Fish & Game New Zealand. NIWA Client Report: CHC98/33, Christchurch.

Unwin, M. and Image, K. 2003. *Angler usage of lake and river fisheries managed by Fish & Game New Zealand: Results from the 2001/02 National Angling Survey.* Prepared by NIWA for Fish & Game New Zealand. NIWA Client Report: CHC2003-114, Christchurch.

Ward, N. 2015. *Environment Southland Recreational Bathing Survey.* Environment Southland, Invercargill

Appendix 1: Interview summaries

9.1 David Murray-Orr, angling guide[11]

David has 50 years' experience fishing the Mataura River and is a professional angling guide, focusing on the Mataura River between Mataura and Gorge Road, and its tributaries. According to Jason Smyth at Southland Fish & Game, he is likely the most experienced angler on the lower Mataura River.

The appeal of the lower River includes its good access, easy and varied water ('more character') for dry fly fishing, relatively few anglers compared with the upper reaches, and good scenery with coal seams and eroded cliffs. David also lives adjacent to the River and knows how to fish it. The best spots are a short walk along the River from the main access points – where angling pressure is least.

David has fishing diaries for the Mataura dating back 25 years. He recently referred to these diaries to compare his experiences on the River now with those of 20 years ago and reports that the difference are 'staggering' – in terms of fish catches and reliability; attributing most of the difference to climate change.

The Mataura is famous for dry fly fishing and 'matching the hatch' – using the right style of dry fly to suit the stage of the mayfly lifecycle (duns, spinners, nymphs, emergers) – much in the same way as many large American rivers – and so the preferred fishing conditions rely on the mayfly hatch – which is temperature dependent. Warm weather means no hatch, and in recent years traditional March events are now occurring in late April and May ('May is the new April'). From October to December, hatches occur throughout the day, and from December to February the hatches tend to be only at night, with spinners on some warm cloudy days. March to April was the 'world famous' period with good cool weather – but is now more into May.

The less dependable hatch means the River is becoming more suitable for the local angler who can pick their fishing day, rather than the visitor whose timing coincides with a period of hot weather.

David doesn't consider the River to be polluted, and its water quality seems to improve further downstream. It is in good order and seems to be in really good shape. The fish and mayflies are still there in good numbers, but the reduced number and later hatches appear to be the main determinant of fly-

fishing quality.

He recalls the River being more heavily polluted in the past, and when Alliance plant did not treat its waste, there were some extremely big fish to be caught near the plant. There used to be a black sediment which would coat the riverbed, but this is no longer seen.

A surface film or scum can be useful for fishing, by slowing the emergence of mayflies and increasing the density of fish in those affected areas. Similarly, the foam generated by the Mataura Falls traps insects and attracts trout, allowing for a variety of fishing methods in adjacent clear spots or within the foam – such as weighted or unweighted nymphs and wet flies.

David describes fishing beside the Alliance plant as 'industrial fishing' and it does not appeal to all his clients – although many are just interested in the fish, and it is often a productive site, with the foam catching insects. The name 'Cappuccino Point' has stuck after one visitor used the term to describe the foam. While it is a natural feature, some see foam as pollution.

David has not seen a lot of other recreational use of the River. There is some swimming at Wyndham at Boiling Point, and a very occasional kayaking group – most likely from a local school.

[11] Confirmed email 30 April 2019

9.2 Barry Perkins, angling guide[12]

Barry guides anglers on the Mataura River between Seaward Downs and Riversdale, and is based in Gore. His angling diary on the Mataura goes back to 2003, and in that period he has seen no change in water quality, the number of invertebrates or the quality and number of fish. The only change is the frequency of the hatch, which is most likely climate-related, with warmer and longer summer seasons. His angling techniques have not changed.

This season featured a good lead in over winter, but the spring was a poor start with heavy rains. However, the trout are still in excellent condition.

He hears negative descriptions of the water quality in the River, but it is not his experience, with similarly good quality from Riversdale downstream – besides the wastewater discharge at Gore, which he trusts is being adequately monitored by the regional council. His clients are generally impressed by the clarity of the water and he has to advise them to not drink it.

Surface foam is evident at Riversdale and below Mataura, and he applies the adage 'where there's foam there's [trout] food', and foam lines are used as fishing targets.

He 'very occasionally' sees kayakers on the River, usually above Gore. They seem to be locals and are very respectful about keeping their distance from anglers.

The Alliance discharge does not feature in his thinking about the River and water quality, although he has heard stories of the original discharge and the size of the local eels.

9.3 Brendan Shields, angling guide[13]

Brendan is a professional angling guide with 40 years' experience, resident in Gore, and he grew up in Wyndham. On the Mataura he guides only above Gore and mostly above Cattle Flat. The water clarity and colour changes quite quickly below Cattle Flat and is not attractive for his international clients, particularly considering their interest in sight-fishing. Wading across the River downstream of Cattle Flat is also a problem, where is it quite slippery with algal growth. The riverbed at and above Cattle Flat is clean and there is less chance of sliding over.

When a lad, the lower Mataura had a reputation as being heavily polluted by poorly treated sewage discharge from Gore, Edendale, Wyndham and Mataura, along with discharge from diary production in Edendale and meat processing from Alliance in Mataura. The latter had a reputation as the spot to hunt for large eels feeding on meat by-products. These are no longer seen as issues, and Brendan's perception is that dairying is now the perceived source of pollution; and the Alliance plant is off the radar in comparison.

Brendan notes people swimming at Gore, but does not visit the River below there, so has no information about other activities downstream.

9.4 Daryl Paskell, angling guide[14]

Daryl has almost 45 years' angling experience and is the head guide at Nokomai Station. He guides on the Mataura but almost exclusively upstream of Riversdale, largely because he lives at Castle Rock and the travel time to the lower River is too great. He might visit the lower River once a year or so if he's interested in doing something a little different or a client is interested.

Daryl thinks the fishing in the Mataura is as good as it ever was – although angling pressure is growing, particularly from international visitors. He has heard about concerns about water quality in the River, but it has never been an issue for him since he's not a regular user of the lower reaches. Pollution sources are mostly considered to be from farm run-off – mostly nitrates. He doesn't think

[12] Confirmed email 2 May 2019

[13] Confirmed email 30 April 2019

[14] Confirmed by phone, 30 May 2019

about the Alliance plant as a source, largely as it's outside his area of interest. He certainly wouldn't drink from the River – at least not below Fairlight, and even then, only in small quantities.

He has heard about fewer mayfly hatches in the lower River but has not associated that with water quality issues.

Water quality in the backcountry is still looking really good.

9.5 Julian Peters, angling guide[15]

Julian is based in Gore and spends most of his guiding time on the Mataura River, from Seaward Downs upstream. He has 27 years' guiding experience and has been fishing locally for 45 years, and lived in Wyndham up to the late 1980s. His experience of the River includes the 'bad old days' when the pulp and paper mill, municipal wastewater, dairy factory and freezing works all had poorly managed discharges, so the current state of the River is, relatively, a great improvement. Julian worked at the Alliance plant in the 1990s and so had direct experience of the original discharge and the redevelopment of the treatment system to today's standard.

However, since the turn of the Century when the various municipal and industrial discharges were controlled, the quality of the River has steadily declined. Some years are better than others, but in general the fishing is not as good as when Julian first started guiding. Twenty years ago, he would have been happy to drink the water above Gore, but no longer. The greatest influence has been the increase in farming intensification and over-development of land – although so much has changed in the region over the past 20 years, that it is hard to pinpoint any singular influence. Municipal inputs are as much an issue as agricultural.

Changes are evidenced by an increase in the frequency and duration of algal blooms and a reduction in invertebrate life. The changes are most evident below Gore but are more obvious below Mataura. Julian would not eat a fish caught in these reaches. Since his younger days in Wyndham in the '80s, algal blooms have not improved. He perceives that there are fewer caddis flies and mayflies, although he notes that there is no scientific benchmark to work from.

There seems to be less water in the River during dry periods – although this may just be perceptual since the hydrographs show more average flows – but the river is certainly peakier, with faster rates of change – both up and down. Land use changes mean there is less flow attenuation.

He has seen 'hardy souls' swimming in the River around Gore and Mataura, but would not do so himself. The odd kayaker goes past, but the River is a bit too tame to be of much interest.

The Alliance discharge still features in his mind as a contributor to water quality issues in the Mataura, partly because of his experience as a staff member. Although, in general terms, it is a meat processor and takes water and discharges waste, and so must be a contributor to water quality issues.

9.6 Lloyd Smith, angling guide[16]

Lloyd guides anglers throughout the Mataura River and is based in Gore, with 40 years fishing experience. He is the past-president of the Wyndham Angling Club, which focuses on encouraging fishing participation and contributing to relevant resource management issues.

The quality of the Mataura River is certainly a huge improvement since the control or cease of discharges from likes of the paper mill, dairy factory and Alliance works – although there are fewer very large fish which fed on their outputs. Water colour and clarity is now more consistent along the River's length. Water quality issues are currently more to do with water takes (water quantity), riparian management and agricultural run-off.

[15] Confirmed email 3 May 2019

[16] Confirmed email 5 May 2019

There appears to be more low flows and less water in the River generally, which leads to warmer water and more algae. Fish are less active when the water warms and not interested in feeding (and are therefore harder to catch). On hot summer days, with low flows, the River often has an odour associated with farming run-off.

However, there are still plenty of healthy fish in the River and Lloyd has many happy clients who enjoy the high catch rate and easy access below Gore. The ideal is casting to a rising or sighted fish, which they can do on anywhere on the Mataura; and not all clients want a backcountry experience. All activity is catch and release – although this might be maintaining a high density of fish, with high competition for food and so fewer large fish.

Fishing can be patchy, but this is mostly related to the weather and recent floods. Lloyd is not a fan of riparian fencing adjacent to the Mataura, which creates stable, weed-infested borders and does not allow the River to function naturally. He would prefer riparian grazing by sheep (there is a strong preference amongst clients to fish adjacent to sheep farms rather than dairy or beef).

Algae is an issue – as it with most streams and rivers in the area. Lloyd didn't register algae in his youth but is now more aware.

Invertebrate numbers appear to have been stable over the past seven or eight years, but there was a gradual decline previously. There are certainly fewer evening and afternoon mayfly rises on the River, and the hatches are certainly not what they were when he was a teenager – although some recent events have been good.

The Alliance plant is not a concern, although Lloyd assumes that the locals would recognise it as having a discharge and therefore some effect on water quality. He notes that industry has been steadily cleaning up its act over time.

He sees kayakers and swimmers in the River, although there is a perception that it is not safe for swimming, particularly from around Gore downstream. Lloyd would not swim in the River below Cattle Flat.

9.7 Zane Moss, Manager Southland Fish and Game[17]

Water quality in the Mataura River downstream of Mataura has improved significantly over the past 15 or so years, particularly associated with Alliance's last upgrade to its treatment system, with a big reduction in dissolved reactive phosphorous (DRP). Algal growth appears to be far less significant, although there is a lack of good data to indicate absolute changes in ecosystem values – and this applies to fish and invertebrates, as well as periphyton.

A notable change over the past 10 years or so has been the decline of the scale and frequency of the Deleatidium mayfly hatch. A decade ago a common sight would be perhaps a hundred fish rising to a major hatch in one long pool – it almost looked look like a fish farm, and would occur on a daily – afternoon – basis, particularly through April. This is no longer an event, with rises happening less often and in the evening or night. Angling activity below Gore has subsequently dropped dramatically as indicated by the national angler survey data. There is still a reasonable abundance of mayflies, however – although noting a lack of empirical data. The fishing is still good, but generally requires a change in technique from dry fly to nymphing. Fishing to a rising fish is, however, a peak experience for many anglers.

Causes of this change are unclear. Temperature could play a role, but might not be the primary issue. Dairying is unlikely to be the sole cause since DRP in the River was higher prior to the Alliance plant upgrade. There needs to be more and better research.

There have been several complaints made about the discharge from the Gore wastewater treatment plant, and it is unclear if this is coping adequately with the recent addition of waste from

[17] Confirmed, and as informal, by email 30 May 2019

Mataura Valley Milk. There is a big question-mark over whether the recent algal blooms in the treatment plant are a consequence. The current discharge from the Alliance plant is not featuring so much in people's minds. It would be interesting to see the reconsenting dates for all wastewater discharges into the Mataura River falling due at the same time so a comprehensive analysis of all treatment options could be considered.

Anglers are common immediately below the Mataura Falls, where trout and the occasional salmon tend to congregate. There might be a little odour from time to time, but Zane assumes the regulars fishing there must be accustomed to this. Foam is an ongoing discussion point, but it is generally accepted by those anglers as being a natural river feature.

9.8 Southland Canoe Club

The Southland Canoe Club requested feedback about kayaking on the Mataura River via its Club Facebook page, and committee member Maurice Rodway compiled advice from other Club members. The River from above Gore to Seaward Downs has a nice mixture of gentle runs and rapids including some interesting small drops where the River goes over coal seams and sandstone structures. The Mataura Falls is 'quite a drop' and is used by only expert and experienced kayakers. The River below Mataura to Tuturau is a gentle run for less experienced paddlers, with good water nearer the get out. The various industrial and municipal wastewater discharges into the River means kayakers are wary of ingesting any water.

Two Club members responded to the Club's Facebook query regarding perceptions of water quality. These included:

- A report of a 'violent illness' after falling out of a kayak immediately below the Mataura Falls 'about 6 years ago'.
- Another of never being sick, but avoiding drinking the water.
- An unpleasant odour from the Alliance discharge below the Falls.

One Club member described the setting below the Falls as 'horrendous' due to the discharge and the proximity of the Alliance buildings to the River.

9.9 Swimming

No active swimmers were tracked down for interviews. Advice was sought from Alan Taylor, member of the Mataura Community Board, and Ian Soper, Parks and Recreation Manager, Gore District Council. Key points include:

- The closure of the Council-operated Mataura swimming pool in 2017 means that there is probably more pressure on the River as a swimming destination than previously, although the River has been a destination for a long period, particularly when kids wanted to avoid supervision at the community pool.
- Swimming is most commonly carried out by people living near the River, with kids and teenagers the biggest user group. There is probably a small but regular number of users. Swimming generally occurs at a number of specific sites. Walnut Grove in Gore is particularly popular.
- There are no common conversations about illnesses resulting from swimming in the River, but many people would avoid it due to perceptions of poor water quality. There have been some specific issues with the Gore and Mataura wastewater discharges, and this has possibly coloured perceptions generally, although bathing water quality indicators are often poor (although they do not appear to affect swimmers' behaviour much).
- At low flows the River can appear unattractive, but freshes and floods regularly flush it. Toxic algae warnings have been issued by Environment Southland, particularly in the

Mataura Island Bridge area. There is a heightened sensitivity over the potential effects farming intensification on water quality.

Appendix 2: Southland Fish & Game Mataura River access map

Mataura River Anglers Access

Fish & Game

Southland Region

Magic of the Mataura

The Mataura is one of New Zealand's most famous fishing rivers. Some claim it is the best fly fishing river in the world, others would beg to differ.

The most famous feature of the Mataura is its hatches of mayfly. Whilst other New Zealand rivers tend to have sporadic hatches in the evenings the Mataura often produces consistent hatches that can start at 10am and last through until nightfall!

Fly fishing patterns & techniques

Most who come to fish the Mataura do so for the dry fly fishing that it offers. Whilst some will tell you Mataura trout are incredibly selective, others will tell you that it's presentation that's the key. The most successful anglers on the Mataura are those that can drop their fly repeatedly only a foot or so in front of a trout's nose.

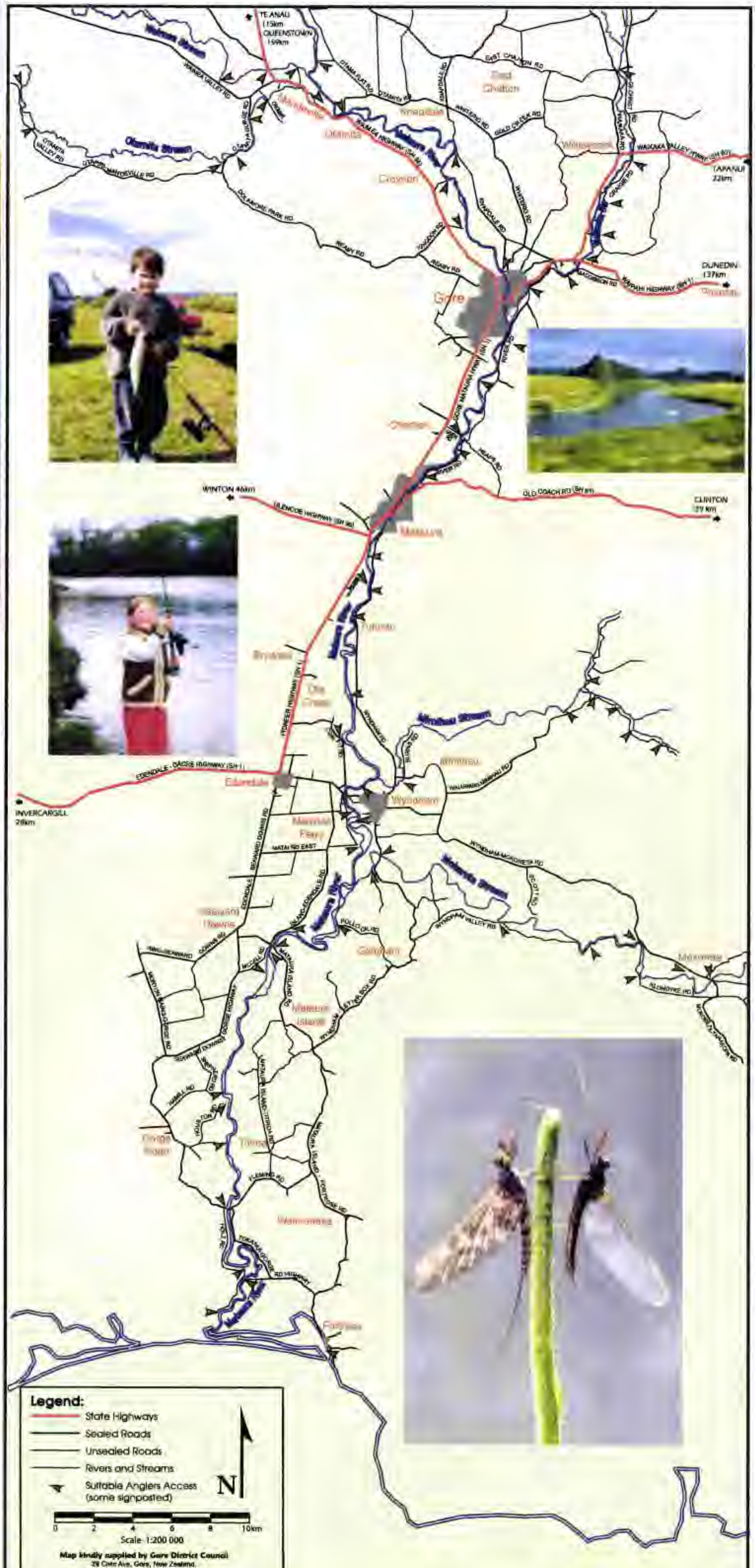
Watch the trout carefully and ensure that they are taking hatched duns and not 'emergers' in the surface film. Try using standard patterns such as Dad's Favourite, Blue Dun or Adams'. Adams' tied in parachute style are particularly popular. Whilst there are many patterns that will work, if in doubt try the 'old faithfuls' and then experiment if not successful. Use sizes 16 or 18.

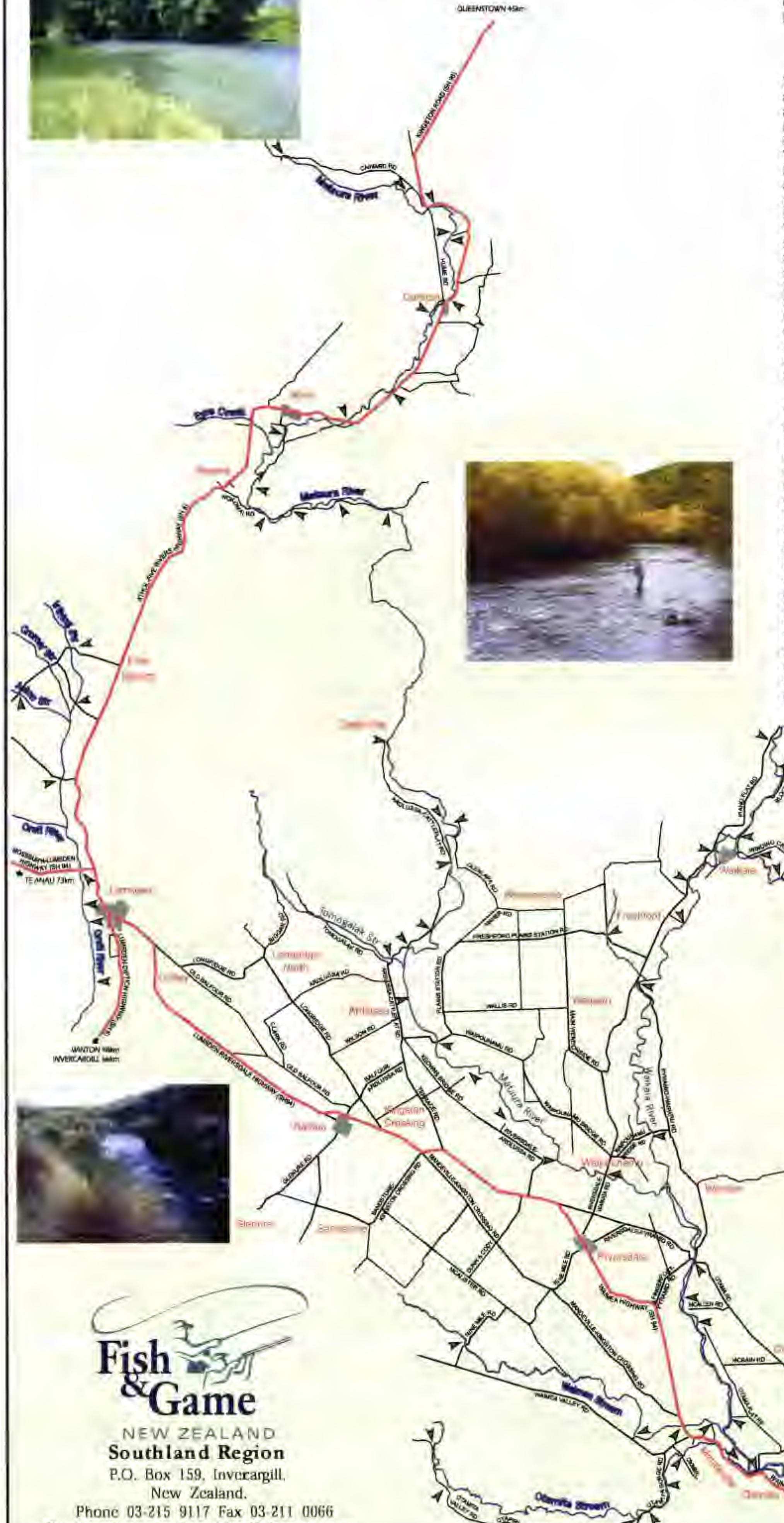
If the trout appear to be targeting 'emergers' try using CDC patterns. These feathers provide moderate floatation to the fly wing, with the body sinking below the surface film. Other anglers use unweighted nymph patterns and grease their leader to present the fly in the surface film. Once again use small patterns.

When surface activity is not obvious trout may be targeting nymphs in the riffles. Most standard patterns will work, if fished in smaller sizes and tied relatively sparsely. The ubiquitous Pheasant-tail remains productive, although patterns tied with a very small bead head are gaining popularity. Don't be scared to fish shallow, as many Mataura browns will lie in water that hardly covers their backs.

Fish & Game New Zealand Southland Region

Gore District Council





Willow grubs are a popular summer food source for the browns in both the Mataura and the Waikaia. Whilst trout feeding on willow grubs can be frustrating to catch, with a very small imitation fished in the surface film they can be successfully outwitted.

Threadline patterns & techniques

Whilst most famous as a fly fishing river the Mataura also offers exciting opportunities for the threadline angler. As with most threadlining, lighter tackle tends to be best, and best fishing times are following a fresh in the river as the clarity improves and at dawn or dusk. The lower river provides a chance to target 'sea-run' browns. Lures that simulate smelt are most productive, such as the various Toby patterns. Fishing natural bait, particularly smelt, is also popular and productive in the lower river.

Throughout the river patterns such as the Mepps blade spinners are very good, fished in the smaller sizes upstream into the riffles. Rapalas are also effective, although somewhat pricey to throw into the willows! Natural bait is popular early in the season and when the river is discoloured.

Over the summer period threadline anglers should experiment with a small bubble and a nymph, cast upstream into the ripples. This can be an extremely effective technique, much more so than traditional options.

Mataura Tributaries

Techniques for the main stem of the Mataura are generally effective on the tributaries, without too much alteration in either pattern or technique, although increasing fly size from 16s & 18s to 12s & 14s improves success. Trout do not rise as consistently in the side tributaries as they do on the Mataura below Gore. However, when the conditions are suitable, these tributaries offer rewarding fishing. Often these tributaries have slightly brackish waters, which can limit spotting fish, and likely spots should be prospected with a nymph or dry fly.

Regulations

Above the Garston bridge the Mataura and its tributaries are designated "catch & release" and artificial baits only. Other Mataura tributaries above the Ardlussa bridge have a two fish per day limit, as have tributaries of the Waikaia and the Otamita mainstream above the gorge bridge. However, these regulations are subject to change and anglers should always refer to their free Sports Fishing Regulation Guide if ever unsure of a new area's regulations.

Fish & Game
NEW ZEALAND
Southland Region
P.O. Box 159, Invercargill,
New Zealand.
Phone 03-215 9117 Fax 03-211 0066
Email: information@southlandfishgame.co.nz

6

APPENDIX 6

Assessment of Economic Benefits,

Mike Copeland – Brown, Copeland & Co, 2019

FINAL

RENEWAL OF RESOURCE CONSENTS TO ENABLE CONTINUED OPERATION OF THE ALLIANCE GROUP LIMITED'S MATAURA MEAT PROCESSING PLANT

ASSESSMENT OF ECONOMIC BENEFITS

Mike Copeland
Brown, Copeland & Co Ltd

31 May, 2019

1. INTRODUCTION

Background

1.1 The Alliance Group Limited (Alliance) is a co-operative owned and supplied by 4,340 shareholder farmers, who supply more than 85% of the livestock processed at its five plants located in the South Island and two in the North Island.[1] The Mataura plant, which accounts for approximately 17% of Alliance's processing capacity, is located in the Gore District, about 50 kilometres north-east of Invercargill. In 2017/18[2], the plant processed approximately 143,000 cattle into meat, offal, hides and other products. Livestock were purchased mostly from Southland, Otago and Canterbury farmers. In addition the plant spent around $12 million per annum on goods and services supplied by local Southland businesses (e.g. Ajax Building, Tullochs Transport, Greenbriar (coal supply) and J Harper Contracting). The plant paid $22 million per annum in wages and salaries to fulltime salaried staff and seasonal staff – at the peak of the season there are 500 employees at the plant.

1.2 Alliance currently holds eight resource consents issued by the Southland Regional Council (Environment Southland) and one issued by the Gore District Council. These resource consents enable the operation of the Mataura plant and authorise discharges to air, land and water, and the taking of water. Alliance is seeking renewal of three resource consents due to expire on 6 December, 2019 and one due to expire on 15 December, 2020 to enable the continued operation of its Mataura meat processing plant for a further 35 years.

Report Objective

1.3 The objective of this report is to assess the Gore District and Southland regional economic effects of the continued operation of the Mataura plant. The report will form part of the Assessment of Environmental Effects to be lodged in relation to the consents renewal applications.

---

[1] The plants are located at Stoke (Nelson), Smithfield (Timaru), Pukeuri (North Otago), Mataura (Southland), Lorneville (Southland), Levin (Horowhenua) and Dannevirke (Hawkes Bay).

[2] I.e. the year ending 30 September, 2018.

Report Format

1.4 This report is divided into 5 parts (in addition to this introductory section). These are:

(a) The background to the Mataura plant operations;
(b) A consideration of the relevance of economic effects under the Resource Management Act (RMA);
(c) A description of the Gore District and Southland regional economies;
(d) The economic benefits from consent renewals; and
(e) Some overall conclusions.

2. BACKGROUND TO THE MATAURA PLANT'S OPERATIONS[3]

2.1 Meat exports of $7.4 billion for the calendar year 2018 were New Zealand's second largest commodity[4] exports by value behind dairy products ($14.7 billion[5]) and ahead of forest products ($6.6 billion), fruit ($3.2 million) and fish ($1.6 billion). In 2018, meat and edible offal and raw hides and skins ($0.4 billion) made up 13.6% of the value of New Zealand's commodity export trade, second only to dairy product exports which made up 25.6%.[6]

2.2 Trade enables New Zealand to specialise in the production of certain products in which New Zealand has a comparative advantage enabling production surplus to domestic consumption to be exported. The production of meat and other animal products is an area in which New Zealand has comparative advantage. Exports of these products provide foreign exchange, enabling New Zealand to finance the purchase of competitively priced imported goods and services. The alternative model of "fortress New Zealand"[7] would see higher priced goods and services, reduced choice in the range of goods and services available in New Zealand and

[3] Material in this section provided by Alliance, unless stated otherwise.
[4] A distinction is made between "commodity trade" or "merchandise trade" and total trade. Commodity trade relates to the exporting and importing of goods only, whereas total trade includes the exporting and importing of both goods and services.
[5] Includes eggs and honey.
[6] Trade statistics from Statistics New Zealand NZ Stat.
[7] I.e. a situation where New Zealand's trade with the rest of the world is constrained and it is not possible for New Zealand to specialize in the production of those goods and services in which it has a comparative advantage, nor access cheaper goods and services from overseas.

a less efficient use of our physical and natural resources. This would result in lower incomes and a lower standard of living for New Zealanders.

2.3 Alliance's total revenues in 2017/18 were $1.8 billion, of which $1.6 billion (89%) were from export earnings. It employs 4,650 fulltime salaried staff and seasonal employees and pays $235 million per annum in wages and salaries. Of Alliance's 4,340 shareholders on the Share Register at 30 September 2018, over a third were in Southland. The shareholders are a mix of family owned farms and corporate entities.

2.4 The Mataura meat processing plant was established in 1893 and processes cattle. The plant provides Alliance with its only processing capacity for cattle within the Southland region and any reduction in the plant's capacity to process cattle would see this livestock processed outside the region.

2.5 The latest estimate (December 2018) for the Mataura plant's insured value is $225 million and much of this value is sunk – i.e. it could not be recovered if the plant was forced to downsize, close or be relocated.

2.6 Stock for the plant is largely sourced locally. In 2017/18, approximately 143,000 cattle were processed at the plant, with a relatively even split between Southland and Otago/Canterbury. Approximately 230 twenty foot equivalent unit (TEU) containers of meat and meat products were shipped from the plant through SouthPort in 2017/18.

2.7 Alliance has analysed the advantages of retaining processing capacity at the Mataura plant relative to other potential new sites and/or the expansion of other existing plants. The key advantages are:

(a) The continued use of existing plant and equipment having significant sunk costs;

(b) Sufficient livestock production in the immediate area and wider surrounding catchment;

(c) Optimised location from the perspective of livestock and processed products' transportation;

(d) The proximity of a trained and experienced workforce;

(e) The proximity of supplier businesses with appropriate expertise and experience;

(f) The proximity of both road and rail networks for plant inputs and outputs;

(g) The availability of sufficient water supply from the Mataura River to enable livestock processing operations;

(h) The ability to discharge treated meat processing waste to the Mataura River and treated wastewater solids to land;

(i) The ability to minimise and mitigate adverse environmental effects for neighbours and the wider community;

(j) Few incompatible adjacent or nearby land uses;

(k) The site is large enough for any future expansion; and

(l) Economies of scale and scope as compared to relocating processing capacity to a number of alternative sites.

2.8 Consent renewals will enable Alliance and its supplier shareholders to continue to benefit from these economic advantages of the plant. Closure or downsizing of the plant due to consents not being renewed or being renewed with more stringent conditions would result in efficiency losses from reduced utilisation of existing assets, higher costs and reduced returns for Alliance's farmer shareholders. In addition there will be economic costs for the broader Gore and Southland communities. These are covered later in this report.

3. ECONOMICS AND THE RMA

Community Economic Wellbeing

3.1 Economic considerations are intertwined with the concept of the sustainable management of natural and physical resources, which is embodied in the RMA. In particular, Part 2 section 5(2) refers to enabling "*people and communities to provide for their ... economic ... well being*" as a part of the meaning of "*sustainable management*", the promotion of which is the purpose of the RMA.

3.2 As well as indicating the relevance of economic effects in considerations under the RMA, this section also refers to *"people and communities"* (emphasis added), which highlights that in assessing the impacts of a proposal it is the impacts on the community and not just the applicant or particular individuals or organisations, that must be taken into account. This is underpinned by the definition of *"environment"* which also extends to include people and communities.

3.3 The continued operation of the Mataura plant enables the residents and businesses of Gore and the Southland region to provide for their social and economic wellbeing by retaining employment, incomes and expenditure within the local economy.

Economic Efficiency

3.4 Part 2 section 7(b) of the RMA notes that in achieving the purpose of the Act, all persons *"shall have particular regard to ... the efficient use and development of natural and physical resources"* which include the economic concept of efficiency[8]. Economic efficiency can be defined as:

> *"the effectiveness of resource allocation in the economy as a whole such that outputs of goods and services fully reflect consumer preferences for these goods and services as well as individual goods and services being produced at minimum cost through appropriate mixes of factor inputs".* [9]

3.5 More generally economic efficiency can be considered in terms of:

- Maximising the value of outputs divided by the cost of inputs;
- Maximising the value of outputs for a given cost of inputs;
- Minimising the cost of inputs for a given value of outputs;
- Improving the utilisation of existing assets; and
- Minimising waste.

3.6 The continued operation of Alliance's Mataura plant is consistent with the efficient use of resources, especially in regard to the ongoing use of significant existing assets, transport cost savings and the economies of scale in production available at the plant.

---

[8] See, for example, in *Marlborough Ridge Ltd v Marlborough District Council* [1998] NZRMA 73, the Court noted that all aspects of efficiency are "*economic*" by definition because economics is about the use of resources generally.
[9] Pass, Christopher and Lowes, Bryan, 1993, *Collins Dictionary of Economics* (2nd edition), Harper Collins, page 148.

Value of Investment to the Existing Consent Holder

3.7 Part 6, section 104 (2A) of the RMA requires the consent authority when considering a renewal of an existing consent to *"have regard to the value of the investment of the existing consent holder."* The value to Alliance of its investment in the Mataura plant can be considered in terms of either the insured value of the plant ($225 million) or the foregone future earnings of the plant if it was forced to close. By both of these measures, the value of the Mataura plant is significant to the existing consents' holder.

Viewpoint

3.8 An essential first step in carrying out an evaluation of the positive and negative economic effects of the granting of consent renewals is to define the appropriate viewpoint that is to be adopted. This helps to define which economic effects are relevant to the analysis. Typically a district (or city) or wider regional viewpoint is adopted and sometimes even a nationwide viewpoint might be considered appropriate.

3.9 The Mataura processing plant is located in the Gore District, which is part of the Southland region. Therefore in this report the economic effects are considered in relation to the Gore District and the Southland region.

3.10 There are also private or financial benefits associated with the granting of consent renewals. Generally these benefits are not relevant under the RMA and the main focus of this report is therefore on the wider economic effects on parties other than Alliance and its customers. Economists refer to such effects as "externalities"[10].

3.11 However, Alliance is owned by its farmer shareholders and financial benefits to Alliance impact on the *"economic (and social) well being"* of these farmer shareholders including those within the local community – i.e. the Southland region. Increased returns to (or reduced costs for) farmer shareholders in Southland will flow through to increased expenditure, employment and incomes within the Gore and Southland economies, as a consequence of increased

[10] Defined as the side effects of the production or use of a good or service, which affects third parties, other than just the buyer and seller.

disposable income for local farmer shareholders. Also financial benefits to Alliance are relevant with respect to the *"efficient use and development of natural and physical resources"* and New Zealand's export competitiveness, given the Mataura plant's significant scale and the importance of meat and meat product exports to the New Zealand economy.

4. BACKGROUND TO GORE DISTRICT AND SOUTHLAND REGION'S ECONOMIES[11]

4.1 Statistics New Zealand's June 2018 population estimate for Gore District is 12,500. In 2010 population in the District was estimated to be 12,400, implying growth of 0.8% over the period 2010 to 2018, as compared to growth of 12.3% for New Zealand as whole. Statistics New Zealand's 'medium' population projections[12] have Gore District's population decreasing to 11,450 in 2043 – i.e. an average rate of decline of 0.4% per annum over the period 2018-43, compared to an average rate of growth for New Zealand of 0.8% per annum.

4.2 Statistics New Zealand's June 2018 population estimate for the Southland region is 99,100. In 2010 population in the region was 94,700. The region's population over the period 2010 to 2018 has grown by 4.6%. Statistics New Zealand's 'medium' population projections have the region's population decreasing to 99,000 in 2043 – i.e. an average rate of decline of 0.01% per annum over the period 2018-43.

4.3 Employment data highlight the importance of the agricultural sector to the Gore District. In February 2018, 1,300 jobs (20.0%) of the District's 6,500 jobs were in the agricultural, forestry and fishing sector with agriculture and agriculture support services contributing 1,117 of these jobs or 17.2% of total employment in the District. Manufacturing contributed 960 jobs (14.8% of total jobs in the District)) with meat and meat products manufacturing contributing 610 of these jobs. Other significant sources of employment within the Gore District are retail trade (960 or 14.8% of total employment), health and social assistance (500 jobs, or 7.7% of

[11] Data in this section from Statistics New Zealand NZ Stat.
[12] Statistics New Zealand prepare three sets of projections – high, medium and low – according to natural population change (i.e. the net effect of birth and death rate assumptions) and net migration assumptions. These projections do not explicitly incorporate assumptions about different rates of economic development.

total employment), healthcare and social services (500 jobs or 7.7% of total employment), and education and training (450 or 6.9% of total employment).

4.4 For the Southland region in February, 2018 there were 49,400 jobs. Agriculture, forestry and fishing with 8,370 jobs (16.9% of total employment) and manufacturing with 8,000 jobs (16.2% of total employment) are the two largest sectors. Within agriculture, forestry and fishing, agriculture and agriculture support services accounts for around 7,141 or 85.3% of these jobs including 2,750 in dairy farming and 2,200 in sheep, beef cattle and grain farming. Within manufacturing, there are 4,750 jobs in food product manufacturing including 3,600 jobs in meat and meat products manufacturing and 630 jobs in dairy products manufacturing. Other important sources of employment for the Southland region are retail trade (5,100 jobs or 10.3% of total regional employment), health and social assistance (4,750 jobs or 9.6% of total regional employment), accommodation and food services (3,450 jobs or 7.0% of total regional employment) and education and training (3,350 jobs or 6.8% of total regional employment). However these service sectors are to a large extent "driven" by the economic activity generated by the so called "economic drivers" of the region – principally agriculture and agricultural product processing and the Tiwai point aluminium smelter. Taken together agriculture, food product manufacturing and the Tiwai Point aluminium smelter directly account for about 27% of total employment in the region. With the inclusion of the flow on, or "multiplier" effects, (see next section of this report), these industries generate around 48% of total employment in the region.

5. ECONOMIC BENEFITS FROM CONSENT RENEWALS

Maintaining Economic Activity within the District and Regional Economies[13]

5.1 The Mataura meat processing plant employs up to 500 full time salaried staff and seasonal workers at the peak. This equates to 340 full time equivalent staff (FTEs). Alliance's Mataura plant pays out $22 million in wages and salaries per annum and spends an estimated additional $12.3 million per annum in the Southland region on goods and services. Goods and services to the plant provided by local firms include transport, engineering, plumbing, electrical and

[13] Unless stated otherwise data in this section provided by Alliance.

security contractors; packaging suppliers; utilities (electricity and telecommunications); providers of medical services and supplies (doctors, physiotherapists, drug testers and other healthcare service suppliers); professional service suppliers; and providers of laboratory equipment and materials, clothing, fuels, knives and food.

5.2 These are the direct economic impacts for the Southland region's economy from the plant's operation.[14]

5.3 However in addition to these direct economic impacts there are indirect impacts arising from:

a. The effects on suppliers of goods and services provided to the plant from within the region (i.e. the "forward and backward linkage" effects); and

b. The supply of goods and services from within the region to employees at the plant and to those engaged in supplying goods and services to the plant (i.e. the "induced" effects). For example, there will be additional jobs and incomes for employees of supermarkets, restaurants and bars as a consequence of the additional expenditure by employees directly employed at the plant.

5.4 Multipliers can be estimated to gauge the size of these indirect effects. The size of the multipliers is a function of the extent to which an area's economy is self-sufficient in the provision of a full range of goods and services and the area's proximity to alternative sources of supply. Multipliers typically fall in the range of 1.5 to 2.0 and taking the mid-point of this range (i.e. 1.75) implies total impacts (i.e. direct plus indirect impacts) of:

- 595 FTE jobs for local Southland residents; and
- $38.5 million per annum in wages and salaries for local Southland residents.

[14] No account is taken in this section of the direct and indirect economic impacts of cattle farming within the region. Cattle farming will in general not be affected by whether the resource consents are renewed – i.e. livestock produced within the region are assumed to be diverted to other meat processing plants if consents are not renewed. However to the extent the non-renewal of consents or stricter consent conditions add costs to meat processing, farmers will be impacted as a consequence of lower payments for livestock.

5.5 The Gore District and Invercargill City are the areas of the region that benefit most from the additional economic activity generated by the ongoing operation of the Mataura plant.

Economic Benefits from Increased Economic Activity

5.6 As indicators of levels of economic activity, economic impacts in terms of increased expenditure, incomes and employment within the local economy are not in themselves measures of improvements in economic welfare or economic wellbeing. However, there are economic welfare enhancing benefits associated with increased levels of economic activity. These relate to one or more of:

a. Increased economies of scale: Businesses and public sector agencies are able to provide increased amounts of outputs with lower unit costs, hence increasing profitability or lowering prices;

b. Increased competition: Increases in the demand for goods and services allow a greater number of providers of goods and services in markets and there are efficiency benefits from increased levels of competition;

c. Reduced unemployment and underemployment[15] of resources: To the extent resources (including labour) would be otherwise unemployed or underemployed, higher levels of economic activity can bring efficiency benefits when there is a reduction in unemployment and underemployment. The extent of such gains is of course a function of the extent of underutilized resources within the local economy at the time and the match of resource requirements and those resources unemployed or underemployed within the local economy; and

d. Increased quality of central government provided services: Sometimes the quality of services provided by central government such as education and health care are a function of population levels and the breadth and quality of such services in a community is higher with higher levels of economic activity, particularly to the extent they lead to or maintain higher levels of population.

[15] Underemployment differs from unemployment in that resources are employed but not at their maximum worth; e.g. in the case of labour, it can be employed at a higher skill and/or productivity level, reflected in higher wage rates.

5.7 The Mataura meat processing plant gives the Gore District greater critical mass and as a consequence the residents and businesses within the District benefit from economies of scale, greater competition, increased resource utilisation and better central government provided services. This is also true for the Southland region, although to a lesser extent given the economic activity generated by the plant is proportionately less for the region as compared to the Gore District.

Economic Efficiency Benefits from Optimising Plant Location

5.8 There are a number of economic efficiency benefits from Alliance obtaining consents to enable the continued operation of the Mataura plant at its current site. These have been listed earlier in section 2 of this report and include the continued use of existing plant and equipment with an insured value of $225 million,[16] the minimisation of transport costs (and carbon footprint) for livestock and finished product dispatch, the availability of a trained and experienced workforce and businesses with appropriate expertise and experience within close proximity of the plant, and economies of scale and scope as compared to re-locating processing capability to a number of alternative sites.

5.9 The Mataura plant provides Alliance with its cattle processing capacity in Southland and farmers would need to truck cattle out of the region for processing if the Mataura plant's processing capacity for cattle was reduced. There is insufficient capacity at other plants within the region to handle cattle processed at the Mataura plant. This would add to farmers' costs, reduce their disposable incomes and reduce spending in the Gore District and elsewhere within the region.

5.10 Alliance is seeking renewal of consents for a minimum period of 35 years. There are also economic efficiency benefits associated with consents being renewed for a longer term as compared to short term (e.g. 10 year) consent renewals. Longer term consent renewals not only save more frequent consent renewal costs, but also provide greater certainty for investment in and management of the plant.

---

[16] In addition to the economic efficiency benefits from the continued use of plant and equipment having an insured value of $225 million, Alliance's significant investment in the Mataura plant is also relevant in terms of Part 6, section 104 (2A) of the RMA, which requires regard to be given to value of the investment of the existing consent holder.

5.11 Maintaining these economic efficiency benefits is consistent with *"the efficient use and development of natural and physical resources"* (Part 2, section 7(b) of the RMA) as well as enabling *"people and communities to provide for their economic and social wellbeing"* (Part 2, section 5(2) of the RMA).

Greater Economic Resilience for the Gore District and the Southland Region

5.12 As discussed earlier in this report, both the Southland region and the Gore District are significantly dependent upon the agricultural sector, especially sheep and beef cattle and dairy farming. Therefore the Mataura plant helps provide greater diversity and balance to the two economies. Although it involves the processing of livestock, having livestock processing manufacturing capacity within the region provides employment opportunities and incomes less dependent upon returns to the agricultural sector. This makes the Gore District and Southland economies more resilient to agricultural commodity price cycles.

Rates Income to the Gore District Council and Environment Southland

5.13 The Mataura plant pays $238,000 per annum in rates to the Gore District Council and Environment Southland.The plant also pays out $13,000 per annum in consent fees. Whilst these payments are for services provided by the Councils and from which Alliance and its employees benefit, economies of scale mean that should the Councils lose this income, the range and quality of services provided by the Councils would diminish and/or payments by other ratepayers in the District and region would need to increase.

Community Sponsorship Programmes

5.14 In recognition of the important role the community plays in helping Alliance realise its potential, the company provides financial support to a number of initiatives at the community and national level. In the year to 30 September, 2018 the Mataura plant made grants totalling around $11,000 to various community organisations.

6. CONCLUSIONS

6.1 The granting of consents enabling the continued operation of the Mataura meat processing plant will maintain the economic wellbeing of people and communities within the Gore District and the Southland region by:

(i) Maintaining significant direct and indirect employment opportunities for local residents;

(ii) Maintaining significant direct and indirect wages and salaries for local residents;

(iii) Maintaining significant levels of direct and indirect expenditure with local businesses;

(iv) Maintaining population and economic activity levels within local communities thereby maintaining the breadth and quality level of services available to local residents and businesses;

(v) Providing greater employment choice for local residents;and

(vi) Continuing Alliance contributions to local community activities, in its role as a responsible employer and "good corporate citizen".

6.2 The granting of consents sought for the Mataura plant will maintain resource use efficiency by enabling:

(i) The continued use of existing plant and equipment with significant sunk costs;

(ii) The minimisation of transport costs for livestock and finished product dispatch;

(iii) The continued utilisation of a trained and experienced workforce and businesses with appropriate expertise and experience within close proximity of the plant;

(iv) The continued benefits from economies of scale and scope as compared to re-locating processing capability to a number of alternative sites; and

(v) The maintenance of population and economic activity levels (or "critical mass") in the Gore District and the Southland region, thereby providing economies of scale and competition in the local provision of goods and services.

6.3 The Mataura plant has an insured value estimated at $225 million. Therefore its value to Alliance (the existing consents' holder) is very significant.

7

APPENDIX 7

Mataura Plant Wastewater Treatment and Disposal Alternatives Assessment,

Pattle Delamore Partners, 2019

Auckland Tauranga Wellington Christchurch

PATTLE DELAMORE PARTNERS LTD

Alliance Mataura Plant
Wastewater Treatment and Disposal
Alternatives Assessment

Alliance Group Limited

solutions *for your environment*

Alliance Mataura Plant Wastewater Treatment and Disposal Alternatives Assessment

∴ Prepared for

Alliance Group Limited

∴ May 2019

PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 523 6900 Fax +64 9 523 6901
Website http://www.pdp.co.nz
Auckland Tauranga Wellington Christchurch

solutions for your environment

Quality Control Sheet

TITLE	Alliance Mataura Plant Wastewater Treatment and Disposal Alternatives Assessment
CLIENT	Alliance Group Limited
VERSION	Final
ISSUE DATE	31 May 2019
JOB REFERENCE	AJ903227
SOURCE FILE(S)	AJ903227R001.docx

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Luke Wilkinson

Reviewed by

SIGNATURE

Daryl Irvine

Approved by

Azam Khan

Limitations:

The information contained in this document produced by Pattle Delamore Partners Limited (PDP) is solely for the use of Alliance Group Limited for the purpose for which it has been prepared and PDP undertakes no duty to or accepts any responsibility to any third party who may rely upon this document. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person other than for its intended purpose set out in the scope. Any such use or reliance will be solely at their own risk.

PDP have prepared the cost estimate for the nominated service or plant in this report. PDP have no control over the cost of labour, materials, equipment or services provided by others, contractor prices, competitive bidding, future market conditions or inflation. Any opinion of estimated cost is PDP's opinion based on our experience and represents our judgement as experienced and qualified professional engineers. PDP cannot guarantee that proposals, bids or actual construction costs will not vary from our estimate.

Executive Summary

Preamble

Alliance Group Limited (Alliance) owns and operates a beef processing plant at Mataura (Alliance Mataura). The inedible offal material and blood is sent off-site for by-products processing.

The site holds consents granted by Environment Southland and Alliance Group Limited is planning to lodge the relevant applications for re-consenting in June 2019. The wastewater generated at the site is discharged into the Mataura River. Alliance Mataura is seeking replacement consents to allow these activities to continue.

In preparing for the new consent application, Alliance Mataura has undertaken environmental investigations, including assessing options and constraints to establish feasible options for the progressive upgrading of wastewater treatment technology at the plant and allowing continued discharges to the Mataura River.

Issues and Constraints

Alliance Mataura has recognised that there are constraints related to the management of wastewater at the site. A comprehensive assessment of the effects of the discharge on the receiving environment has determined that no adverse effects trigger the need for immediate or urgent mitigation. However, the planning framework which applies here anticipates a long-term, catchment wide improvement in water quality for a range of water quality parameters. If a longer-term consent is to be sought and obtained it will be necessary to show how the plant is to be managed to progressively improve the quality of the discharge to address the contaminants in question. Alliance Mataura recognises a need to address these issues and is committed to doing its part in assisting long-term catchment scale improvement.

As part of the re-consenting process, Alliance Mataura is reviewing the site's ability to treat wastewater, with consideration of a range of options, including a continued discharge of wastewater into the Mataura River. The key contaminants of concern in the discharge are *E. coli*, ammoniacal nitrogen, total nitrogen and total phosphorus.

This report has been prepared to provide a shortlist of options for consideration and more detailed evaluation. It will ultimately assist to inform the assessment of environmental effects that will be prepared in support of the application.

Shortlisted Options

A range of wastewater treatment technologies have been investigated to achieve contaminant removal to various levels and including discharge options to different receiving environments.

A qualitative assessment was conducted to compare a range of short-listed options. This assessment has resulted in an expressed preference for continued discharge of wastewater to the Mataura River but with a reduction of both nitrogen and *E. coli*.

The treatment option ultimately selected will be based on a range of considerations including existing and emergent policy directives relating to water quality, assessment of the receiving environment and the effects of the discharge on that environment, the feasibility of the option, and matters raised and considered during consultation with key stakeholders. In the event there is tightening of contaminant limits, a biological treatment option will become necessary together with tertiary disinfection of microbial contaminants.

Table of Contents

Table of Figures

Table of Tables

1.0 Introduction

Alliance Group Limited (Alliance) owns and operates a beef processing plant at Mataura (Alliance Mataura), processing up to 1,062 animals per day. Water utilised in the beef processing plant is sourced from the Mataura River and all generated process wastewater is treated on-site as two main waste streams, green waste and non-green waste, in a chemically assisted dissolved air flotation (DAF) based system prior to being discharged back to the Mataura River. Treated wastewater discharged to the Mataura River is allowed under Environment Southland Regional Council (ESRC) Resource Consent 202327, which is due to expire in December 2019.

The Alliance Mataura Plant has historically processed up to 10,000 sheep per day and 560 beef animals per day (with additional by-products processing including casings and rendering), with an allowable discharge rate of 14,400 m^3 of treated wastewater per day. In 2012, the processing of sheep and rendering ceased and beef production increased to up to 1,062 beef animals per day. For the foreseeable future, it is expected that the Mataura site will continue to operate solely as a beef processing plant.

To enable the continued discharge of treated wastewater to the Mataura River, Alliance must apply for a replacement consent by June 2019. In examining the requirements of the re-consenting of a discharge, under Schedule 4, Clause 6(d)(ii) information to be provided with the consent application needs to include a description of *any possible alternative methods of discharge, including discharge into any other receiving environment.*

With regards to the current discharge to the Mataura River, the assessment of environmental effects prepared by Freshwater Solutions Limited (2019) has identified the key contaminants of concern in the discharge are:

- *E. coli;*
- Ammoniacal-nitrogen;
- Total Nitrogen; and
- Total Phosphorus.

No adverse effects of the Alliance Mataura discharge, requiring immediate or urgent mitigation, have been identified in respect of the above parameters (Freshwater Solutions 2019). However, the planning framework which applies anticipates a long-term catchment wide improvement in water quality for each parameter. If a longer-term consent is to be sought and obtained, it will be necessary to show how the plant is to be managed to progressively improve the quality of the discharge to address the contaminants in question. Therefore, Alliance has requested that this report examine options for the Alliance Mataura plant doing its part in realising that long-term catchment scale improvement.

No detail is available yet on the extent of the catchment scale improvement anticipated for each parameter, or the timeframes and methods for achieving that improvement, including which parameter should be afforded priority. The planning framework anticipates these matters will be determined via a collaborative planning process for the Mataura Freshwater Management Unit, involving all key stakeholders, which is expected to commence soon but is not expected to be complete until 2022.

This is reflected in the recommended process improvements set out in Section 5 and 6 of this report which include:

1. A preferred option if there is no preference for the order in which each parameter is improved;
2. Preferred options if it were determined that a reduction in either *E. coli* or nitrogen should be prioritised for environmental reasons (noting this report's conclusion that the wastewater system is already optimised in terms of minimising its discharge of dissolved reactive phosphorus (part of total phosphorus).

This assessment of alternatives takes into consideration the key contaminants of concern with the existing discharge, potential alternative disposal options available and wastewater treatment alternatives necessary to meet the requirements of the respective disposal options.

A long-list of available alternatives was developed, and from that a shortlist of potential options was prepared. Each of the short-listed options was then assessed further, considering the potential for the option to reduce contaminant loads to the Mataura River, option resilience, and lifecycle costs.

This report summarises both the long-list options assessment and assessment of the short-listed alternative options.

2.0 Background Information

The following information has been used in developing this options assessment:

1. A review of the existing wastewater treatment and disposal methods;
2. Identification of current and future wastewater flows and loads;
3. Key assumptions made during the assessment of all options.

2.1 Existing Wastewater Treatment and Disposal

Two waste streams are produced at the plant; these are referred to as Green Waste and Non-Green Waste. Green waste is generated from stockyards, gut cutting areas and tripe processing. Non-green wastes are sourced from the slaughter floor, further processing and hides wash overflow. Both streams are passed through separate milli-screening screens and saveall tanks for gross solids removal. The green waste contains a high total phosphorus load so is treated in a 2 stage DAF-in-Series system, consisting of an acid DAF stage and then an alkali DAF stage for phosphorus precipitation. The non-green waste does not contain a high phosphorus load so undergoes an acid DAF treatment for protein precipitation. In total there are 12 DAFs on site, 9 of which are currently operational. There are 3 parallel Non-Green waste acid DAFs and three parallel sets (6 in total) of acid/alkali DAFs for Green waste treatment. Refer to Figure 1 for a block diagram of the existing process.

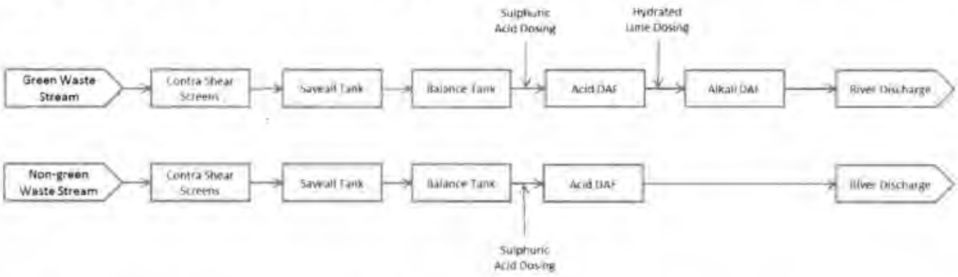


Figure 1: Existing wastewater treatment process

The streams are discharged via separate diffusers to the Mataura River. The existing discharge is located adjacent to the site and downstream of the Mataura Falls.

2.2 Contaminants of Concern

The assessment of environmental effects for the discharge of treated wastewater to the Mataura River (Freshwater Solutions 2019) has identified the key contaminants of concern in the discharge are:

- *E. coli;*
- Ammoniacal-nitrogen;

- Total Nitrogen; and
- Total Phosphorus.

2.2.1 *E. coli*

E. coli levels in the Mataura River are particularly high both upstream and downstream of the Alliance discharge and water quality in both reaches of the river is in the Red attribute state specified in the National Policy Statement for Freshwater Management 2017 (NPSFM). The relatively high concentration of *E. coli* in the wastewater also means *E. coli* concentrations downstream of the discharge are elevated.

A Quantitative Microbial Risk Assessment (QRMA) has been undertaken for the discharge which shows while the Plant causes *E. coli* concentrations in the Mataura River to increase significantly below the Plant's discharge point, this does not equate to a significant increase in health risk, and the risk of a person swimming below the Plant becoming ill due to the Plant's discharge is well below 1% (Streamlined Environmental 2019).

However, Southland Regional Council is obliged to set policy and methods to improve water quality in the Mataura River so it is suitable for primary contact more often and the indicator used by the NPSFM for how this is being achieved is instream *E. coli* concentrations. Alliance has requested that this report still examine options for reducing the concentration of *E. coli* in its discharge such that it does it's part in reducing the in-stream concentrations of this parameter. A timeframe for improving *E. coli* concentrations in the Mataura River has not yet been developed and is dependent on the impending collaborative planning process referred to above. However, as shown in Table 1, a substantial improvement in water quality is required for the Mataura River to improve its attribute state from its current Red status. Streamlined Environmental has also completed modelling which identifies the 95th percentile concentration of *E. coli* the Alliance Mataura discharge would need to achieve so as to maintain that improved attribute state downstream of the discharge.

Table 1: Mataura River Water Quality Improvement Requirements

NPSFW Attribute State	Improvement in upstream water quality required to achieve Attribute State	Alliance discharge 95th percentile *E. coli* concentration required to maintain attribute state downstream of the discharge
Orange (median *E. coli* >130 cfu/100 mL, 95th percentile >1,200 cfu/100 mL)	63%	< 160,000 cfu/100 mL
Yellow (median *E. coli* ≤130 cfu/100 mL, 95th percentile ≤ 1,200 cfu/100 mL)	77%	<40,000 cfu/100 mL
Green (median *E. coli* ≤130 cfu/100 mL, 95th percentile ≤ 1,000 cfu/100 mL)	90%	<140,000 cfu/100 mL

2.2.2 Nutrients

Key observations from the ecological investigations are:

- Nitrate-N in the river above and below the discharge meet the NPSFM attribute state A for toxicity.
- Ammoniacal-N meets NPSFM attribute state A above the discharge but reduces to attribute state B below the discharge.
- Dissolved nitrogen upstream and downstream of the Alliance discharge exceeded the guideline for protecting benthic diversity and ANZECC levels for nuisance plant growths (but noting these haven't been observed in recent years).
- Total phosphorus did not exceed the ANZECC guideline upstream or downstream of the discharge. Phosphorus concentrations have been increased downstream relative to upstream in earlier years but not in 2017-18.
- Reports in 2012 and 2017 show that the Toetoe Estuary continues to degrade with extensive macro-algal growth driven by very high nutrient loads from the catchment. Total nitrogen (TN) from the discharge contributes 1.1%-1.7% of the catchment load to the Toetoe Estuary and 0.7%-1.3% of the TP.

The increase in ammoniacal-N, TN, and *E. coli* downstream, and at times phosphorus, means that Alliance will need to investigate ways to decrease these contaminants to the lower river and Toetoe Estuary, likely as part of catchment-wide improvements.

Total phosphorus has not been considered as a key contaminant to reduce during this assessment as a significant percentage (in the order of >90% dissolved reactive phosphorus removal) of the load produced is already removed by the existing process. In the event, if further removal is required, even though levels are already proportionally very low, then further chemical precipitation of phosphorus could be included with treatment options, which already incorporate separation technologies such as a clarifier or sand filter, at a cost of around $70k/yr to $100k/yr. This could achieve a mean final effluent total phosphorus concentration of approximately 1 g/m^3.

2.2.3 Organic load ($cBOD_5$)

While the organic load of the wastewater, as measured by carbonaceous biochemical oxygen demand ($cBOD_5$), is not a contaminant of concern, removal of $cBOD_5$ has been considered in this assessment as it is a contaminant that is present in the wastewater in reasonable quantities and is removed as part of biological nitrogen removal processes. It has therefore, been included as an additional indicator of general improvement in wastewater quality, even though it is not a contaminant of concern in the receiving surface water environment.

2.3 Existing Wastewater Treatment Plant Resilience

The existing wastewater management and treatment system was investigated to assess the resilience of the existing asset against failure, for the ongoing operational use of the system.

While in general good operational order, some resilience issues associated with the wastewater management and treatment system have been identified, summarised as follows:

1. Green Waste Cross Contamination;
   Separation of the green waste system is essential for minimising the phosphorus load discharged to the Mataura River via the Non-Green waste stream. However, there is the potential for over flow of the tripe wash wastewater at the yards area to a Non-Green waste stream sump and there is the potential for overflow of the Beef Sump Green waste milli-screening unit to the red waste stream. Modification of the system would decrease the risk of cross contamination.

2. Wastewater Transfer Pipe Location Risk;
   The main Green waste, Non-Green waste and pelt house pipelines run through or above the hydro scheme water race at some locations adjacent to the old rendering plant. This presents the risk of accidental discharge of contaminants directly to the River or an influx of river water if any of the pipes fail. Relocation of the pipes outside of the hydro-race would minimise this risk.

3. At the wastewater treatment plant some of the existing DAF infrastructure is over 40 years old. The remaining lifespan of this treatment system and therefore the resilience of this and any additional wastewater systems installed needs to be considered. There is a requirement in the future to refurbish or replace some of the existing wastewater treatment infrastructure to ensure the adequate treatment and compliant discharge of future waste.

The resilience issues raised above are discussed in more detail in the separate report, covering the water use survey and asset resilience assessment.

2.4 Wastewater Flows and Loads

2.4.1 Water Usage Survey and Reduction

PDP undertook a water use survey within the plant in January 2019. As part of this survey, flow monitoring of the incoming green and non-green waste stream sources was undertaken to identify water use within the various processing areas of the plant. The DAF white-water flows were also recorded. This data was used to assess water use efficiencies at the site and whether there may be opportunities for reducing water use and wastewater volume.

The process flows measured were truck wash, cattle wash, cattle yard and cattle wash, Green waste in, Green waste out, Non-Green waste in and Non-Green waste out. This allowed water usage in key parts of the plant to be identified utilising a mass balance. A walk through the main processing areas of the plant was also undertaken to observe water use within the plant.

Good water usage practice was observed around the main processing plant, with water conservation measures utilised, from sensor based wash systems to restricted flow knife wash systems. Additionally, water recirculation practices are utilised in the tripe plant to limit the amount of water added to the Green waste. No major water saving measures were identified within the main processing plant.

White-water (dissolved air water) recycling within the wastewater treatment plant, however, was identified as a major water saving opportunity for the site. Currently white-water is generated with the use of water drawn from the Mataura River using the sites river take (approximately 2,000 m^3/d which makes up approximately 37% of the overall wastewater volume). Most moderns DAF treatment systems utilise recycled treated water for generation of the white-water and for any future plant development, it is recommended that this approach is followed, so long as there is no increase in the risk of foam generation within the dissolved air saturation vessel and the DAF plant. This will help reduce the capital cost associated with hydraulic sizing of equipment required in the future.

2.4.2 Flows and Loads

The data from the water usage survey was utilised to develop the flow design envelope to be used as the basis for sizing alternative options as part of this options assessment. Treated wastewater discharge compliance sampling results for the season 2016-2017 were used as a basis for quantifying contaminant concentrations and loads that will need to be accounted for in the development of the options. See Table 2 for a summary of the current wastewater flows and concentrations within the plant.

For this options assessment it is assumed that the water consumption measure to reduce white-water consumption will be put into place, therefore, wastewater volumes will be reduced by the percentage contributed by white-water volumes (approximately 37%). This reduction in flow will mean that the proportional contaminant loads in the wastewater will increase. See Table 3 for the design flow and loads used as the basis for the majority of the assessed options. Some options involve treatment of the green waste stream only, the flow and loads used as a basis for these options are shown in Table 5.

Table 2: Current Treated Wastewater Flows and Concentrations

Parameter	Unit	Min	Mean	Median	Max
Total Flow	m^3/d	336	4,183	4,436	6,438
Green Waste Flow	m^3/d	198	2,050	2,262	3,283
Non-green waste flow	m^3/d	138	2,134	2,174	3,155
$cBOD_5$	g/m^3	61.0	161.1	155.0	320.0
Ammoniacal N	g/m^3	2.1	14.1	13.0	37.0
TKN	g/m^3	16.0	39.5	40.0	59.0
Total Phosphorus	g/m^3	1.11	3.65	3.25	7.91
pH	-	7.4	8.5	8.6	9.5
E. coli	MPN/100 ml	1.2×10^3	3.6×10^4	2.4×10^3	2.4×10^5

Notes:

1. *Flows include white water contributions.*
2. *Concentrations based on treated wastewater after DAF treatment.*
3. *Flows based on 2013-18 records and concentrations based on 16/17 season compliance data.*
4. *Green and Non-Green flows based on flow splits observed during water survey.*

Table 3: Design Flows and Loads

Parameter	Unit	Min	Mean	Median	Max
Total Flow [1]	m^3/d	212	3,488	3,570	5,105
$cBOD_5$	kg/d	261	893	859	1,734
Ammoniacal N	kg/d	9	78	72	205
TKN	kg/d	68	219	222	327
Total Phosphorus	kg/d	5	20.2	18	44

Notes:

1. *Based on water usage survey data and 16/17 compliance data.*
2. *Flows include for a 37% reduction in flow due to proposed water saving measures.*
3. *Wastewater loads unaffected by the water usage reduction.*

Based on information provided by Alliance regarding the number of shifts per month at the main processing site a monthly distribution of the flow, TN load and *E. coli* load discharged to the Mataura River. This information was used to assess the overall yearly reduction in load to the Mataura River each option could achieve. The existing average monthly loads discharged to the Mataura River are summarised in Table 4. Month volumes are based on no white-water volume contributions.

Table 4: Monthly Discharged Flow and Load Distribution

	Processing Days	Flow (m^3/month)	TN Load (kg/month)
January	22	77,241	4,850
February	20	69,766	4,381
March	22	77,241	4,850
April	26	89,699	5,633
May	27	92,689	5,821
June	18	65,537	3,990
July	9	30,896	1,940
August	3	11,586	728
September	0	0	0
October	11	38,620	2,425
November	16	56,062	3,521
December	17	59,799	3,755

Notes:

1. *1 processing day is equivalent to 2 shifts.*

The monthly *E. coli* load is expected to be in the order of 1.0 x 10^{12} to 1.0 x 10^{13} cfu per month.

To prepare a suitable basis of design for the options that include the treatment of separate waste streams, post treatment composite sampling of the green and non-green waste streams was undertaken by Alliance to determine the distribution of the TKN load between the two streams. The results from the separate waste stream sampling are shown in Table 5.

Table 5: TKN Sampling Results

Date		28/02/19	04/03/19	05/03/19	Average
TKN (g/m^3)	Green Waste	75	72	84	77
	Non-Green Waste	56	20	30	35

Notes:

1. *Samples based on 24 hour composite sampling.*

Based on the monitoring results it is assumed that 50% of the BOD load is contained in the green waste and that the green waste contains 60% TKN load. Existing data provided by Alliance has shown that the green waste stream contains 80% of the ammoniacal-N load.

These assumed distribution factors were used to generate the loads shown in Table 6. The flows shown are based on actual flow data collected during the PDP water usage survey with the expected water savings applied.

Table 6: Green Waste Design Flows and Loads

Parameter	Unit	Min	Mean	Median	Max
Total Flow [1]	m^3/d	1,588	1,739	2,041	2,601
cBOD$_5$	kg/d	130	447	429	865
Ammoniacal-N	kg/d	6.3	54.5	50.5	140
TKN	kg/d	41.0	131	133	191
Total Phosphorus	kg/d	1.5	6.1	5.4	12.8

Notes:

1. *Flows include for a 37% reduction in flow due to proposed water saving measures.*
2. *Wastewater loads unaffected by the water usage reduction.*

2.5 Summary of Key Assumptions

In summary, the options assessment outlined in this report is based on the following key assumptions:

1. The number of beef animals processed at the site will not increase;
2. Wastewater flows will be reduced by at least 35% due to the use of recycled treated wastewater white-water generation. The contaminant loads will be unaffected by this reduction in volume, hence wastewater concentrations post-DAF will increase;
3. Based on the operating information received from Alliance the following number of processing days have been assumed as follows for summer (Nov – Apr) 125 days and winter (May – Oct) 70 days, where one day consists of 2 shifts;
4. Wastewater treatment option cost estimates are based on the following assumptions:
   a. Geotechnical conditions are suitable for tank foundations and for construction of earthen based lagoons, based on a cut to fill construction;
   b. Land can be purchased for cut and carry irrigation within 5 km of the site for a price of $70,000/ha;
   c. A discount rate of 10% over 10 years has been assumed for the NPV calculations.

3.0 Potentially Available Wastewater Management Options

A long-list of available alternatives was developed, and from that a shortlist of potential options was prepared. Each of the short-listed options was then assessed further, considering the potential for the option to reduce contaminant loads to the Mataura River, option resilience, and lifecycle costs.

Sixteen possible options were initially identified, based on 7 discharge options with several treatment sub-options. These identified options formed the initial longlist, as follows:

1. Discharge to Mataura River:
   - A. Existing system (status quo);
   - B. Biological treatment for $cBOD_5$ removal only, with UV disinfection;
   - C. Biological treatment for $cBOD_5$and nitrogen removal with UV disinfection;
   - D. Filtration and UV disinfection only;
   - E. High pH disinfection of green waste stream;
   - F. Biological treatment for $cBOD_5$and nitrogen removal of Green waste only, with combined UV disinfection.
2. Irrigation to third party owned dairy pasture:
   - A. Year round irrigation with current level of treatment;
   - B. October to April irrigation, with biological treatment and storage from May to September.
3. Irrigation to cut and carry system, on purchased land:
   - A. Year round irrigation with current level of treatment;
   - B. October to April irrigation, with biological treatment and storage from May to September;
4. Dual discharge to Mataura River (May to September) and irrigation to third party owned dairy pasture (October to April):
   - A. No treatment prior to river discharge;
   - B. Biological treatment for $cBOD_5$and nitrogen removal with UV disinfection prior to river discharge.
5. Dual discharge, to Mataura River (May to September) and irrigation to a cut and carry system (October to April) on purchased land:
   - A. No treatment prior to river discharge;

B. Biological treatment for $cBOD_5$and nitrogen removal with UV disinfection prior to river discharge.

6. Transfer Wastewater to Gore municipal WWTP.
7. Transfer Wastewater to Mataura municipal WWTP.

An assessment of each option is summarised Table 7.

3.1 Assessment of Long List Options

Of the assessed long list options, those incorporating significant risk and uncertainty, and substantial lifecycle costs are removed from further assessment. This includes:

- Options that do not provide improvement to the level of discharge to the Mataura River, specifically Option 1A (the status quo) and Option 1E (pH disinfection) as neither option will provide for a significant reduction in *E. coli* levels or nitrogen in the discharge, which have been identified as contaminants of concern;
- Option 1B was discounted as BOD is not considered a priority contaminant to remove from the effluent. This option therefore, does not provide any additional reduction in loads of priority contaminants to the river compared to Option 1D, for the additional costs;
- Options incorporating discharge to land all year (Options 2A and 3A) as these will require securing purchase of, or access to, considerably large land areas and may become operationally difficult to manage, particularly during winter;
- Options involving discharge to Gore District Council municipal treatment systems (Options 6 and 7) due to uncertainty associated with consenting, treatment plant capacity and future costs;
- Options involving excessive capital and/or operational costs that do not offer a good value return on investment, in terms of net reduction in load to the river, ease of operation and efficient use of expenditure. This includes options which involve investment in both treatment and irrigation (Options 2B 3B, 4B and 5B) and options which incorporate treatment upgrades (or capital contribution) and ongoing trade waste charges (Options 6 and 7).

On this basis the options refined for further assessment include:

- Option 1C – Existing river discharge with biological treatment for $cBOD_5$ and nitrogen removal with UV disinfection;
- Option 1D – Existing river discharge with filtration and UV disinfection;

- **Option 1F – Existing river discharge with biological treatment for $cBOD_5$ and nitrogen removal of the green waste stream with UV disinfection;**
- **Option 4A – Dual discharge with the existing river discharge combined with discharge to dairy pasture with no treatment prior to river discharge;**
- **Option 5A – Dual discharge with the existing river discharge combined with discharge to a cut and carry system with no treatment prior to river discharge.**

Table 7: Alliance Mataura Plant Wastewater Management Options: Initial Screening Analysis

Disposal Option	Treatment Option	Advantages	Disadvantages	Comments	Very Rough Order Cost Estimates
1 - Existing disposal to Mataura River	**1A - No additional treatment**	- No change in plant operation - Low cost	- Does not improve wastewater quality -		CAPEX: $0M
	1B - Biological treatment for cBOD$_5$ Activated sludge tank + Clarifier + UV	- Smaller footprint tank based biological treatment system - Could be located next to existing site in place of old lamb plant - Reduced risk associated with pumping compared to Option 1C - Simple commonly used process	- Does not reduce nitrogen load - Increased operational complexity - Sludge management requirements - If located close to Mataura, some odour management may be required but not allowed for in costing		CAPEX: $9.3M
	1C - Biological treatment for cBOD$_5$and Nitrogen Activated sludge lagoon + Clarifier + UV	- All target wastewater quality parameters improved - Best practice wastewater treatment	- Needs to be located on new site, potentially near pelt house - Significant pumping and piping requirement - Increased operational complexity - Sludge management requirements		CAPEX: $14.0M
	1D - UV treatment (with filter) Sand filter + UV	- Best practice for *E. coli* reduction - Sand filter should reduce some wastewater contaminant concentrations - Could be located next to existing site	- Insufficient improvement in wastewater cBOD$_5$ or Total Nitrogen quality - UV lamps may foul quickly and may need frequent maintenance; or - Requires method to deactivate polymer to minimise fouling		CAPEX: $3.8M
	1E - High pH disinfection Lime dosing + Tank	- Wastewater *E. coli* reduced - Simple solution to operate and implement - Could be located next to existing site - Some existing equipment on site could be used - Additional treatment on only half of wastewater stream	- Not best practice for *E. coli* reduction - Unlikely to achieve the required *E. coli* reductions, only 50% load reduction expected which will not comply with the QMRA requirements - No improvement in wastewater BOD or Ammonia quality	- Would likely only be implemented for green waste stream as non-green is at pH 4. - Potential *E. coli* reduction is limited based on trials done in 2006.	CAPEX: $1.7M
	1F – Green waste Biological treatment for cBOD$_5$and Nitrogen Activated Tanks + Clarifier + UV	- BOD and TN target treated wastewater quality parameters improved but for Green Waste Only - Could be located next to existing site in place of old lamb plant - Reduced risk associated with pumping compared to Option 1C - Simple commonly used process	- Provides partial treatment of BOD, and nitrogen only - Increased operational complexity - Sludge management requirements - If located close to Mataura, some odour management may be required but not allowed for.	- Filtration and UV treatment on both streams	CAPEX: $11.5M

Table 7: Alliance Mataura Plant Wastewater Management Options: Initial Screening Analysis

Disposal Option	Treatment Option	Advantages	Disadvantages	Comments	Very Rough Order Cost Estimates
2 - Discharge to land (year round) - Slow rate irrigation to dairy grazing land	**2A -No additional treatment**	- No additional wastewater treatment required - No wastewater discharged to the river - Land purchase not required - Dairying common land use in area	- Additional operational complexity - Significant pumping requirement - Limited potential irrigation during winter - Cannot store wastewater for extended periods due to odour risk - Reliance on third party land may cause issues in the future - Limited suitable land - Would require consultation with Dairy company regarding receipt of milk	- 160 ha Irrigation area - Land purchase not anticipated - hydraulically limited	CAPEX: $12.2M
	2B -Biological treatment for winter storage Activated sludge lagoon + Clarifier + UV	- No wastewater discharged to the river - Summer only irrigation will be less problematic - Treatment and storage provides additional resilience - Land purchase not required - Dairying common land use in area	- Additional operational complexity - Significant construction required for winter storage - Significant pumping requirement Limited suitable land - Reliance on third party land may cause issues in the future	- 160 ha Irrigation area - Land purchase not anticipated - Hydraulically limited - Treatment prior to storage required to reduce the risk of odour generation	CAPEX: $25.8M
3 - Discharge to land (year round) - Slow Rate irrigation to company owned cut and carry operation	**3A -No additional treatment**	- No additional wastewater treatment required - No wastewater discharged to the river - Potential income from cut and carry crop to offset operating costs - No reliance on third party land for discharge	- Additional operational complexity - Significant pumping requirement - Limited potential irrigation during winter - Cannot store wastewater for extended periods due to odour risk; - Significant land purchase required	- 160 ha Irrigation area - Land purchase required - Hydraulically limited	CAPEX: $24.0M
	3B -Biological treatment for winter storage Activated sludge lagoon + Clarifier + UV	- No wastewater discharged to the river - Summer only irrigation will be less problematic - Treatment and storage provides additional resilience - Potential income from cut and carry crop to offset operating costs - No reliance on third party land for discharge	- Additional operational complexity - Significant land purchase required - Significant construction required for winter storage - Significant pumping requirement	- 160 ha Irrigation area - Land purchase required - Hydraulically limited - Treatment prior to storage required to reduce the risk of odour generation	CAPEX: $37.0M

Table 7: Alliance Mataura Plant Wastewater Management Options: Initial Screening Analysis

Disposal Option	Treatment Option	Advantages	Disadvantages	Comments	Very Rough Order Cost Estimates
4 - Dual discharge to land and existing river outfall - Slow rate irrigation to dairy grazing land	**4A - No additional treatment**	- Summer only irrigation will be less problematic - Wastewater only discharged to the river in winter when flows are high - No additional wastewater treatment required - 2 disposal methods provide additional resilience - Land purchase not required	- Additional operational complexity - Untreated wastewater load still discharged to river in winter and wet periods - Requirement to establish long term agreement with third parties - Significant pumping requirement	- 103 ha Irrigation area - Land purchase not anticipated - Hydraulically limited	CAPEX: $10.7M
	4B - Biological treatment for BOD and Nitrogen Activated sludge lagoon + Clarifier + UV	- Summer only irrigation will be less problematic - Low wastewater load only discharged to the river in winter when flows are high - No additional wastewater treatment required - 2 disposal methods provide additional resilience - Land purchase not required	- Additional operational complexity - Requirement to establish long term agreement with third parties; - Significant pumping requirement - Treatment process needs to be located on new site, potentially near pelt house - Sludge management requirements	- 103 ha Irrigation area - Land purchase not anticipated - Hydraulically limited	CAPEX: $24.7M
5 - Dual discharge to land and existing river outfall - Slow Rate irrigation to cut and carry crop	**5A - No additional treatment**	- Summer only irrigation will be less problematic - Wastewater only discharged to the river in winter when flows are high - No additional wastewater treatment required - 2 disposal methods provide additional resilience - Potential income from cut and carry crop to offset operating costs - No reliance on third party land for discharge	- Additional operational complexity - Untreated wastewater load still discharged to river in winter and during wet periods - Significant land purchase required but smaller land requirement than other land treatment options - Cannot store wastewater for extended periods due to odour risk - Significant pumping and piping requirement	- 103 ha Irrigation area - Land purchase required - Hydraulically limited	CAPEX: $18.0M
	5B - Biological treatment for BOD and Nitrogen Activated sludge lagoon + Clarifier + UV	- Summer only irrigation will be less problematic - Low wastewater load only discharged to the river in winter when flows are high - No additional wastewater treatment required - 2 disposal methods provide additional resilience - Potential income from cut and carry crop to offset operating costs - No reliance on third party land for discharge	- Additional operational complexity - Significant land purchase required but smaller land requirement than other land treatment options - Significant pumping and piping requirement - Treatment process needs to be located on new site, potentially near pelt house - Sludge management requirements	- 103 ha Irrigation area - Land purchase required - Hydraulically limited	CAPEX: $32.0M

Table 7: Alliance Mataura Plant Wastewater Management Options: Initial Screening Analysis

Disposal Option	Treatment Option	Advantages	Disadvantages	Comments	Very Rough Order Cost Estimates
6 - Transfer to Gore municipal WWTP	**6A - Partial biological treatment (to typical municipal sewage quality)** Activated sludge lagoon + Clarifier	- No direct discharge to the river from the plant - Reduced compliance sampling requirement - Potential for combining with Mataura WW for capital cost sharing on pipeline (savings not included in cost estimate)	- Requires agreement from local authority - Additional capacity at the WWTP may need to be provided - Significant pumping and piping requirement - Additional wastewater treatment still required prior to transfer - Potentially high trade waste fees for discharging to WWTP	- Assessment of the capacity headroom of the WWTP is required - Risk of additional costs if WWTP changes to land discharge - Combining with human waste may restrict irrigation to land opportunities	CAPEX: $15.4M
7 - Transfer to Mataura municipal WWTP	**7A - Partial biological treatment (to typical municipal sewage quality)** Activated sludge lagoon + Clarifier	- No direct discharge to the river - Reduced compliance sampling requirement	- Requires agreement from local authority - Small Mataura municipal WWTP treatment plant is expected to not be able to cope with the significant increase in load therefore upgrades to provide additional capacity at the WWTP will need to be provided - Additional wastewater treatment still required prior to transfer - Significant pumping and piping requirement - Potentially high trade waste fees for discharging to WWTP	- Assessment of the capacity headroom of the WWTP is required - Risk of additional costs if WWTP changes to land discharge - Combining with human waste may restrict irrigation to land opportunities	CAPEX: $11.3M

Notes:

1. *Selected options are based on an initial assessment and more options or sub-options may be available.*
2. *All costs exclude GST and are in NZD.*
3. *Cost estimates are very rough order for the purpose of initial screening only.*
4. *Costs include a 40% contingency factor.*
5. *Costs do not allow for foreign currency fluctuations.*
6. *Land purchase price is based on $70k/ha.*
7. *Irrigation prices are based on irrigation to land within a 5km radius and solid set irrigation at $17k/ha.*

4.0 Wastewater Treatment and Disposal Options Shortlist

Each of the shortlisted options outlined in Section 3.1 have been investigated further. This has enabled initial equipment sizes to be calculated and additional certainty to be applied to cost estimates which have been presented in each section below. For the options involving land treatment, local weather data and soil moisture models have been used to obtain more accurate land area requirements and soil maps have been used to identify suitable areas to locate the irrigation schemes.

4.1 Assessment of Treatment Options Costs

PDP have assessed high level costs for a number of short-listed options as outlined in this report. All costs exclude GST and are in NZD (based on January 2019 equipment budget cost estimates) and do not take into account any foreign exchange currency fluctuations. These estimated costs are prepared based on a concept design level and are suitable for indicative budget requirements, rather than approval for actual capital works budgets.

4.1.1 Costing Assumptions and Limitations

The cost estimates are based on the process flow diagrams. For each option, the estimate is also based on the expected treatment performance.

A number of assumptions were made to prepare the cost estimates. These include:

a. All bulk earthworks on nominated sites have suitable material for cut-to-fill with no site-specific geotechnical assessment undertaken;

b. There is unrestricted access to the site and management of any existing services encountered and/or temporary works excluded;

c. There is no contaminated material encountered on pipeline routes or any excavated material and no ground improvement has been allowed for;

d. Estimates for plant equipment is based on initial budget supply prices (January 2019). Sumps and building structure costs estimates are based on similar previous/historical projects;

e. All above ground pipework is stainless steel and all below pipework HDPE or PVC;

f. Existing DAF treatment system is suitable for continued use with bolt-on further treatment process trains;

g. No provision for upgrade of existing outfall;

h. Access to land treatment sites available within 5 km of the site;

i. Operating costs include electrical power, chemicals, operator time allowances and expected maintenance costs of mechanical equipment; and

j. The cost estimating is based on Class 4 Class (AACE International), on the basis of a 40% safety contingency, giving a +40%/-20% estimate range.

A 10 year period has been used for the net present value (NPV) calculation as this is the typical time span used in the industry for NPV assessments of upgrade investments. The NPV analysis has utilised a discount rate of 10%.

4.1.2 Summary of Costs and Implications

Initial concept level cost estimates have been prepared for the shortlisted treatment options with the use of existing disposal routes, namely discharge to river and land treatment.

PDP has investigated options for staging the treatment options to minimise initial capital expenditure based on the likely treatment requirements at each stage and to allow for time to validate the treatment performance at each stage prior to progressing on further upgrades.

4.2 Option 1C Biological Nitrogen Removal and UV Disinfection

Option C incorporates a large, lagoon based, biological reactor, intended to reduce BOD, ammoniacal nitrogen and total nitrogen loads. The process design is based on achieving an average wastewater BOD concentration of below 20 g/m^3 and a total nitrogen concentration below 20 g/m^3, as these are typical values that are reasonable to expect from the proposed treatment system. Due to the large lagoon size, it cannot be located near the existing DAF WWTP and it would likely need to be located on Alliance land, adjacent to the pelt house site.

4.2.1 Process Description

The process description of the proposed Option 1C WWTP is outlined as follows:

- DAF wastewater from the two waste streams will be combined in a wet-well prior to being pumped in a 300 mm OD main a distance of 2 km to the proposed treatment plant site. It is suggested the main follows the route of SH1 from the main treatment plant to the pelt house site.
- The pumped wastewater will flow into an 8,500 m^3 aerated lagoon of volume for BOD, ammoniacal N and total N treatment. The lagoon has been sized to maintain a sludge retention time of 20 days at a mixed liquor concentration of 3,000 mg/L. This provides a mean hydraulic retention time of 2.5 days. It is assumed that the lagoon would be HDPE lined and of earthen construction. 210 kW of aeration would be provided by floating mechanical surface aerators.

- Waste Activated Sludge (WAS) will be wasted to a WAS storage tank, it is proposed that WAS be dewatered onsite in a decanter centrifuge, it has been assumed the system used for handling DAF float sludge currently has the capacity to dispose of the dewatered WAS. Daily dewatered WAS production is expected to be 6 m^3/d (wet volume) at 15% DS.
- A single circular clarifier will follow the aeration lagoon to provide solids separation. The clarifier will have a diameter of approximately 25 m, this is based on a conservative hydraulic overflow rate of 10 $m^3/m^2/d$. The RAS ratio has been assumed to be 60% of the incoming wastewater flow, which is within the typical range used in similar treatment systems. The clarifier will be of concrete construction with a mechanical launder, inlet diffuser, scraper system and walkway.
- Clarified wastewater will pass through a sand filter that will act as protection for the UV unit downstream from limited solids carryover occurrences from the clarifier. The filter will have a working area of 18 m^2, this is based on a hydraulic loading rate of 0.2 $m^3/m^2/min$. Dirty backwash water will be returned upstream of the DAF system.
- Based on the UV trial work previously performed by PDP at Alliance Mataura, and the Alliance Pukeuri UV installation, it is estimated that peaks flows can be treated by 2 No. 40 low pressure, high output UV lamp reactors (such as the Wedeco LBX 1000). The reactors would each be sized for a peak flow rate of 30 L/s and it has been assumed that with clarification and filtration upstream a design UVT of 50% is appropriate.
- Following the UV system the treated wastewater will be pumped back to the site of the main processing and wastewater treatment plant, this will require another wet-well, pump station, and 300 mm main that will follow the same route and the DAF wastewater main. The main will tie into the existing discharge pipework. No changes to the discharge infrastructure are anticipated at the stage.

4.2.2 Load to the River

The expected load discharged to the river by this option has been estimated and compared to the current load. These estimates have been based on the target BOD outlet concentration (20 g/m^3), target TN concentration (20 g/m^3) expected days processing at the plant and current wastewater flows and loads. The UV system will reduce the *E. coli* load to the river by a 3 to 4 log reduction, with a 95th percentile of <1,000 cfu/100 mL.

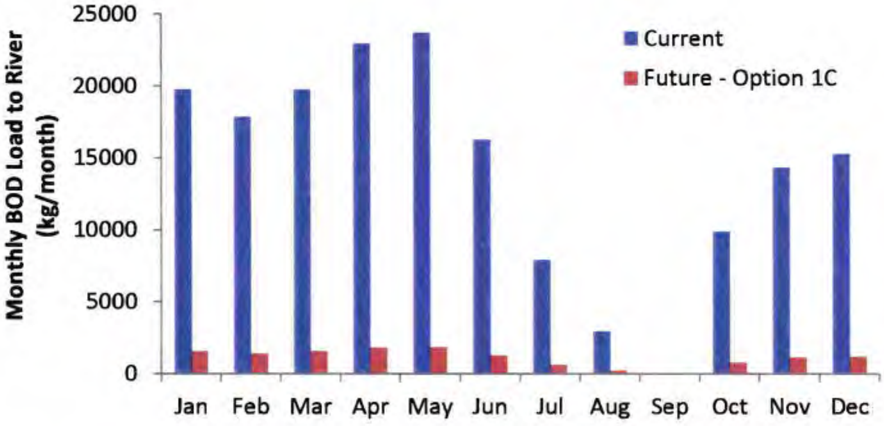


Figure 2: Option 1C current and future BOD load to the Mataura River

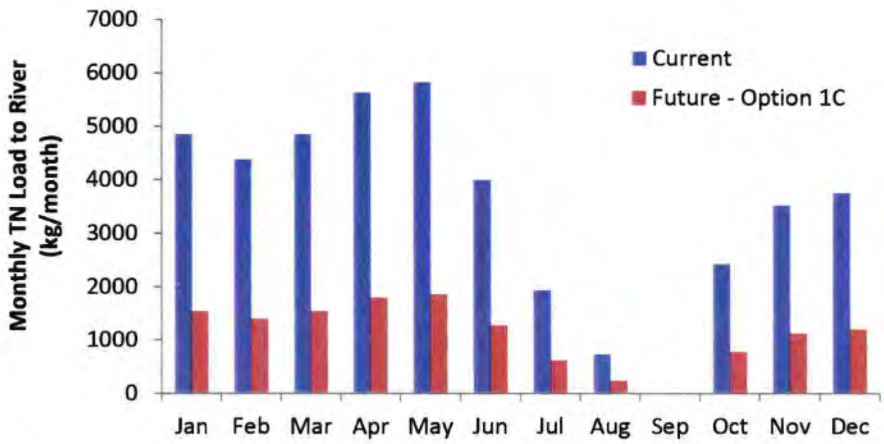


Figure 3: Option 1C current and future TN load to the Mataura River

4.2.3 Cost Estimate

The following cost estimate has been prepared based on the process sizes outlined above:

Table 8: Option 1C Cost Estimate

Item	Cost ($000)
1 – Pump Stations	$1,600
2 – Aeration Lagoon	$1,150
3 – Clarifier	$1,280
4 – Sand Filter	$920
5 – Sludge Dewatering	$560
6 – UV Disinfection	$960
7 – Miscellaneous	$260
8 - Electrical and Control	$650
A – Preliminary and General (15%)	$1,110
B – Professional Services (15%)	$1,270
C – Unscheduled Items (10%)	$850
D – Contingency (40%)	$3,390
E – Land Purchase	$0
Total Capital Expenditure	**$13,980**
Annual Operating Cost	**$1,060**
Net Present Value	**$20.5M**

Notes:

1. *All costs are in $NZD and exclude GST.*
2. *Land purchase excluded from contingency due to greater level of certainty on land price.*
3. *Net Present Value based on a 10 year return period and a 10% discount rate.*

4.2.4 Key Advantages of this Option

The key advantages to this option include:

- Decrease in BOD and nitrogen load and significant decrease in bacterial load on the Mataura River;
- New plant away from residential areas.

4.2.5 Key Disadvantages and Risks

- Long pumping distances;
- More sludge management requirements;

- High capital cost;
- Geotechnical limitations need to be investigated.

4.3 Option 1D UV Disinfection

Option D is based on UV disinfection of the existing DAF treated wastewater. Trials were conducted in 2008 by PDP, which indicated low UV transmissivity and potential risk of fouling due to polymer solids attraction. The polymer would potentially need to be deactivated, with the conceptual design costings based on sand (or alternative media) filtration prior to the UV disinfection unit.

The system would likely be located on the site of the demolished lamb processing plant. It has still been assumed that the sand filter will not reduce any contaminant loads significantly enough for this to be considered as part of this assessment.

4.3.1 Process Description

The process description of the proposed Option 1D WWTP is outlined as follows:

- The existing DAF treatment system will be retained and operated as it is currently, with the exception of the proposed change to the white-water generation.
- DAF wastewater will be combined in a wet-well and pumped to the sand filter feed
- A sand filter is proposed, to act as protection for the UV units downstream, as there is no treatment of the wastewater following the DAFs it is expect the UV lamps would foul extremely quickly with frequent automated cleaning required. The sand filter has therefore been proposed in order to remove additional solids and polymer flocs from the waste to significantly reduce the amount of maintenance required. The filter will have a working area of 18 m^2, this is based on a hydraulic loading rate of 0.2 $m^3/m^2/min$. Dirty backwash water will be returned upstream of the DAF system.
- The proposed UV system is based on work previously performed by PDP when investigating tertiary treatment processes at Alliance Mataura, the system will feature 3 duty/duty/standby parallel reactors with the intention that peaks flows can be treated by 2 reactors. The reactors will each be sized for a peak flow rate of 30 L/s and it has been assumed that with filtration upstream a design UVT of 25% is appropriate at this stage, based UVT data provided by Alliance a mean combined waste stream UVT of 25% was estimated. The additional standby reactor is proposed as a contingency to account for the reduced upstream treatment and increased risk of fouling.

- Pipework from the UV system will tie into the existing discharge pipework. No changes to the discharge infrastructure are anticipated at this stage.

4.3.2 Load to the River

This option will only decrease the BOD and TN loads to the river by an insignificant amount, associated with a BOD and TN bound to solids. Therefore a current and future comparison of load reduction is not provided. The UV system will reduce the *E. coli* load into the river by a 2 to 3 log reduction, with a 95th percentile of <10,000 cfu/100 mL.

4.3.3 Cost Estimate

The following cost estimate has been prepared based on the process sizes outlined above:

Table 9: Option 1D Cost Estimate

Item	Cost ($000)
1 – Sand Filter	$920
2 – UV Disinfection	$1,060
3 - Electrical and Control	$200
A – Preliminary and General (15%)	$330
B – Professional Services (15%)	$380
C – Unscheduled Items (10%)	$250
D – Contingency (40%)	$1,000
E – Land Purchase	$0
Total Capital Expenditure	**$4,140**
Annual Operating Cost	**$230**
Net Present Value	**$5.6M**

Notes:
1. *All costs are in $NZD and exclude GST.*
2. *Land purchase excluded from contingency due to greater level of certainty on land price.*
3. *Net Present Value based on a 10 year return period and a 10% discount rate.*

4.3.4 Key Advantages of this Option

The key advantages to this option include:

- Low other capital cost that other options;

- Significant reduction in bacterial concentrations in discharge, to address one of the key contaminants;
- Plant can be located adjacent to existing WWTP;
- Potential interim upgrade step, leading to other discharge to river options;
- No significant additional sludge generation.

4.3.5 Key Disadvantages and Risks

- Insignificant reduction in total nitrogen load to the Mataura River;
- Risk of low UV transmissivity if not adequately filtered. Risk of rapid blinding of the filters and bulb fouling due to the polymer content of the wastewater. Requires investigation of sand-filter performance at deactivating polymer and subsequent UV transmissivity.
- Risk around UV transmissivity and bulb fouling needs to be investigated;
- May not be considered best practice on a longer term basis;
- Moderate difficulty in obtaining consents due to BOD load and nutrient load discharge to river remaining the same.

4.4 Option 1F Green Waste Biological Nitrogen Removal and UV Disinfection

Option 1F incorporates biological treatment of the green waste stream, as the higher contaminant load source, with 50% of the BOD load, 70% of the ammoniacal nitrogen load and 60% of the total nitrogen load. Filtration and UV disinfection will be performed on both waste streams.

It is not expected that the high pH of the green stream will inhibit biological treatment so pH correction has not been accounted for in the costing of this option. Due to the reduced volume of the biological reactor, the location of the new plant could be adjacent to the existing WWTP.

4.4.1 Process Description

The process description of the proposed Option 1F WWTP is outlined as follows:

- DAF wastewater from the green waste stream will be buffered in a wet-well prior to being pumped to the proposed treatment plant.
- The pumped wastewater will flow into two aerated tank reactors of a combined volume of 4,500 m^3 for BOD, ammoniacal-N and total N treatment. The tanks are sized to maintain a sludge retention time of 20 days at a mixed liquor concentration of 3,000 mg/L. This provides a

mean hydraulic retention time of 2.5 days. Aeration would be provided by diffused aeration.

- Process calculations have indicated the peak aeration requirement of the system is 120 kW; this is based on maximum hourly green waste flows and maximum green waste BOD and ammoniacal-N concentrations.
- A single circular clarifier will follow the aeration tank to provide solids separation. The clarifier will have a diameter of approximately 18 m, this based on a hydraulic overflow rate of 10 $m^3/m^2/d$. The RAS ratio has been assumed to be 60% of the incoming wastewater flow, which is within the typical range used in similar treatment systems. The clarifier would be of concrete construction with a mechanical launder, inlet diffuser, scraper system and walkway.
- Waste Activated Sludge (WAS) will be wasted to a WAS storage tank, it is proposed that WAS be dewatered onsite in a decanter centrifuge and it is assumed the system used for disposing of DAF float sludge currently has the capacity to dispose of the dewatered WAS. Daily dewatered WAS production is expected to be 2.8 m^3/d at 15% solids.
- Clarified wastewater will be combined with the existing DAF treated non green waste stream and then be filtered in a sand filter prior to UV disinfection. If low level solids carryover occurs from the clarifier, the filter will help maintain UV transmissivity and minimise fouling of the UV bulbs. The sand filter will also help remove residual solids from the non-green waste stream. Dirty backwash water will be returned upstream of the DAF system.
- Based on the UV trial work previously performed by PDP at Alliance Mataura, and the Alliance Pukeuri UV installation, it is estimated that peaks flows can be treated by 2 No. 40 low pressure, high output UV lamp reactors (such as the Wedeco LBX 1000). The reactors would each be sized for a peak flow rate of 30 L/s and it has been assumed that with clarification and filtration upstream a design UVT of 50% is appropriate.
- Following the UV system the treated green waste wastewater would be discharged to the Mataura River. No changes to the discharge infrastructure are anticipated at the stage.

4.4.2 Load to the River

The expected load discharged to the river by this option has been estimated and compared to the current load. These estimates have been based on assumed load reductions and target effluent concentrations stated previously of an overall 50% reduction in BOD and a target treated green stream TN concentration of 20 g/m^3, expected days processing at the plant and current wastewater flows and loads. The UV system will reduce the *E. coli* load into the river by a 2 - 3 log reduction, with a 95th percentile of <10,000 cfu/100 mL.

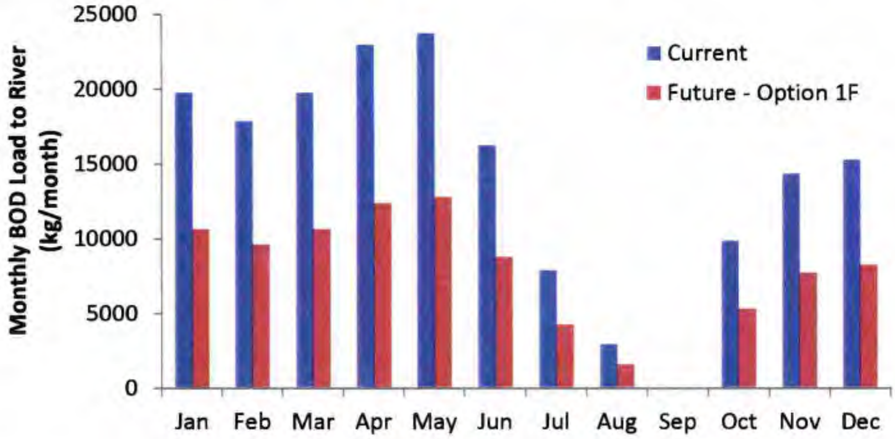


Figure 4: Option 1F current and future BOD load to the Mataura River

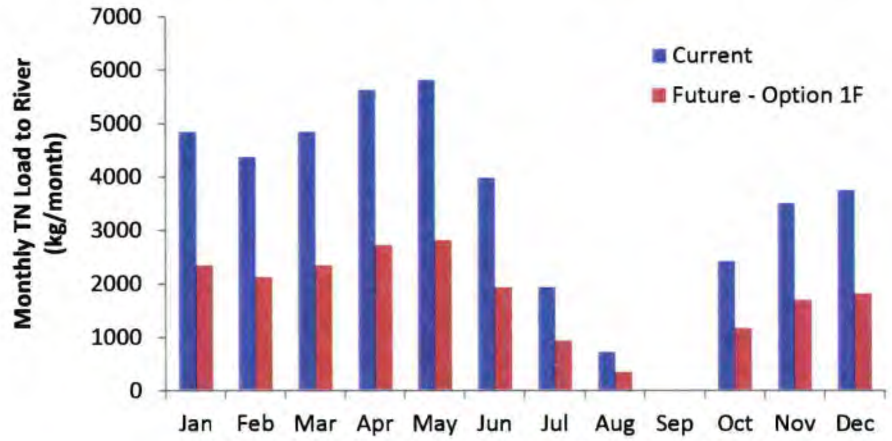


Figure 5: Option 1F current and future TN load to the Mataura River

4.4.3 Cost Estimate

The following cost estimate has been prepared based on the process sizes outlined above:

Table 10: Option 1F Cost Estimate

Item	Cost ($000)
2 – Aeration Tanks	$1,900
3 – Clarifier	$860
4 – Sand Filter	$920
5 – Sludge Dewatering	$530
6 – UV Disinfection	$960
7 – Miscellaneous	$260
8 - Electrical and Control	$520
A – Preliminary and General (15%)	$890
B – Professional Services (15%)	$1,030
C – Unscheduled Items (10%)	$680
D – Contingency (40%)	$2,730
E – Land Purchase	$0
Total Capital Expenditure	**$11,260**
Annual Operating Cost	**$790**
Net Present Value	**$16.1M**

Notes:

1. *All costs are in $NZD and exclude GST.*
2. *Land purchase excluded from contingency due to greater level of certainty on land price*
3. *Net Present Value based on a 10 year return period and a 10% discount rate*

4.4.4 Key Advantages of this Option

The key advantages to this option include:

- Partial reductions in BOD and nitrogen loads (approximately 40% to 50% reduction) and significant reduction in bacterial concentrations in discharge, which would comply with the requirements determined by Alliance Mataura QMRA report;
- Plant can be located adjacent to existing WWTP.

4.4.5 Key Disadvantages and Risks

- More sludge management requirements;
- Risk that land adjacent to WWTP may be allocated for other purposes;
- Low risk of odour generation.

4.5 Option 4A Dual Discharge, Existing River Location and Irrigation to Dairy Farms with No Treatment Prior to River Discharge

Option 4A is based on a dual discharge system, utilising the existing treatment plant but with irrigation to third party owned dairy farm land, from October to April, while discharging to the river predominantly from May to September. With processing significantly reduced during wetter, mainly winter months, see Table 4, a much smaller volume of wastewater would be discharged to the river, estimated at 30% of the total annual wastewater volume.

Soil moisture models based on irrigation only during the summer months showed that an irrigation rate of 565 mm/yr could be achieved meaning a land area of 160 hectares would be required, this is a slightly larger area then estimated during the longlist assessment due to a more detailed approached used.

As stated previously, agreement with the dairy farm owners and dairy companies is required for the operation of this system. Feasibility of this has not been tested and it may be difficult to find 3 suitably sized farms located closely together, in order to allow a single irrigation system to be built. Without farmland in proximity, the cost of this option could be expected to escalate.

4.5.1 System Location

The possible locations were evaluated using GIS layers to determine larger lots of land (meaning fewer farmers to deal with) that were in flat areas with moderate to well-draining soils.

Figure 8 shows the suitability of farmland in the vicinity of the processing plant that could be utilised for land treatment.

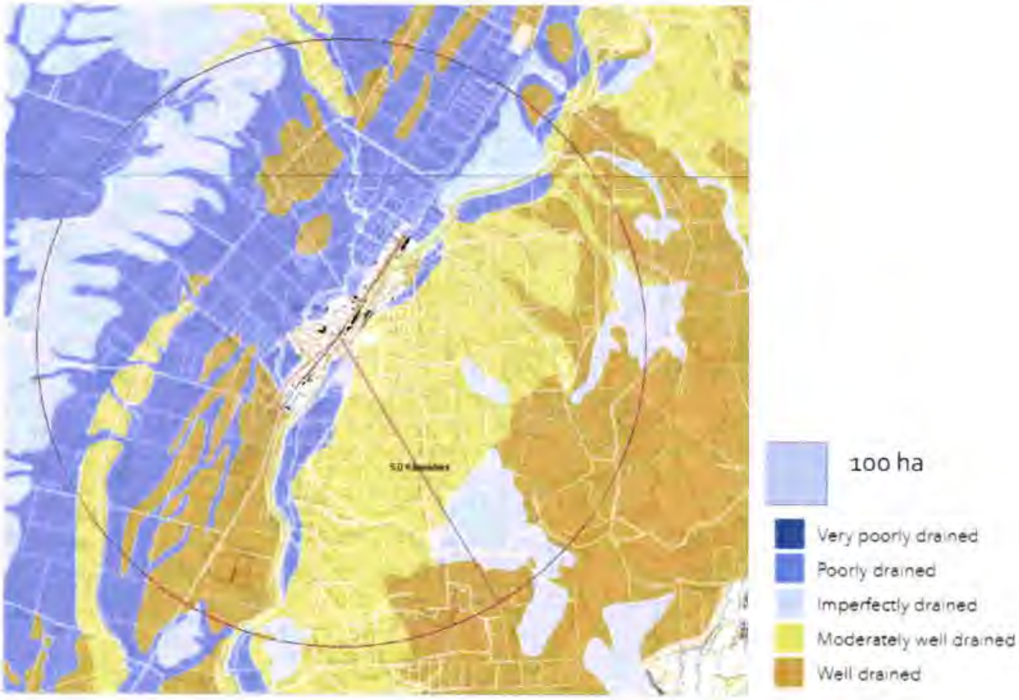


Figure 6: Land Suitability for Potential Land Treatment

The area selected as the most appropriate and most likely location was the moderately draining soils to the east of the Mataura River. This area was selected due to the reduced distance from the site, relatively flat, but terraced, topography and acceptable soil properties. There are some larger land parcels in the selected area so it would be expected that the option would only rely on the cooperation of three to four landowners.

The selection of this area for the irrigation scheme has reduced the assumed wastewater main length to 3 km. Some lower capital cost irrigation systems, when compared to solid set, may also be appropriate to use as the land is relatively flat when compared with some other areas close to Mataura.

4.5.2 System Description

The description of the proposed Option 4A discharge system is outlined as follows:

- DAF treated wastewater will be combined and collected in a wet-well, high lift pumps will be used to pump the wastewater to the irrigation site for short-term storage and disposal. A 300 mm OD main will be required of estimated length 3 km.

- A storage pond will be required at the irrigation site to allow for buffering of the flows and short-term storage during periods of heavy rainfall when irrigation is not possible due to soil conditions. As part of the soil moisture model a storage volume of 5,000 m^3 has been selected, this will provide 1 day of balancing storage when required. The pond would be HDPE lined.
- Based on the soil properties of the most likely location for the irrigation scheme a soil moisture model estimated an area requirement of 135 hectares. This has assumed a maximum irrigation rate of 25 mm/d. The model is based on peak processing rates at the plant provided by Alliance Mataura.
- A K-line/Pod irrigation system has been assumed for the irrigation of the dairy pasture as this will be suitable for use around livestock as it can be moved when required.
- The existing discharge infrastructure will be retained for when the discharge to river is used. No additional treatment will be provided prior to discharge to the river.

4.5.3 Load to the River

The expected load discharged to the river by this option has been estimated and compared to the current load. These estimates have been based on the proposed irrigation period, the expected days processing at the plant and current wastewater flows and loads. The *E. coli* load to the river ceases during summer but remain at similar rates to the existing discharge during winter.

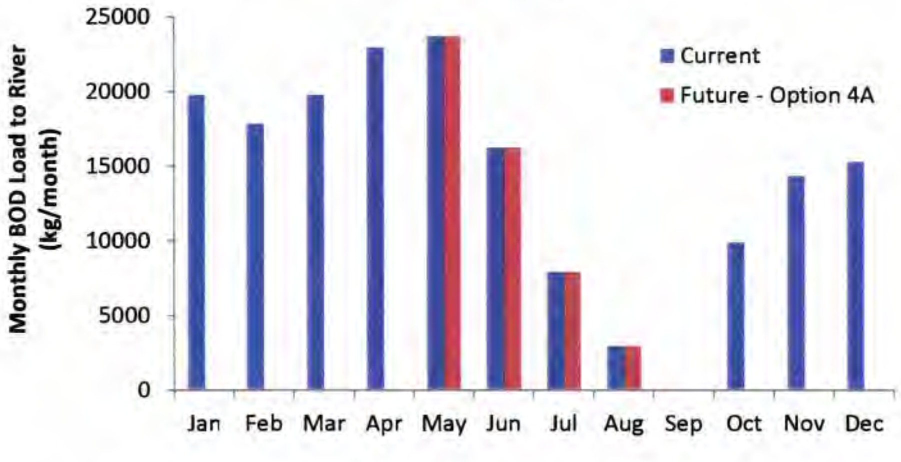


Figure 7: Option 4A current and future BOD load to the Mataura River

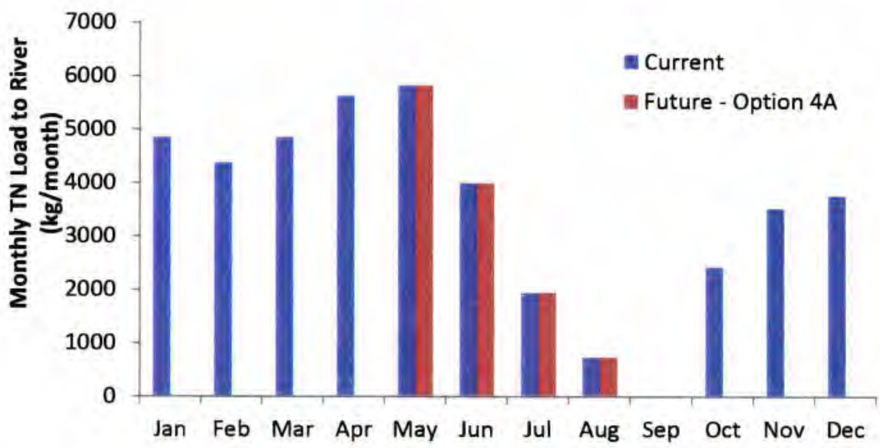


Figure 8: Option 4A current and future TN load to the Mataura River

4.5.4 Cost Estimate

The following cost estimate has been prepared based on the system outlined above:

Table 11: Option 4A Cost Estimate

Item	Cost ($1000)
1 – Pump Station	$300
2 – Pipeline	$1,120
3 – Electrical and Control	$430
4 – Irrigation System	$3,950
A – Preliminary and General (15%)	$870
B – Professional Services (15%)	$1,000
C – Unscheduled Items (10%)	$670
D – Contingency (40%)	$2,660
E – Land Purchase	$0
Total Capital Expenditure	**$11,000**
Annual Operating Cost	**$530**
Net Present Value	**$14.2M**

Notes:

1. *All costs are in $NZD and exclude GST.*
2. *Land purchase excluded from contingency due to greater level of certainty on land price.*
3. *Net Present Value based on a 10 year return period and a 10% discount rate.*

4.5.5 Key Advantages

The key advantages to this option include:

- Low volume of wastewater discharged to Mataura River during summer months;
- Decrease in annual contaminant load to river;
- No additional wastewater treatment requirements and no additional sludge generation;
- No land purchase required.

4.5.6 Key Disadvantages and Risks

- The operation of a discharge to land system can be complex and will require significantly more operator involvement than the current discharge system;
- This option relies on the third-party owners of the land that is to be irrigated, this may lead to difficulties in the future if ownership changes or new agreements need to be made;
- Wastewater treated to the same standard as currently will still be discharged to the river during winter;
- During wet weather periods in the summer wastewater will still need to be discharged to the river for approximately 5 to 10 days over the season;
- Will require investment in third party owned farms;
- Consultation and agreement with the dairy company that receives the milk from the farms that are to be irrigated is required;
- May result in concerns for neighbours to the land disposal areas;
- There may be significant difficulty in finding suitable land for irrigation. The flatter land areas around Mataura do not have soil with favourable properties for irrigation. Well-drained soils are situated to the east of the site but are in areas with steeper, terraced topography, which decreases the available irrigation area. Finding enough suitable pockets of land that are in close proximity to each other, with agreement from land owners may not be possible without increasing the complexity and cost of the system.

4.6 Option 5A Dual Discharge, Existing River Location and Irrigation to Cut and Carry with No Treatment Prior to River Discharge

Option 5A is based on irrigation of treated wastewater to a cut and carry system on land purchased and owned by Alliance. This is the only option that will require land purchase so there is a significantly higher capital cost; however a significant proportion of the cost is invested in the land.

As with option 4A the dual discharge system has been assumed to operate between October and April summer, with discharge to the Mataura River predominantly from May to September. The land requirement is hydraulically limited so an area of 135 hectares is still required.

A cut and carry system offers two advantages, the first being the lack of reliance on third parties to enable the discharge, this will mean there is less risk associated with the long term operation of the system. The second advantage is the income generated from the cut and carry crop, this will offset a signification portion of the operating costs associated with the new disposal system. The cost estimate has shown that 50% off the operating costs could be recovered with this system. This has been accounted for and shown in the cost estimate presented in Table 12.

4.6.1 System Description

The system proposed will be same as that proposed for Option 4A, see section 4.6.2. The only difference will be that the system will be a cut and carry system on Alliance owned land. The different land use could potentially allow a more cost effective irrigation system to be installed, such as a centre pivot system, however, due to the rolling nature of the some areas of terrain around Mataura, a solid set system has been assumed for pricing purposes as a system with lower operating costs but higher capital costs is more suited to use on land owned by Alliance.

4.6.2 System Location

The same criteria for determining a suitable land area were used for both option 4A and 5A therefore the same possible locations are proposed, see Figure 8. The same moderately draining solids have been selected for the scheme.

As with option 4A it is estimated that three to four land parcels will need to be purchased to make up the 135 ha of active irrigation area.

4.6.3 Load to the River

The expected load discharged to the river by this option will be the same as option 4A, refer to Figure 9 and Figure 10.

4.6.4 Cost Estimate

The following cost estimate has been prepared based on the system outlined above:

Table 12: Option 5A Cost Estimate

Item	Cost ($1000)
1 – Pump Station	$300
2 – Pipeline	$1,120
3 – Electrical and Control	$460
4 – Irrigation System	$4,270
A – Preliminary and General (15%)	$920
B – Professional Services (15%)	$1,060
C – Unscheduled Items (10%)	$710
D – Contingency (40%)	$2,830
E – Land Purchase	$11,200
Total Capital Expenditure	**$22,853**
Annual Operating Cost (Income from product)	**$256** ($288)
Net Present Value	**$24.4M**

Notes:

1. *All costs are in $NZD and exclude GST.*
2. *Land purchase excluded from contingency due to greater level of certainty on land price.*
3. *Net Present Value based on a 10 year return period and a 10% discount rate.*
4. *Annual operating cost includes the income generated from the crop product.*

4.6.5 Key Advantages

The key advantages to this option include:

- Low volume of wastewater discharged to Mataura River during summer months;
- Decrease in annual contaminant load to river;
- No additional wastewater treatment requirements and no additional sludge generation;
- Irrigation land would be company owned so Alliance would have control over land use, with less potential for conflict.

4.6.6 Key Disadvantages and Risks

- The operation of a discharge to land system can be complex and will require significantly more operator involvement than the current discharge system;
- Large capital cost required for land purchase irrigation system set up;
- Wastewater treated to the same standard as currently will still be discharged to the river during winter;
- During wet weather periods in the summer wastewater will still need to be discharged to the river for approximately 5 to 10 days;
- There may be significant difficulty in finding suitable land for irrigation. The flatter land areas around Mataura do not have soil with favourable properties for irrigation. Well drained soils are found to the east of the plant and are in areas with steeper, terraced topography. This will significantly decrease the potential irrigable area. Finding enough suitable pockets of land that are near each other and able to be purchased may not be possible without increasing the complexity and cost of the system.

5.0 Assessment of Preferred Option

5.1 Qualitative Comparative Assessment

The options selected for further assessment have been subjected to consideration against the following qualitative assessment criteria:

- Capacity to reduce contaminant load to the Mataura River;
- Resilience;
- Life-cycle costs.

5.1.1 Reduction in Load to the Mataura River

Full biological treatment or land treatment are the most effective methods proposed for the reduction of contaminant load into the river.

It is likely Option 1C would achieve the largest overall reduction in load (nitrogen and *E. coli*) discharged to the river. Options 1F, 4A and 5A would also achieve load reduction to the river. Option 1D would only reduce the bacterial load and therefore organic (BOD) load and nutrient loads discharged to the river would remain the same. Options 4A and 5A would result in reduced loads during the summer processing high season. However, no change in the discharge would occur over winter and at times when the absorptive capacity of the land disposal system was constrained because of ground conditions, there would be an estimated 5 to 10 days of discharge to the river in summer due to rain preventing irrigation.

Table 13 summarises the estimated load reductions to the river each shortlist option could achieve.

Table 13: Estimated Reduction in Yearly Total Wastewater Loads to the River

Option	BOD	Total N	*E. coli*
Option 1C	92%	68%	3- 4 log
Option 1D	negligible	negligible	2 – 3 log
Option 1F	50%	52%	2 – 3 log
Option 4A	70%	70%	Seasonal only
Option 5A	70%	70%	Seasonal only

5.1.2 Resilience

The dual discharge options 4A and 5A offer a significant amount of resilience as the river discharge could be used as an alternative disposal method if there were operational issues experienced by the irrigation system.

The river disposal options only have one disposal method so options that discharge to the river and require a high level of treatment (Option 1C and to a lesser extent, 1F) have lower resilience should non-compliances occur. An appropriate level of redundancy has been accounted for in the outline designs and costings of the systems to ensure the risk of failure for the treatment systems is minimised to a suitable level.

There may be a slightly greater risk to the resilience of option 1C due to its reliance on the 2 No. pump stations required to convey the wastewater to and from the treatment locations and a single pipeline in both directions. If these pump stations were to become inoperable or a pipeline temporarily be unavailable due to urgent maintenance, then no further treatment could be provided to the wastewater prior to discharge for the period of failure. Whilst standby pumps significantly reduce this risk, it is still present.

There is an additional resilience risk to Option 1D, that the sand filter upstream of the UV units will blind quickly due to the polymer in the waste and lack of upstream treatment. A 3-dimensional filter, such as a sand-filter, has been utilised in this assessment as it is expected to perform better that the 2 dimensions screen that was utilised in trials in 2006 (PDP 2006). While rapid blinding of a filter is still a risk, and back washing can be utilised to manage this to a certain extent, this risk can be quantified and mitigated with the use of pilot trials to test the rate at which the filter would blind, and if necessary the use of alternative filtration technologies such as suspended bed system prior to filtration.

5.1.3 Life-cycle Costs

The financial implications to Alliance for each option are an important consideration as the cost of the final option can have big impacts on the viability of operating the plant. It is therefore, important to consider the cost of each option and compare this against the other attributes of each option.

Option 5A represents the highest net present value (NPV) lifecycle cost of the shortlisted options. This is due to the significant land purchase required. Option 1C is also a high cost option due to the high level of treatment provided and significant pumping and pipeline costs.

Most of the other options have very similar NPV estimates with the exception of Option 1D which has a significantly lower cost.

A summary of the option life-cycle costs has been provided in Table 14.

Table 14: Shortlisted Options Cost Comparison

	1C	1D	1F	4A	5A
NPV cost	$20.5M	$5.6M	$16.1M	$14.2M	$24.4M

5.2 Summary of Preferred Option Assessment

Based on the qualitative assessment above, Options 1C, or 1F are considered to be better options for the site to progress with for wastewater management as they provide a reduction of both *E. coli* and nitrogen, identified as contaminants of concern on a longer term basis. While 1D presents the lowest capital cost, and reduces bacterial load (as a key contaminant) it does not address nitrogen loads. Option 1D may still be viable however, as it is effective at providing for *E. coli* removal, with the option of adding onto it to target the other key contaminants at a later date.

Option 1C on the other hand, addresses bacterial, BOD and nitrogen loads but it has a very large capital cost. Option 1F provides for bacterial removal and partial BOD and total nitrogen removal.

Option 4A and Option 5A are less favoured as the same contaminant load is still discharged to the River during winter months, and greater contaminant load reduction opportunities are presented by other assessed options for similar capital and operating costs. An estimated 5-10 days or discharge to the river during summer will be required due to rain events, the consent conditions related to this would be complex and make the system difficult to operate. There is also an uncertainty as to whether enough suitable land can be made available for irrigation, local soil properties and topography mean it may not be possible to obtain the required land without increased capital investment or system complexity.

Therefore, the remaining options are Options 1C and 1F, with the potential intermediate stage of Option 1D. These options rely on the continued discharge to the Mataura River. The option ultimately selected will be based on a range of considerations including existing and emergent policy directives relating to water quality, assessment of the receiving environment and the effects of the discharge on that environment and matters raised and considered during consultation with key stakeholders.

There is an opportunity to stage the upgrade of the treatment system, particularly if *E. coli* is identified as the priority contaminant requiring reduction. In this case it would be feasible to install Option 1D as an intermediate upgrade.

If nitrogen is identified as the priority contaminant requiring reduction the there is less opportunity to stage the upgrade.

5.3 Upgrade Approach

Based on the assessment the existing wastewater management system and the potential alternatives options, the following upgrade approach is recommended:

1. Address existing system resilience issues, including:
   minimising cross contamination risk points, re-routing pipes away from hydro-race and undertaking structural maintenance of the DAF systems;
2. Implement water reduction opportunities, including:
   recycling of treated wastewater for white water generation;
3. Programme towards treatment plant upgrades, in line with the outcomes of the consenting process with either:
   a. If there is no identified priority between contaminants of concern (*E. coli* and nitrogen) or *E. coli* is identified as the priority contaminant of concern, upgrade the wastewater treatment plant with a staged approach, with Option 1D implemented followed by Option 1C or 1F at a later date (if a staged approach is preferred). There would be little additional cost for a staged approach over an un-stage approach. There is a risk of rapid filter blinding, due to polymer in the wastewater, and this risk needs to be assessed with pilot scale trial. If necessary, additional mitigation measures, such as mobile bed polymer deactivation, may be required.
   b. If nitrogen is identified as the priority contaminant of concern then there is less benefit associated with a staged upgrade due to the increased initial capital expenditure, therefore, the upgrade would incorporate the complete system of either Option 1C or 1F.
   c. If phosphorus is identified as an additional contaminant of concern, requiring additional removal beyond what the site is already achieving, then chemical phosphorus removal, with the use of alum dosing, can be installed as part of the upgrades either upstream of the sand filter or clarifier. The additional capital cost of this upgrade would be negligible (in comparison to the wider capital costs) and the additional OPEX would be approximately $100k per year.

6.0 Conclusions and Recommendations.

For the assessment of potential alternative wastewater management options for the Alliance Mataura site, options incorporating continued discharge to the Mataura River, irrigation to land, or a dual discharge combination, and discharge to trade waste were considered.

The selected options for further assessment included continued discharge of treated or partially treated wastewater to the river and irrigation to land during summer months, as a dual discharge combination with discharge to the river during winter months.

A qualitative assessment was conducted to compare the shortlisted options. Continued discharge of wastewater to the Mataura River was identified as the preferred option but with a reduction of both nitrogen and *E. coli*, based on Option 1C or Option 1F. With these two options there is the potential to develop Option 1D as an intermediate stage.

Of the selected options, selection of the preferred approach going forward depends on a range of considerations including existing and emergent policy directives relating to water quality, assessment of the receiving environment and the effects of the discharge on that environment and matters raised and considered during consultation with key stakeholders.

- If *E. coli* is identified as the priority contaminant requiring reduction, then there is the opportunity to install Option 1D as an intermediate upgrade.
- If nitrogen is identified as the priority contaminant requiring reduction then there is less opportunity to stage the upgrade.

Identification of the priority contaminant of concern (*E. coli* or nitrogen) will help clarify the upgrade approach and timing, however, the following overall approach is recommended.

1. Address system resilience issues, including:
   minimising cross contamination risk points, removing pipes from hydro-race and undertaking maintenance of the DAF systems;
2. Implement water reduction opportunities, including:
   recycling of treated wastewater for white water generation;
3. Programme towards treatment plant upgrades, in line with the consenting process with either:
   a. If there is no identified priority between contaminants of concern (*E. coli* and nitrogen) or *E. coli* is identified as the priority contaminant of concern, upgrade the wastewater treatment plant with a staged approach, with Option 1D implemented followed by

Option 1C or 1F at a later date (if a staged approach is preferred). There would be little additional cost for a staged approach, over an un-stage approach however, there is a risk of rapid filter blinding, due to polymer in the wastewater, and this risk needs to be assessed with pilot scale trial. If necessary, additional mitigation measures, such as mobile bed polymer deactivation, may be required.

b. If nitrogen is identified as the priority contaminant of concern, then there is less benefit associated with a staged upgrade due to the increased initial capital expenditure, therefore, the upgrade would incorporate the complete system of either Option 1C or 1F.

c. If phosphorus is identified as an additional contaminant of concern, then chemical phosphorus removal, with the use of alum dosing, can be installed as part of the upgrades either upstream of the sand filter or clarifier. The additional capital cost of this upgrade would be negligible while the additional OPEX would be approximately $100k per year.

7.0 References

Freshwater Solutions Ltd 2019. *Assessment of the Effects of Alliance Mataura's Discharges and Water Take on Mataura River and Toetoe Estuary. Submitted to Alliance Group Ltd* (DRAFT). March 2019.

Streamlined Environmental 2019. *Quantitative Microbial Risk Assessment for the discharge of treated meat processing factory wastewater into the Mataura River.* Report AES1704 Prepared for Alliance Group/ Aquatic Environmental Sciences Ltd.

8

APPENDIX 8

Alliance Mataura Plant – Water Use and Wastewater Management Resilience Assessment

Auckland Tauranga Wellington Christchurch

PATTLE DELAMORE PARTNERS LTD

Alliance Mataura Plant – Water Use and Wastewater Management Resilience Assessment

Alliance Group Limited

solutions *for your environment*

Alliance Mataura Plant – Water Use and Wastewater Management Resilience Assessment

∴ Prepared for

Alliance Group Limited

∴ May 2019

pdp

PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 523 6900 Fax +64 9 523 6901
Website http://www.pdp.co.nz
Auckland Tauranga Wellington Christchurch

solutions for your environment

Quality Control Sheet

TITLE	Alliance Mataura Plant – Water Use and Wastewater Management Resilience Assessment
CLIENT	Alliance Group Limited
VERSION	Final
ISSUE DATE	31 May 2019
JOB REFERENCE	AJ903227
SOURCE FILE(S)	AJ903227R002.docx

DOCUMENT CONTRIBUTORS

Prepared by

SIGNATURE

Luke Wilkinson

Daryl Irvine

Reviewed by and approved by

SIGNATURE

Azam Khan

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Alliance Group Limited. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Alliance Group Limited for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

Executive Summary

Alliance Group Limited (Alliance) owns and operates a beef processing plant at Mataura, where all wastewater is treated and discharged to the Mataura River, in accordance with Environment Southland Regional Council (ESRC) Resource Consent 202327. Resource Consent 202327 is due to expire in December 2019 and Alliance is required to apply for a new consent by June 2019.

To assist with the consenting process, it is important that Alliance reviews the water use rates at the plant, to assess if water use (and subsequent wastewater generation volumes) is efficient, and that the resilience of the existing wastewater management system is reviewed to identify potential risks for the site going forward.

Pattle Delamore Partners Limited (PDP) was engaged to undertake a water use assessment and a wastewater management resilience assessment, for guidance during the consenting process.

Based on the water use assessment, water use within the processing plant areas is slightly higher than common water use rates at other large export meat plants. The slightly higher water use is attributed to the further tripe processing that occurs at the site. The use of raw river water for generation of white-water (at approximately 2,000 m^3/d) is not an efficient use of water, and is a potential area where water use could be reduced (by approximately 37% depending on daily process volumes), by recycling the treated wastewater for white-water generation purposes.

Assessment of the resilience of the wastewater management systems identified potential intermittent cross contamination points between the Green and Non-Green waste streams and potential failure points within the reticulation system. On the basis of these findings, the following actions are recommended, in order of priority:

1. Where practical, re-route all pipework that runs above or in the water race or above the river to locations that prevents waste leaking into the water race or fresh water leaking into the treatment system; and
2. Modify the beef sump milli-screen overflow and tripe recycle area, to prevent green waste overflows into the non-green waste stream.

Table of Contents

Table of Figures

Table of Tables

1.0 Introduction

Alliance Group Limited (Alliance) owns and operates a beef processing plant at Mataura, where all wastewater is treated and discharged to the Mataura River, in accordance with Environment Southland Regional Council (ESRC) Resource Consent 202327. Resource Consent 202327 is due to expire in December 2019 and Alliance is required to apply for a new consent by June 2019.

To assist with the consenting process, it is important that Alliance reviews the water use rates at the plant, to assess if water use (and subsequent wastewater generation volumes) is efficient, and that the resilience of the existing wastewater management system is reviewed to identify potential risks for the site going forward.

Alliance has engaged Pattle Delamore Partners Limited (PDP) to undertake a water use assessment and a wastewater management resilience assessment, for guidance during the consenting process. This report discusses the methodology, findings and recommendations of these investigations.

1.1 Water Use

The water use investigation focused on the measurement of water flows to and from various areas of the processing plant to identify areas of high water consumption as well as the observation of water management practices throughout the plant.

Optimising the water usage within the existing plant has the potential to reduce the volume of generated wastewater, reducing the size and cost of potential additional wastewater treatment systems or disposal systems required in the future.

A water usage survey was undertaken by PDP in January 2019. The flow data collected during this time has been used as the basis for the investigation. It is noted this was a one-off survey therefore, does not fully account for the daily variation in processing rates.

1.2 Infrastructure Resilience

The assessment of the resilience of the plant is approached in thee ways, being:

- system performance risks;
- environmental risks; and
- system failure risks.

A site walk over was conducted by PDP staff during January 2019, to investigate the plant. This report discusses the findings of the resilience investigation and recommended actions.

2.0 System Summary

The Alliance Mataura Plant processes up to 1,062 beef animals per day. Water use and wastewater generation is from the following main plant areas: stockyards, truck wash, beef plant, tripe plant and the pelt house. Wastewater from these areas is divided into either green waste (high phosphorus concentration) or non-green waste (low phosphorus concentration). These two waste streams are collected separately (as shown in Figure 1) and are treated via separate wastewater treatment streams for targeted phosphorus removal, based on dissolved air flotation (DAF) based treatment.

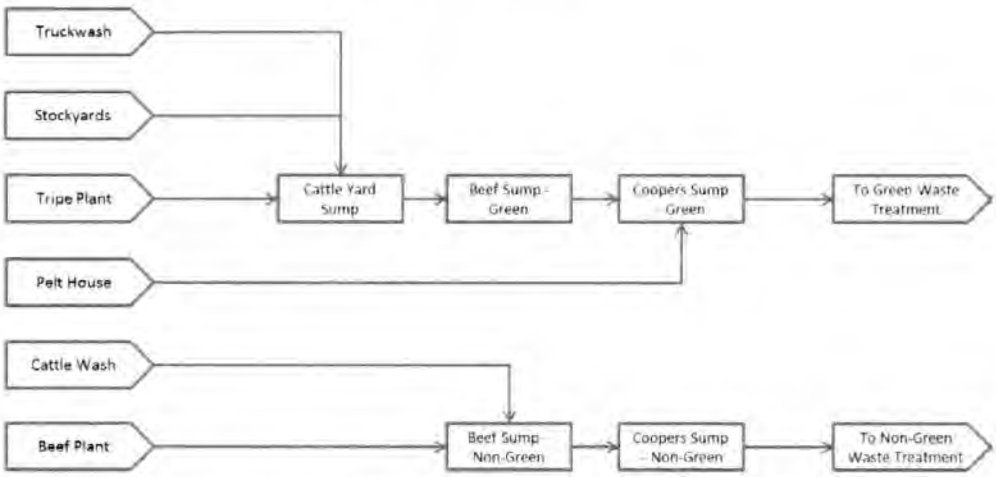


Figure 1: Main Plant Process Flow Diagram

Each of the processing areas requires a water supply for equipment washing and/or for general cleaning of the areas. The wastewater treatment process also has a water demand for use in the DAF systems, specifically for dissolved air (white-water) generation.

Both Green and Non-Green waste streams are passed through separate milli-screening screens and saveall tanks for gross solids removal. The green waste contains a high total phosphorus load, so is treated in a 2 stage DAF-in-Series system, consisting of an acid DAF stage and then an alkali DAF stage for phosphorus precipitation. The non-green waste does not contain a high phosphorus load, so undergoes an acid DAF treatment for protein precipitation.

In total there are 12 No. DAFs on site, 9 of which are currently operational. This is made up of 3 parallel Non-Green waste acid DAFs and 3 parallel sets (6 in total) of acid/alkali DAFs for Green waste treatment. The DAFs tanks each use a supply of fresh water for the generation of air saturated 'white-water' for use in the process. Refer to Figure 2 for a block diagram of the existing process.

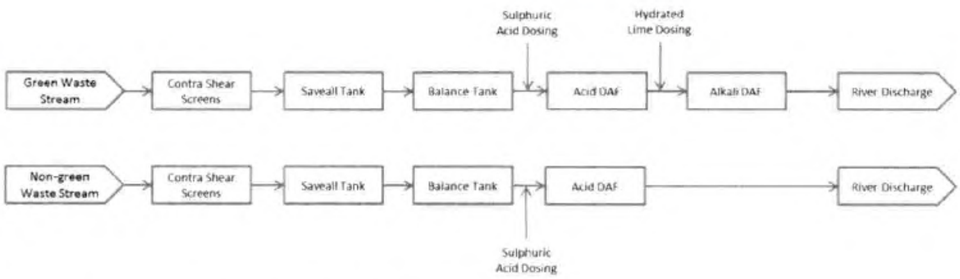


Figure 2: Existing wastewater treatment process

The treated waste streams are then discharged via separate bank-side diffusers to the Mataura River, downstream of the Mataura Falls.

3.0 Water Use Assessment

PDP undertook a water use survey at the Mataura Plant, from 9:00 am on 21 January 2019 to 10:00 am 23 January 2019. As part of this survey, not all water use rates in each plant were able to be monitored, therefore, waste streams and water supplies were monitored and flows to each plant established based on a mass balance. The process flows measured were truck wash, cattle wash, cattle yard and cattle wash, green waste in, green waste out, non-green waste in and non-green waste out.

This data has been used to assess water use efficiencies at the site, in comparison to animals processed, for comparison with water utilisation at other beef processing plants. Animal processing at the time was 436 animals per shift during both days and 280 animals per shift during both nights, with a total of 716 animals processed per 24 hour period.

A walk through the main processing areas of the plant was also undertaken to observe water use and water management within the plant, checking for any obvious areas where water use could be improved. This walk through was conducted on 20 December 2018.

3.1 Summary of Flows and Water Use

The mass balance, based on the flow data recorded on site, allowed average flows for the main process areas to be calculated. These are shown in **Error! Reference source not found.**.

3.2 Plant Inspection

Visual assessment within the processing plant indicated that there was a generally good approach to water conservation, with measures such: as sensors for apron washing and gut tray washing; and restricted flow knife washing systems. Within the processing plant, there did not appear to be much in the way of unnecessary water use.

Site staff indicated that on occasions, a hose is utilised within gut cutting room to aid with air cooling (a practice that is discouraged by site management) however, it appears that the practice continues. This could be an area of potential water saving, if cooling systems were installed, however, the potential saving could not be verified due to the unknown frequency of operation. This has not, therefore not been identified as an opportunity for saving but could be pursued in the future.

Within the tripe area, recycled water is utilised for paunch mobilisation, to conserve water use.

Table 1: Summary of wastewater flows across main processing plant areas

Plant	Water Use/Wastewater Volumes			
	Mean (m^3/hr)	Daily[1] (m^3/d)	Use per animal[3] (m^3/head)	Expected Peak Processing Use Rate per Animal[4] (m^3/animal)
Truck wash	2.0	47.3	0.07	0.07
Stockyards	4.0	95.5	0.13	0.09
Tripe Plant	43.8	1,051	1.47	0.99
Pelt House	0.1	1.0	0.001	0.01
Green Waste Total	**49.9**	**1,195**	**1.67**	**1.16**
Cattle Wash	15.4	370.6	0.52	0.52
Beef Plant	73.0	1,751	2.45	1.65
Non Green Total	**88.4**	**2,122**	**2.97**	**2.17**
Total Combined Waste Stream	**138.3**	**3,317**	**4.63**	**3.33**
Green Waste White-water	53.5	1,283	1.79	1.21
Non-Green Waste White-water	31.0	743	1.04	0.70
White-Water Total[2]	**84.5**	**2,026**	**2.83**	**1.91**
Treated Green Waste	103.3	2,478	3.46	2.37
Treated Non-Green	119.4	2,865	4.00	2.87
Wastewater Total	**222.7**	**5,343**	**7.46**	**5.24**

Notes

1. *Based on combined day and night shift water use rates.*
2. *Based on assumed 2/3 use in Green DAF plants and 1/3 use in non-green DAF plants.*
3. *Based on a processing rate of 716 head/d, balanced across the day.*
4. *Peak rate processing based on 1,062 head/d, balanced across the day.*

3.3 Discussion

Based on the overall plant water use rates prior to the wastewater treatment plant, the Alliance Mataura Plant was utilising approximately 4.62 m^3/animal processed at the time of the assessment. Common industry water use rates in larger export plants are in the order 10-11 m^3/tonne of carcass weight processed (MLA 2008). Based on an average carcass weight of 240 kg/carcass at the time of the assessment, this equates to 2.7 m^3/animal processed. In comparison to standard use rates, the water use rate at the Alliance Mataura Plant at the time of the assessment was higher, by approximately an additional 1.92 m^3/animal.

Many of the water use systems within the Mataura Plant do not appear to be processing rate based, with the exception of the cattle wash system. At the time of the assessment, the plant was only processing at approximately 70% capacity, with a slightly lower than average carcass weight (seasonal average is 240 kg/carcass). On this basis, if the plant was operating at 1,062 animals per day, then the water use rate would be in the order of 3.3 m^3/animal, compared with a common industry use rate of 2.9 m^3/animal (adjusted for average Alliance Mataura season carcass weight of 260 kg/carcass).

Observations within the beef slaughter and boning plant indicates that there are not many potential areas for water conservation. Based on monitoring data, adjusted for peak processing, water use rates were in the order of 1.65 m^3/animal (2.45 m^3/animal at the time). This compares relatively well with a common industry rate for larger export plant more order of 1.48 m^3/beef animal (based on 51% use in slaughter/boning areas (MLA 2008)).

The water use rate in the stock yards is relatively low and there appeared to be minimal use of hoses. The cattle wash, however, is a relatively large user of water for the area, at 0.5 m^3/animal processed. The total water use in the yards area equates to 0.7 m^3/beef animal, which compares well with the common industry rate for larger export plant of 0.6 m^3/beef animal (based on 21% use in stock yards and truck wash areas (derived from MLA 2008)).

The tripe plant is a large user of water, at 1.0 m^3/beef animal, adjusted for peak processing (1.47 m^3/animal at the time). It is noted that the plant already recycles some of the screened tripe wastewater for mobilisation water. A common industry rate for wet paunch dump and green offal wash is approximately 0.4 m^3/beef animal (derived from MLA 2008)), however, it is noted that the Alliance Mataura plant conducts further tripe processing than would be conducted in most plants, which would likely account for the additional water use.

Overall, it is concluded that the Alliance Mataura processing plant is utilising water at a slightly higher rate than common industry use averages for larger export plants. The slightly higher water use rate is attributed to additional tripe processing.

Following the processing plant, the generated wastewater is treated utilising a DAF based treatment system. The wastewater treatment system utilises raw river water for white-water generation for use in the DAF plant, which equates to 37% of the overall plant water use. Most DAF systems utilise recycled treated wastewater for white-water generation, and therefore, white-water generation is identified as an area that could represent a significant water usage reduction for the plant. This has the potential to reduce water use in the plant by approximately 2,000 m^3/d.

Recycling of treated wastewater for white-water generation will require careful management to avoid foam generation in the inter-stage tank. Consideration will also need to be given to the implications of the decreased dilution effect of the white-water and the existing consent concentration limits.

4.0 Infrastructure Resilience Investigations

It is essential that the wastewater management system at the Alliance Mataura plant is resilient against failures to allow for continued reliance. It is likely that the existing wastewater management systems will continue to be utilised as part of any future treatment system and therefore, it is important that the condition and associate risks of the existing system are assessed. If new wastewater management systems are installed, in addition to the existing plant, then these systems will be subject to additional resilience assessment.

Potential resilience issues that could occur fall into 3 major categories:

- System performance risks,
- Environmental risks,
- System failure risks.

4.1 Method

A site walk over was conducted by PDP on 21 and 22 January 2019, the purpose of this was to visually inspect the configuration and condition of the wastewater reticulation and treatment systems in order to identify possible risks that fell into the categories above. Discussions with site managers and operators were also used to gather site information and confirm the issues observed on site.

4.2 Resilience Issues

The following resilience issues were identified during the site walkover.

4.2.1 Green waste cross contamination

There is the potential for overflow of the tripe wash recycle sump (Green Waste) to a Hide Wash sump (Non-Green waste stream), in the yards area. There is also the potential for overflow of the Beef Sump green waste milli-screen, to the red waste stream.

Separation of the green and non-green waste systems is essential for minimising the phosphorus load discharged to the Mataura River. These overflows therefore, represent a risk that phosphorus, that would otherwise be removed in the green waste treatment process, would be discharged to the Mataura River via the non-green stream. This would cause an increase in the phosphorus load discharged to the river. Phosphorus has been identified as a high priority contaminant to reduce in the river. It is therefore, critical that all phosphorus in the green waste stream remains in the green waste stream for removal.

Modification of the system would decrease the risk of cross contamination and decrease the risk of increased phosphorus loading into the Mataura River. It is noted that since sheep and lamb processing ceased, the plant has remained complaint with regards to phosphorus discharge limits.

4.2.2 Wastewater Pipes in or above Hydro-race

The main green waste, non-green waste and pelt house streams are conveyed in separate pipes to the Coopers sump, prior to being pumped to the wastewater treatment plant. Prior to the pipes entering the Coopers sump, they pass through and over the hydro scheme water race. Additionally, some pipes near the saveall tank run above the wall adjacent to river itself. This presents the risk of accidental discharge of contaminants directly to the river or an influx of river water if any of the pipes fail.

A leak in a pipe in or above the water race or river would lead to untreated wastewater being discharged directly to the river, potentially un-detected.

If a pipe submerged in the water race is compromised, river water may flow into the pipe and into the wastewater treatment system. This could significantly increase the hydraulic loading onto the wastewater treatment process and negatively impact its performance, which could increase the wastewater contaminant loads discharged to the river. Discussions with site operators indicate that this may have occurred in the past, associated with the Pelt House wastewater pipe.

Relocation of the pipes outside of the hydro race or away from the wall above the river would help minimise the risk of uncontained and undetected discharge.

4.3 Summary of Resilience Assessment Findings

Each of the resilience issues noted above represent a significant risk to the plant in terms of performance, environmental or safety, therefore, these issues need to be addressed adequately under urgency in order to minimise and/or eliminate any risk. As a priority it is recommended the following measures are actioned, in order of priority:

1. Where practical, re-route all pipework that runs above, or in, the water race to a location that prevents waste leaking into the water race or fresh water leaking into the treatment system;
2. Re-route all pipework that runs above the river to a location that prevents waste leaking into the river;
3. Modify the beef sump milli-screen overflow to prevent green waste overflows into the non-green waste stream;
4. Modify the stockyard and tripe recycle area to prevent green waste overflows into the non-green waste stream.

5.0 Conclusions and Recommendations

Based on the water use assessment, it is concluded that water use within the processing plant areas is in keeping with, but slightly higher than, water use rates at other large export meat plants. The slightly higher water use is attributed to the level of tripe processing that occurs at the site.

The use of raw river water for generation of white-water (at approximately 2,000 m^3/d) is not an efficient use of water, and is a potential area where water use could be reduced, by recycling the treated wastewater for white-water generation purposes. This is common practice with DAF treatment systems. Consideration will need to be given to managing the risk of foaming in the white-water generation system, and the impact the removal of the additional diluting raw water will have on treated wastewater contaminant concentrations and concentration consent limits.

Assessment of the resilience of the wastewater management systems identified potential intermittent cross contamination points between the Green and Non-Green waste stream and potential failure points within the reticulation system. On the basis of these findings, the following actions are recommended, in order of priority:

1. Where practical, re-route all pipework that runs above or in the water race to a location that prevents waste leaking into the water race or fresh water leaking into the treatment system;
2. Re-route all pipework that runs above the river to a location that prevents waste leaking into the river;
3. Modify the beef sump milli-screen overflow to prevent green waste overflows into the non-green waste stream;
4. Modify the stockyard and tripe recycle area to prevent green waste overflows into the non-green waste stream.

6.0 References

MLA 2008, *Review of Abattoir water Usage Reduction, Recycling and Reuse*, Meat & Livestock Australia Limited 2008.

9

APPENDIX 9

Summary AEE document circulated to key stakeholders during consultation

ALLIANCE

FARMERS' PRODUCE

SINCE 1948

Mataura Processing Plant
Resource Consent Applications

Summary Document for Consultation

May 2019

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

For Consultation Purposes

1. INTRODUCTION

Alliance Group Limited (Alliance) owns and operates the Mataura Meat Processing Plant (the Plant) on the true right bank of the Mataura River in the Mataura township.

Alliance is a farmer owned cooperative and the Plant is a vital component of Southland's agricultural sector – processing stock from the region. It is also a vital component of the local and regional economy, employing approximately 500 people in the peak of the season and contributing approximately $160 million per year to the economy (mostly in livestock payments) and approximately $25 million per year for wages and salaries for the 2017/2018 season.

Figure 1: The Alliance Mataura Plant (foreground).

The Plant currently operates under 10 resource consents issued by Southland Regional Council (Environment Southland) and/or Gore District Council (District Council). Three of these consents expire on 6 December 2019, namely:

- The take and use of water for cooling and processing purposes;
- The discharge of cooling water; and
- The discharge of wastewater.

Alliance will be applying for replacement consents for these activities in June this year.

The discharge to air permit for the site also expires shortly - in December 2020. Applications to replace that resource consent will be made separately, probably in the first half of 2020.

The Plant is specifically provided for in the Gore District Plan and industrial activities are permitted on the site. No consents are needed or being sought from the District Council.

Alliance intends on seeking a 35 year consent term for all replacement consents being sought. A long term suitably recognises the existing asset value of the Plant and the significant economic contribution it provides to the Southland Region and New Zealand.

Alliance has explored a range of options for improving the way that wastewater from the site is treated. The capital expenditure associated with these options is still being refined, but it is clear that the options require a significant investment to be made. A significant commitment of this nature will require and be contingent on securing a long consent term in order to enable the upgrades to be progressively implemented and allow the financial investment to be justified and secured over an appropriate timeframe.

1.1 PURPOSE OF THIS DOCUMENT

To assist with the preparation of the consents necessary to continue to operate the Mataura Plant, Alliance has engaged various technical experts to prepare a robust assessment of environmental effects.

This document is intended to assist with the consultation process and summarises the work done to date by the various experts in assessing the effects of the Mataura Plant.

Following consultation and after considering any feedback it receives during this period, Alliance intends to finalise the technical assessments and prepare the necessary application documents. The applications will be lodged with Environment Southland in June 2019.

2. ENVIRONMENTAL SETTING

The Alliance Mataura Plant is located in the Mataura township on the true right bank of the Mataura River. The true left bank of the river is occupied by the former Carter Holt Harvey paper mill now an industrial site managed by the Mataura Industrial Estate (MIE).

The Mataura township has a population of 1509 (2013 census) and is a small rural service centre whose residents have a high reliance on the Mataura Plant for employment opportunities.

The Mataura River catchment is the largest river catchment in the Southland Region with a catchment area of 5,400 km^2 which stretches from its headwaters in the north near Lake Wakatipu to the south coast of Southland at Toetoes Estuary approximately 35 km east of Bluff.

Over 70 percent of the Mataura catchment has been developed for farming (reflected in the prevalence of dairy farming related consents shown in Figure 2) and between 1940 to

1980 there was widespread willow clearing, channel straightening and artificial drainage installed which has significantly altered the catchment hydrology and water quality. The Mataura Plant is in the lower section of the Mataura Catchment, approximately 12 km downstream of Gore, and 44 km upstream of the Toetoes Estuary (at Fortrose).

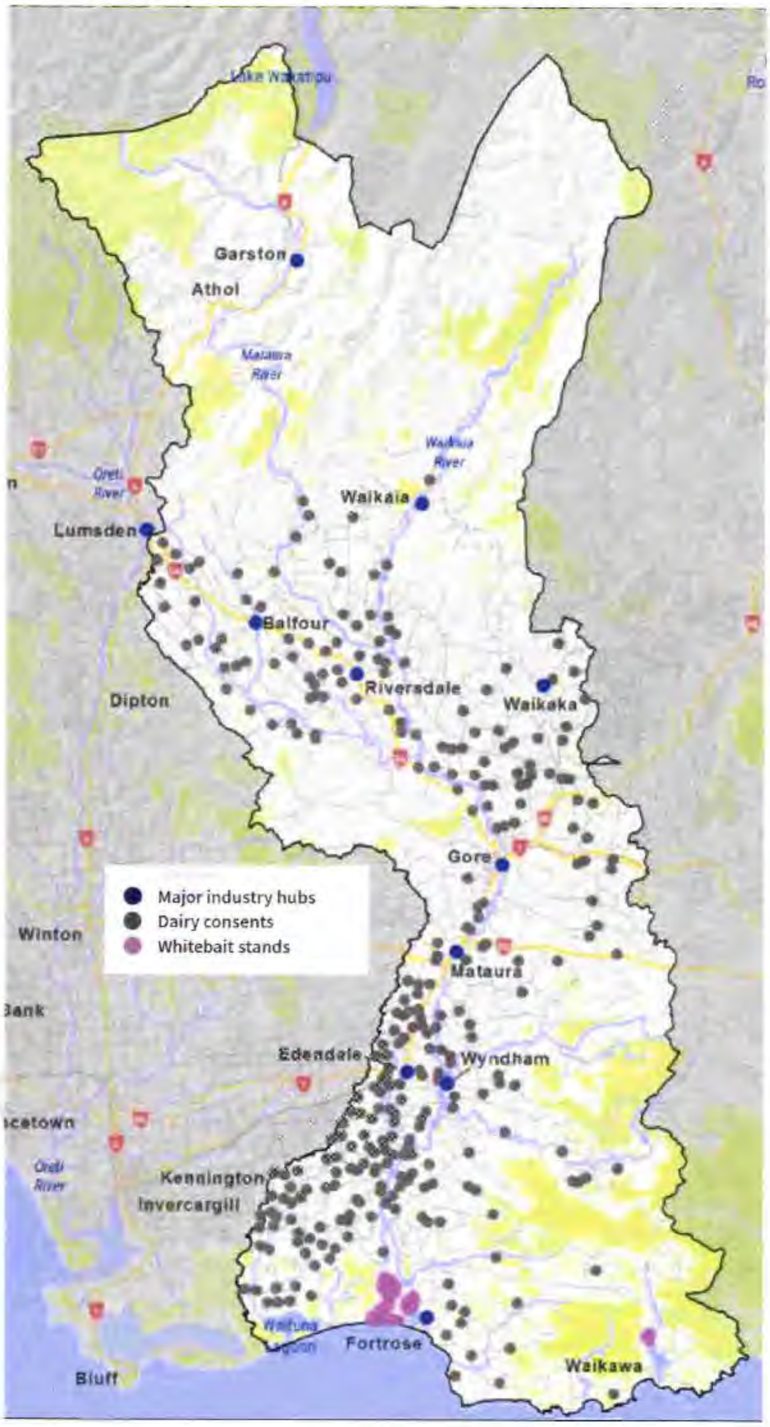


Figure 2: **The Mataura Catchment.**

The flow within the Mataura River is highly variable, mostly because of its alpine headwaters and also considerable catchment size. The flow regime is characterised by long periods of low flow interspersed with high magnitude but low frequency flood events.

Habitat in the lower Mataura catchment is characterised by its cobble dominated bed and willow lined channel (see Figure 3), although coal seams and bedrock outcrops become more common in the reach below Mataura.

Figure 3: Mataura River approximately 2 km downstream of the discharge point.

The Mataura Falls (see Figure 1) are located on the Mataura River adjacent to the Plant and extend right across the width of the River. The Falls are a natural feature while the water take weir located immediately upstream of the Falls (see Figure 1 and Figure 7) was constructed in the 1890s and the two adjacent water races for hydro-electric power were built in the 1920s/1930s. The Falls have always provided a natural barrier to upstream fish migration, and this section of the waterbody is dynamic and turbulent at times. However, the Falls are passable under certain flow conditions and physical conditions (suitable rock surfaces) for those species with good climbing ability (eels, lamprey, giant kokopu (juveniles) and koaro).

Surface water quality in the Mataura catchment has undergone significant changes over the past 30 years. Point-source discharges and associated effects (BOD, ammonia and dissolved oxygen) in the lower catchment were a major issue in the 1970's (as shown in Figure 1 there are several industry hubs in the catchment), but improvements to the quality of wastewater discharges have reduced these effects.[1] However, over the corresponding period an increase in contaminants (particularly nutrients) associated with the intensification of agricultural land use occurred across much of the catchment. The surface water quality monitoring data that Alliance has obtained generally supports these findings. This shows water quality in the vicinity of Mataura is characterised by:

- Water temperature (between 2.3–23.2°C) and dissolved oxygen levels (>5 g/m^3) suitable for protecting river ecosystem health;
- Nitrate and ammoniacal nitrogen (Amm-N) concentrations which meet National Policy Statement for Freshwater Management 2014 (NPSFW) Attribute State A or B for toxicity, but which exceed the relevant ANZECC (2000) 'physical and chemical stressor' trigger values which relate to nuisance plant growth;
- Nutrient indicators (e.g. Dissolved Inorganic Nitrogen (DIN) and Dissolved Reactive Phosphorus (DRP)) which regularly exceed the Ministry for the Environment periphyton guideline for protecting benthic biodiversity; and
- Very high *E.coli* concentrations which mean the Mataura River sits in the Red NPSFW Attribute State for *E.coli*.

The Mataura River benthic macroinvertebrate community in the vicinity of Mataura upstream and downstream of the Plant is typical of stony bed lowland river and supports a range of water quality sensitive and tolerant taxa. It is dominated by Ephemeroptera (mayflies) and Trichoptera (caddisflies) with Diptera (true flies) the next most common group. *Deleatidium* are the most common mayfly and the filter feeding *Aoteapsyche* the most abundant caddisfly taxon recorded across all years. Alliance's ecological monitoring data has generally recorded poor to fair macroinvertebrate community quality class across all monitoring sites both upstream and downstream of the Plant

While water quality indicates that periphyton growths should occur, such growths are not frequent in the Mataura River below Gore. However, periphyton growths are observed during longer accrual periods and when this occurs the Macroinvertebrate Community Index (MCI – a measure of benthic invertebrate health) score typically decreases.

The lower Mataura River supports moderate to high native fish diversity (13 native fish have been recorded) including eight species with an 'At Risk Declining' conservation status - longfin eels, torrentfish, lamprey, Gollum galaxias, galaxias southern, inanga, giant kokopu and koaro.

The Mataura River is also regarded as one of New Zealand's premier lowland brown trout fisheries and is internationally recognised. The Water Conservation Order (1997)

---

[1] *Mataura Catchment Strategic Water Study*, Report prepared for Environment Southland. May 2011. Liquid Earth Aqualinc Research Harris Consulting

recognises the importance of the River from source to sea with its outstanding fisheries and angling amenity. With respect to other recreational values, the Mataura river supports a very popular whitebait fishery in its lower reaches (see Figure 2) and is subject to relatively high use for swimming during the summer months, both up and downstream of Mataura. It's various riverbanks, berms, reserves and angler access points are also used for a variety of terrestrial activities, mostly around settlements.

Iwi have a long association and a strong traditional relationship with the Mataura River. A Statutory Acknowledgement exists for the Mataura River in Schedule 42 of the Ngai Tahu Claims Settlement Act 1998. This Statutory Acknowledgement outlines Ngai Tahu's association with the Mataura River. Above the Mataura Falls the river was traditionally used by the descendants of the Ngati Mamoe chief, Parapara Te Whenua, along with other famous tupuna. The Statutory Acknowledgement states that:

> *"The Mataura was an important mahinga kai, noted for its indigenous fishery. The Mataura Falls were particularly associated with the taking of kanakana (lamprey). The tupuna had considerable knowledge of whakapapa, traditional trails and tauranga waka, places for gathering kai and other taonga, ways in which to use the resources of Mataura, the relationship of people with the river and their dependence on it, and tikanga for the proper and sustainable utilisation of resources. All of these values remain important to Ngai Tahu today.*
>
> *The mauri of the Mataura represents the essence that binds the physical and spiritual elements of all things together, generating and upholding all life. All elements of the natural environment possess a life force, and all forms of life are related. Mauri is a critical element of the spiritual relationship of Ngai Tahu Whanui with the river."*

The Mataura River is also subject to the Mātaitai Reserve. This reserve status recognises the importance of the river as providing a mahinga kai resource for Ngāi Tahu Whānui because of its use as an access route between coastal Muruhiku (Southland) to Fiordland and the West Coast for the gathering of pounamu. The Mataura was particularly noted for the gathering of kanakana (lamprey) and tuna (eels), with annual fishing expeditions in season to favoured nohoanga (campsites) along the river. The bylaw for the reserve prohibits commercial fishing within the area. Customary fishing is permitted subject to approval.

The Mataura River flows into the Toetoes Estuary. This estuary is a medium sized "tidal lagoon" type estuary that discharges to Toetoes Beach at Fortrose, and it drains a large and primarily high productivity agricultural catchment. The shallow estuary (mean depth of around 2m) has a large freshwater influence because the estuary is small in relation to the freshwater input. It has a wide range of habitats (extensive mudflats and saltmarsh areas, very small patches of seagrass) but has historically lost large areas of saltmarsh (estimated loss of approximately 75% (250ha)), while virtually all the surrounding wetland has been lost through drainage and reclamation and conversion to pasture. This has greatly reduced the estuary's ability to filter, dilute, and assimilate nutrient and sediment inputs.

Recent Environment Southland monitoring has shown the estuary is in a "MODERATE" but declining condition in relation to eutrophication, and that the ongoing drainage and loss of saltmarsh and densely vegetated terrestrial margins is also placing the estuary under pressure. Excessive nutrient inputs are the primary driver of the eutrophication symptoms being expressed.

3. ALLIANCE MATAURA PLANT PROCESSES AND ACTIVITIES

The first meat processing plant was established on this site in 1893, and since that time the Plant has been a vital component of the Southland's agricultural sector, processing stock from the region. The Plant has historically processed up to 10,000 sheep per day and 560 beef animals per day (with additional by-products processing including casings and rendering). However, in 2012 the processing of sheep and rendering ceased and beef production increased to up to 1,060 beef animals per day. For the foreseeable future, it is expected that the Mataura site will continue to operate solely as a beef processing plant.

The Plant generally operates 5 days per week / 24 hours per day. However, Sunday processing has also been undertaken recently for mycoplasma bovis infected stock.

Alliance holds a number of resource consents which authorise various activities associated with the ongoing operation, use and maintenance of its Mataura Plant. As noted above, three key operating consents are due to expire in December 2019. These relate to the abstraction of water from the hydro race, the discharge of cooling water and the discharge of wastewater to the Mataura River. A brief description of these activities follows.

3.1 WATER TAKE

Abstraction of water is essential for operations at the Plant. The existing consent authorises the taking of up to 35,600 m^3/day of water for freezing works supply. This is made up of:

- 21,200 m^3/day for cooling water; and
- 14,400 m^3/day for processing water.

The existing consent was amended in May 2018 to require meters to be installed on all intakes which abstract processing water. The taking of engine room condenser water and engine room cooling water is treated as a non-consumptive water take and is not metered.

Eleven of the intake pumps (No 1 – 11) are screened with an aperture size of 5 - 6 mm to prevent debris and fish from being drawn into the takes. The remaining pumps (No. 12 –

18) are in a channel between the hydro race and the plant. Fish and debris are prevented from entering this channel by a passive screen which has a bar spacing of 1.5 mm.

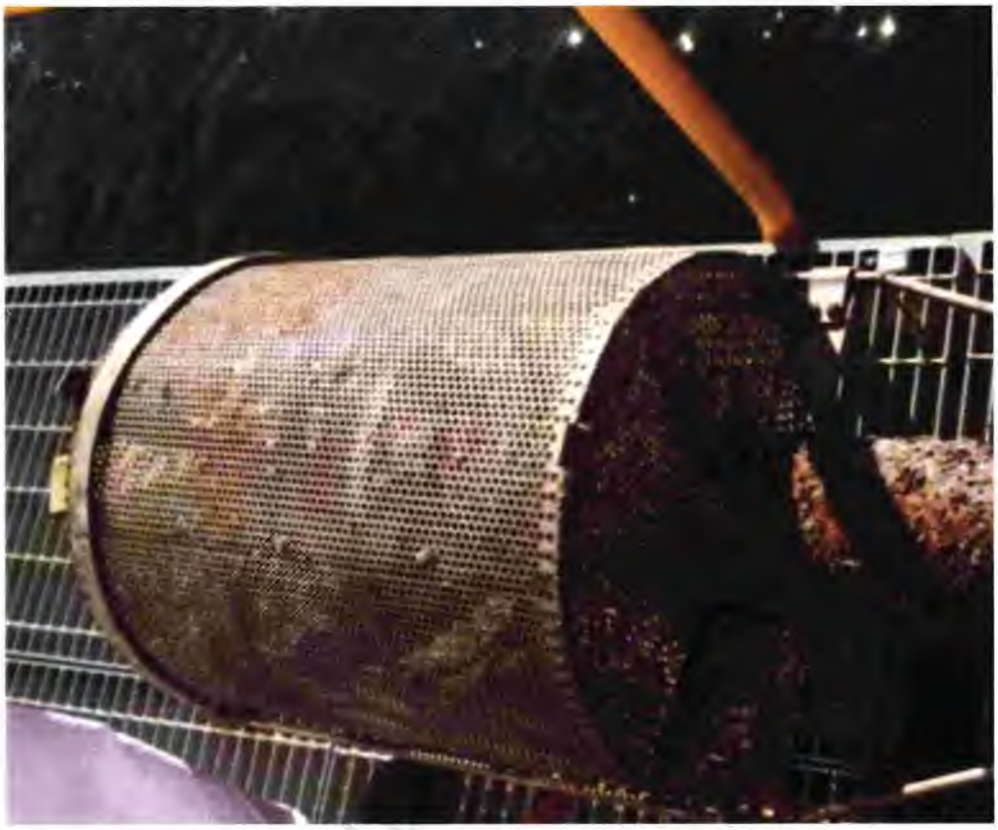


Figure 4: Screen on one of the intake pumps within the hydro race.

3.2 COOLING WATER DISCHARGE

Discharge of cooling water is essential for operations at the Plant.

The condenser cooling water pumps operate continuously because the demand for refrigeration at the site is continuous. The estimated total condenser cooling water take is 21,200 m^3/day based on pump capacities. The cooling water system takes water from the race, passes through the condensers once and then discharges water back into the race.

There are water temperature monitoring requirements upstream and downstream of the discharge.

3.3 WASTEWATER DISCHARGE

Wastewater treatment at the Mataura Plant is divided into following components:

- Separation of high (green) and low (non-green, red) phosphorus (P) site waste streams;

- Primary screening of all wastewater;
- Removal of heavy solids, via settlement, through save-alls
- Chemically assisted (i.e. acid and polymer are added) dissolved air floatation (DAF) treatment to remove floatable, lighter, solids
- The green stream receives a second round of DAF treatment (i.e. pH is lifted through the addition of lime) to remove phosphorus as part of the 2004 consenting upgrades
- All solids are transported from site where they composted by third parties, however there is contingency for discharge to land, the Lorneville treatment plant or landfill in the event the material is not suitable for composting.

The treated wastewater is then discharged to the Mataura River.

Figure 5: Final dried DAF solids ready to be taken offsite for composting.

The current consent authorises the discharge of up to 14,400 m^3/day to the river. Key limits on the discharge stream are as follows:

- Suspended solid concentration shall not exceed 200g/m^3 and shall be consistently maintained at less than 100 g/m^3;
- Total sulphide concentration shall not exceed 5 g/m^3 and shall be consistently maintained at less than 2 g/m^3;

- Total ammoniacal-nitrogen concentration shall not exceed 50 g/m^3 and shall be consistently maintained at less than $30g/m^3$;
- Carbonaceous BOD5 concentration of the wastewater shall not exceed 300 g/m^3;
- Total loading of carbonaceous BOD5 discharged to the river shall not exceed 3,500kg/day; and
- Total load of dissolved reactive phosphorous discharged to the river shall not exceed 14.4 kg/day.

Treated wastewater is discharged through two 200mm diameter pipes that exit the Plant and drop approximately 10m to the river bed.

It should be noted that wastewater from staff amenities is separated at source and discharged to the Gore District Council wastewater system.

Since the existing resource consents were granted in 2004 Alliance has completed a significant upgrade to its wastewater treatment plant to reduce Dissolved Reactive Phosphorus (DRP) concentrations in the discharge. This means a significant percentage (in the order of >90% DRP removal) of the DRP load produced at the Plant is now removed by the existing process.

4. ASSESSMENT OF ENVIRONMENTAL EFFECTS

Alliance has commissioned several independent technical advisors to complete assessments as part of its reconsenting programme. The assessments include:

- An economic assessment – Brown, Copeland and Company Limited.
- An assessment of in river recreational values – Rob Greenway & Associates.
- Water quality and ecological assessment – Freshwater Solutions Limited (FWS) and Aquatic Environmental Sciences (AES).
- A Quantitative Microbial Risk Assessment – Streamlined Environmental Ltd.
- Wastewater Treatment Upgrade Alternatives Assessment, – Pattle Delamore Partners (PDP).
- Mataura Awa Cultural Values Report – Te Ao Marama Inc.
- Resource Management Act 1991 and planning matters – Mitchell Daysh.

Alliance and its independent technical advisors collaborated to identify potential adverse environmental effects of the ongoing operation and use of the Plant along with associated measures to ensure that any such effects are appropriately avoided, remedied or mitigated and relevant statutory considerations addressed.

A summary of the key findings from each assessment is provided below.

4.1 ECONOMIC EFFECTS

The economic assessment has confirmed that there are significant economic benefits accruing from the Plant, and that it is an asset for the Gore District and Southland region. It employs 500 full time salaried staff and seasonal workers at the peak. This equates to 340 full time equivalent staff (FTEs). The Plant pays out $22 million in wages and salaries per annum and spends an estimated additional $12.3 million per annum in the Southland region on goods and services. These are quantified as direct economic impacts for the region's economy arising from the Plant's operation.

Figure 6: Beef boners at the Mataura Plant.

In addition, the economic assessment has identified a number of indirect impacts arising from:

- The effects on suppliers of goods and services provided to the Plant from within the region (i.e. the "forward and backward linkage" effects); and
- The supply of goods and services from within the region to employees at the plant and to those engaged in supplying goods and services to the plant (i.e. the "induced" effects). For example, there will be additional jobs and incomes for employees of supermarkets, restaurants and bars as a consequence of the additional expenditure by employees directly employed at the plant.

When these indirect effects are accounted for, the total contribution of the Plant's operation is assessed to be 595 FTE jobs for Southland residents, and $38.5 million per annum in wages and salaries for local Southland residents.

The economic assessment notes that the Mataura meat processing plant gives the Gore District greater critical mass and as a consequence the residents and businesses within the District benefit from economies of scale, greater competition, increased resource utilisation and better central government provided services. This is also true for the Southland region, although to a lesser extent given the economic activity generated by the plant is proportionately less for the region as compared to the Gore District.

Continuation of the Plant at its current site, on a longer consent term (i.e. 35 years) also generates a number of economic efficiency benefits. The economic assessment identifies these as including:

- the continued use of existing plant and equipment with an insured value of $225 million (much of this value is sunk – i.e. it could not be recovered if the plant was forced to downsize, close or be relocated);
- the minimisation of transport costs (and carbon footprint) for livestock and finished product dispatch;
- the availability of a trained and experienced workforce and businesses with appropriate expertise and experience within close proximity of the Plant; and
- greater certainty for investment and management of the Plant.

If the Plant were to cease operation and Southland and farmers had to truck cattle out of the region for processing, it would add to farmers' costs, reduce their disposable incomes and reduce spending in the Gore District and elsewhere within the region.

Alliance also contributes directly to the economic and social wellbeing of the community via its rates payments and other community contributions.

4.2 EFFECTS OF THE WATER TAKE

4.2.1 Entrainment

The Plant abstracts up to 35,600 m^3/day of water using 18 pumps located on the true left side of the hydro-race. As outlined above the intakes are fitted with screens. The water velocity within the hydro-race is high which creates a high sweep velocity across the face of the intake at the screen faces. This reduces the potential for entrainment of juvenile fish in these intakes. However, despite this, FWS and AES have recommended that all the intakes that are currently fitted with 5 – 6 mm screen mesh be fitted with 2 - 3 mm screens to further reduce the potential for entrainment and to meet best practice standards for screening intakes. Alliance propose to implement this recommendation.

4.2.2 Instream Flows

Resource consents 20171566-01 and 20171566-02 enable the diversion of water to the hydro race and it's discharge from the hydro race discharge (see Figure 7). The effect of this diversion on river hydrology, allocation, natural character, instream habitat and water quality have all been considered via those consents and they form part of the existing environment.

Figure 7: Take and discharge points.

Of the 35,600 m^3/day Alliance is authorised to abstract from the Mataura River, 21,200 m^3/day is used for cooling purposes and is returned to the Mataura River via the hydro race outlet (see Figure 7). The remaining 14,400 m^3/day is used for various process activities onsite, and [nearly] all of that water is returned to the Mataura River a further 100m below the hydro race discharge via the wastewater treatment plant outfall (see Figure 7).

4.3 EFFECTS OF THE COOLING WATER DISCHARGE

The only potential impact of the cooling water discharge is on receiving water temperature. To assess this effect temperature loggers were deployed in the hydro race upstream and downstream of the water takes and the cooling water discharge to measure temperature every 30-minutes over a 9-month period between 1 December 2017 and 31 August 2018. Results from the continuous temperature survey show there is very little difference in water temperature between upstream and downstream locations and the water take and cooling water discharge was not having a detectable effect on river water temperatures. This is consistent with the findings of previous surveys.

4.4 EFFECTS OF THE WASTEWATER DISCHARGE

4.4.1 Effects on Mataura River Water Quality

Wastewater is discharged into the Mataura River on the true right bank (see Figure 7). A summary of the discharge quality since the cessation of sheep and lamb processing at the Plant occurred in 2012/2013 is provided in Table 1.

Table 1: Summary of the discharge quality for the period November 2012 – March 2019 (all units g/m^3 unless stated).

	pH	Conductivity[2]	TSS	Sulphide	COD	BOD	TKN	Amm-N	TP	DRP
Med.	8.5	130	67	0.48	340	190	40	15	3.5	0.20
Min.	5.5	46	30	<0.4	50	30	10	2.1	1.0	0.013
Max.	9.6	470	220	2.1	1600	430	140	40	8.0	2.2
5%-ile	6.8	58	42	<0.4	180	83	19	5.9	1.5	0.06
95%-ile	9.3	360	100	1.1	520	290	59	29	5.9	0.88

[2] Units: mS/m.

With respect to the discharges microbial content, monitoring shows it contains very high *E.coli* concentrations, up to 10^6 CFU/100mL. Whilst *E. coli* are the key faecal indicator bacteria (FIB) used for regulatory purposes in NZ freshwaters, it is the pathogens for which they are intended to indicate that are of most concern for human health risk assessment. The two key groups of pathogens of most concern in animal wastewater are bacteria (mainly Campylobacter and E.coli 0157:H7) and protozoans[3]. Monitoring of the wastewater from Mataura Plant has shown levels of these pathogens is much lower and more variable (see Table 2). This is discussed further in Section 4.4.4.

Table 2: Pathogen monitoring data for treated wastewater from the Mataura Plant.

Pathogen	May 18	Dec 18	Jan 19	Feb 19
Salmonella (CFU/100ml)	1	21	4	<3
Campylobacter (CFU/100ml)	24	<3	9	4
E.coli 0157: H7 (CFU/100ml)	0	<3	<3	*4
Giardia (oocysts /1,000ml)	<1	32	150	2
Cryptosporidium (oocysts /1,000ml)	<1	310	250	1
E.coli (CFU/100ml)	1,460,000	300,000	4,500,000	90,000

The existing consent conditions set the reasonable mixing zone at Mataura Bridge 330 m downstream of the wastewater discharge (see Figure 7), however, more recent assessment has shown the discharge is fully mixed before this point.

Since the last resource consent was granted Alliance has undertaken regular water quality monitoring at two sites: one 430m upstream of the discharge; and one 330m downstream of the discharge. Longitudinal surveys of river oxygen concentrations, temperature, BOD and nutrients at several points upstream and downstream of the discharge were also undertaken in January 2018 and 2019.

3 literature indicates there are no substantial human health risks established for transmission of fungi and viruses through animal wastewater discharge.

4 *E. coli* 0157 was detected in this sample, however quantification was not possible due to the presence of inhibitory substances in the matrix.

FWS and AES have analysed that monitoring data and advised that it shows no evidence that the discharge from the Plant is causing consistent measurable effects on water quality except:

- In the immediate vicinity downstream of the discharge Amm-N and TN are elevated; and
- *E. coli* is significantly elevated for many km downstream of the Plant.

The elevated *E.coli* levels are discussed below in Section 4.4.4.

With respect to Amm-N, the monitoring data shows water quality reducing from attribute NPS Freshwater State A for toxicity (annual medians 0.02 – 0.03 g/m^3) upstream of the Plant to NPS Freshwater State B (annual medians 0.05 – 0.06 g/m^3) downstream. AES and FWS have looked at this in some detail and have advised it does not represent an effect which requires immediate or urgent mitigation on ecological grounds.

This is because freshwater mussels are the only species protected by Amm-N attribute A water quality, and they do not occur in the Mataura River immediately upstream or downstream of the discharge. The Amm-N sensitive species that do occur in the Mataura River in the vicinity of the discharge are the mayfly *Deleatidium* sp. and the snail *Potamopyrgus antipodarum* and these are protected by the Attribute B state – which is achieved.

AES and FWS have also advised that the catchment overall is degraded with respect to water quality, and monitoring both upstream and downstream of the discharge has shown that various nutrient indicators (including DIN and DRP) regularly exceed the relevant guidelines relating to nuisance algal growth. But, as set out in Section 4.4.2 below observations of periphyton suggest these relatively high levels are not generally stimulating periphyton growths except following very long late summer / early autumn accrual periods. Alliance's response to this catchment degradation matter is discussed further in Section 5.3 below.

4.4.2 Ecological Effects in Mataura River

In addition to monitoring and assessing effects on water quality, FWS have monitored and assessed effects on in-stream ecological values with a view to identifying any instream effects of the Plant's discharge. Potential effects of concern which FWS and AES were looking for included:

- Proliferation of nuisance algal growths;
- Reduced benthic invertebrate community health; and
- Reduced fish abundance and diversity.

Nuisance Algal Growths

Nuisance algal growths include sewage fungus and periphyton. The amount of periphyton in a river is determined by interactions between flow regime, nutrient status, light and temperature, streambed substrate and benthic invertebrate grazing. Algal growths are the most direct indicator of nutrient related effects on rivers and in turn have been monitored at least annually since 2012.

This monitoring has recorded variable algal cover and biomass between sites upstream and downstream of the Plant and among surveys. And it indicates that while DRP and DIN concentrations are relatively high, this is not stimulating periphyton growths upstream or downstream of the Plant except following very long late summer – early autumn accrual periods (the most noticeable example of which was in February / March 2019). FWS and AES have also advised the sewage fungus and periphyton monitoring data shows no effect from the Plant's wastewater discharge.

Benthic Invertebrates

Benthic invertebrates are a commonly used indicator of water quality with indices such as the MCI, QMCI and percent EPT[5] designed to specifically assess nutrient related effects. Benthic invertebrates have been monitored at least annually at several locations upstream and downstream of the Plant since the early 1990s.

Overall the benthic invertebrate community upstream and downtream of the discharge reflects the cumulative effect of catchment wide inputs upstream and is generally in fair to poor health across most benthic invertebrate indices.

Total taxa number and EPT taxa number have been variable across sites and between surveys over the 2012–2019 period with no clear evidence that the discharge causes a reduction in total diversity or the diversity of water quality sensitive taxa. Prior to the most recent surveys there had been a general increasing trend in *Deleatidium* sp. abundance at downstream monitoring locations. In February 2019 *Deleatidium* sp. abundance at the downstream monitoring sites was lower compared to upstream sites. The decline in *Deleatidium* sp. abundance at downstream sites in February 2019 is not explained by periphyton cover and biomass or Amm-N concentrations, which are all potential effects of the discharge. However, it has been assessed that this decline in abundance could be attributed to high river temperatures leading up to and at the time of the February 2019 survey and an increase in overall stress that occurred at the time. A sharp decline at upstream and less pronounced decline at downstream sites in *Deleatidium* sp. was also recorded in March 2019. This is very likely to be related to the elevated river temperature and extensive late successional stage algal growths at the time of the survey associated

[5] EPT h stands for Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) which are macroinvertebrates that are sensitive to water pollution.

with the longest late summer – early autumn accrual period since 2012. It also suggests the upstream decline may have been slightly delayed compared with downstream.

MCI scores have been similar upstream and downstream of the Plant over the period between January 2012 and March 2019 and remained within the 'fair' stream health range for all sites. QMCI scores have been variable across years largely as a result of differences in the relative abundance of *Deleatidium.* Overall FWS and AES advise that results indicate the treated wastewater discharge has not resulted in a consistent decrease in MCI and QMCI scores between upstream and downstream locations over a range of accrual periods between April 2013 and December 2017. As outlined above the February and March 2019 surveys recorded lower *Deleatidium* abundance, and in turn reduced MCI and QMCI scores downstream of the discharge and in the case of March 2019 upstream as well. However, these are likely to be due to a mixture of factors and cumulative stress including temperature and algal growths.

Fish

The lower Mataura River is a migratory pathway for eels or tuna, and important for a range of whitebait species, brown trout and salmon. Fish abundance and health can be influenced by a wide range of factors including proximity to the coast, barriers such as the Mataura Falls, habitat quality and water quality.

Results from fish surveys indicate the fish community in run habitats is dominated by a small number of species – longfin and shortfin eel, (including elvers) and upland bully. Elvers were more abundant at downstream sites compared to upstream sites, and could either be attributed to differences in habitat suitably, or simply the timing of the upstream migration by a particular group of new recruits into the river. The fish community in the reach between the Mataura Falls and Mataura Bridge based on survey results indicates that the Mataura River immediately upstream and downstream of the discharge supports a healthy longfin eel population including several very large fish (+5 kg).

Anecdotal evidence indicates that there is a large resident population of brown trout and late summer and early autumn run of sea run brown trout and salmon are regularly seen and caught between the Mataura Falls and the Mataura Bridge. The presence of such large numbers of brown trout and seasonal migration of some brown trout and salmon indicate that the water quality in this section of the river is suitable for supporting salmonids that are amongst the most water quality sensitive species present in New Zealand.

4.4.3 Effects on Toetoes Estuary

As outlined in Section 2 Toetoes Estuary is in a declining condition in relation to eutrophication with excessive nutrient inputs as the primary driver of the eutrophication symptoms being expressed.

The contribution of the Plant's discharge to Toetoes Estuary TN loads has been assessed as being 1.1-1.7% and its contribution to TP has been assessed as 0.7-1.3%, with the majority of the TN and TP load entering Toetoes Estuary derived from other catchment inputs particularly diffuse sources. While even a marked reduction of the Plant's TN and TP loads would have little, if any, detectable effect on the nutrient status of Toetoes Estuary, Alliance acknowledge that it should contribute to any catchment wide plan for improving water quality and the health of Toetoes Estuary.

4.4.4 *E.coli* and Human Health

E.coli is the principle measure used by the NPSFW and Environment Southland's RMA plans for determining the suitability of a river for contact recreation. *E. coli* is used as the indicator of possible faecal contamination because it is commonly found in human and animal faeces and it is relatively inexpensive to monitor. As is the case for a significant number of New Zealand's waterbodies in lowland farming areas, *E.coli* levels in the Mataura River, including downstream of the Plant, are high. They sit in the Red NPSFW Attribute State, and exceedances of the New Zealand single sample bathing water standards[1] are common. They also do not meet the relevant Southland Land and Water Plan standards. A recent Environment Southland study of *Campylobacter* risk in this catchment using actual instream data for that parameter (rather than levels of *E.coli* as an indicator) suggests that the health risk in this catchment may not be anywhere near as high as is suggested by the *E.coli* concentrations present,[2] and additional monitoring data collected in 2018 by Streamlined Environmental supported this finding. However, Alliance understands that baseline water quality conditions in the Mataura River (absent any contribution from the Plant) may be 'un-swimmable' at times due to contributions from other sources.

As outlined in Section 4.4.1 the Plant's discharge also contains relatively high concentrations of *E.coli*, and instream monitoring data shows *E.coli* concentrations increase significantly downstream of the Plant due to its wastewater discharge. However, as is also outlined in Section 4.4.1, despite the Plant's discharge containing relatively high *E.coli* levels, the level of pathogens in the discharge, which are of most concern when considering effects on human health, are much lower and more variable.

To further understand the effect of the Plant elevating downstream *E.coli* levels on human health, a Quantitative Microbial Risk Assessment (QRMA) has been undertaken by Streamlined Environmental to predict the health risk to people swimming in the Mataura River below the Plant's discharge point as a result of the Plant's discharge only.

---

[1] 260 CFU/100mL and 540 CFU/100ml.

[2] Cressey, P., Hodson, R., Ward, R., & Moriarty, E. (2017). Cressey, P., Hodson, r. Ward, N. and Moriarty, E (2017) Use of QMRA to Assess the Human Health Risk of the Mataura River, Southland http://isrs2017.com/images/Cressey_Peter.pdf.

The QMRA shows that while the Plant causes *E.coli* concentrations in the Mataura River to increase significantly below the Plant's discharge point, this does not equate to a significant increase in health risk, and the risk of a person swimming below the Plant becoming ill due to the Plant's discharge is well below 1% which is considered an acceptable level. It is noted that this is broadly consistent with the aforementioned Environment Southland study which concluded the Plant's discharge contributed only a relatively small proportion of the overall Campylobacter risk in this catchment.[3]

However, while the Environment Southland and Streamlined Environmental studies show the baseline health risk in this catchment, and the Plant's contribution to that health risk, are not as significant as measured *E.coli* levels *would* suggest, this does not equate to there being no risk. It is evident that there are times when the Mataura River is un-swimmable and Environment Southland is obliged under the NPSFW to set policy and methods to improve water quality so that it is suitable for primary contact more often. The key indicator for how that is being achieved is also instream *E.coli* concentrations. In that context Alliance acknowledges it should contribute to any catchment wide plan for improving water quality for contact recreation, and reducing *E.coli* concentrations in the Mataura River. This is discussed further in Section 5.3 below.

4.4.5 Effects on Recreation

Rob Greenaway & Associates has undertaken a qualitative and quantitative assessment in order to determine the recreational values that exist in the Mataura River and whether these are being affected by the Plant and more specifically the wastewater discharge to the Mataura River.

The following key recreational values have been identified:

- The outstanding nature of the Mataura River for brown trout fishing;
- Its relatively high use for swimming, both upstream and downstream of Mataura;
- A very popular whitebait fishery in the lower reaches;
- Use of the riverbanks, berms, reserves and angler access points for a variety of terrestrial activities, mostly around settlements, and with relatively high activity levels at the Coal Pit Road angler access point;
- A low level of use of the River for salmon fishing;
- Some use of the River for jet boating and kayaking, but with no relevant data to quantify these uses.

---

[3] Cressey, P., Hodson, R., Ward, R., & Moriarty, E. (2017). Cressey, P., Hodson, r. Ward, N. and Moriarty, E (2017) Use of QMRA to Assess the Human Health Risk of the Mataura River, Southland http://isrs2017.com/images/Cressey_Peter.pdf.

Consultation (including formal interviews) with key recreational stakeholders and users of the Mataura River is currently underway. This is intended to identify what the key determinants of in-river recreation value are, particularly for water quality, and the degree to which the discharge affects these values. The findings of this assessment will form part of the application.

4.4.6 Cultural Effects

The Mataura River is significant to Maori. This has been recognised in statute under the Ngai Tahu Claims Settlement Act 1998. The Mataura River is identified as a Statutory Acknowledgement Area under that Act and contains a Mātaitai Reserve.

Alliance has commissioned Te Ao Marama Inc. to complete a cultural impact assessment of the proposed activities. That work is ongoing and will form part of the resource consent applications.

5. MITIGATION, MANAGEMENT AND MONITORING OF EFFECTS

5.1 ABSTRACTION

As set out in Section 4.2 the only potential effect of any consequence associated with the take of water is the potential for juvenile fish to be entrained in the intakes. FWS recommended that all the intakes that are currently fitted with 5 – 6 mm screen mesh be fitted with 2 - 3 mm screens to further reduce the potential for this to occur and to meet best practice standards for screening intakes. Alliance propose to implement this recommendation.

5.2 COOLING WATER DISCHARGE

No adverse effects requiring mitigation have been identified.

5.3 WASTEWATER DISCHARGE

A comprehensive assessment of the effects of the discharge on the receiving environment has determined that no adverse effects trigger the need for immediate or urgent mitigation.[6]

However, that assessment has identified that:

- The lower Mataura River contains very high levels of *E.coli* above and below the discharge, but the Plant's discharge significantly increases those levels in the receiving water downstream.

[6] Freshwater Solutions Ltd 2019. Assessment of the Effects of Alliance Mataura's Discharges and Water Take on Mataura River and Toetoes Estuary. Submitted to Alliance Group Ltd (DRAFT). March 2019.

- The Mataura River can generally be characterised as degraded in terms of the nitrogen levels present, periphyton reflects moderate to high enrichment at times, and MCI and QMCI data are representative of fair to poor health. Toetoes Estuary also continues to degrade with extensive macroalgal growth driven by very high nutrient loads from the catchment. While there is no evidence suggesting the Plant's discharge has a direct adverse effect on these stressors downstream of the discharge, it does contribute to the overall loads of Amm-N and TN present downstream of the discharge.

The planning framework which applies here anticipates a long-term catchment wide improvement in water quality for these key parameters. No detail is available yet on the extent of the catchment scale improvement anticipated for each parameter, or the timeframes and methods for achieving that improvement, including which parameter should be afforded priority. The planning framework anticipates these matters will be determined via a collaborative planning process for the Mataura Freshwater Management Unit (FMU) involving all key stakeholders which is expected to commence soon. The initial outputs from that collaborative planning process are not expected to be complete until 2022, and they are not expected to be formalized via the RMA Schedule 1 process until at least 2024. However, given Alliance will be making applications for long term consents, the plan for improving water quality in the catchment will be finalised, and implemented during the term of those new resource consents.

Alliance has sought advice from PDP on what methods and technology could be potentially employed in order to reduce the loads of these key parameters from the Plant to the Mataura River over the term of the consent to be sought.

As an initial step PDP developed a long-list of available alternative management options for the Plant. Options incorporating continued discharge to the Mataura River, irrigation to land, or a dual discharge combination, and discharge to trade waste were considered. Of the assessed long list options, those incorporating significant risk and uncertainty, and substantial lifecycle costs were removed from further assessment.

The options selected for further assessment included:

- Existing river discharge with biological treatment for $cBOD_5$ and nitrogen removal with UV disinfection;
- Existing river discharge with filtration and UV disinfection;
- Existing river discharge with biological treatment for $cBOD_5$ and nitrogen removal with UV disinfection of the green waste stream;
- Dual discharge with the existing river discharge combined with discharge to dairy pasture with no treatment prior to river discharge;

- Dual discharge with the existing river discharge combined with discharge to a cut and carry system with no treatment prior to river discharge.

Each of the short-listed options was then assessed further, considering the potential for the option to reduce contaminant loads to the Mataura River, option resilience, and lifecycle costs.

As a result of that further assessment it appears that:

- Reducing *E.coli* concentrations in the discharge will likely require tertiary disinfection of microbial contaminants at a capital cost of approximately $4.1 million, and additional annual operational expenditure of $230,000.
- Reducing Amm-N, TN and *E.coli* in the discharge will likely require the installation of a biological treatment system at a capital cost of approximately $11 - 15 million and additional annual operational expenditure of $530,000 - $790,000.
- A dual discharge option is unlikely to be preferred in this case because:
    - There is a limited amount of suitable irrigation land in proximity to the Plant, and the volumes involved mean a large portion of that which is available would need to be utilised; and
    - This option would only be economically sensible if no further upgrades to the WWTP are completed over the term of the consent, meaning the current levels of Amm-N, TN and *E.coli* would still be discharged to the Mataura River during the winter months, and at other times of the year during wet periods. Alliance's freshwater ecology advisors have cautioned against this due to the propensity for spring, autumn and even winter blooms in phytoplankton.

Alliance is still refining the options to address the catchment degradation issue in its applications. The key matters currently being worked through are:

- The estimated capital cost of an upgrade to address both *E.coli* and nitrogen is approximately $11 - 15 million, with increased annual operational expenditure of $530,000 - $790,000. This would represent a significant project, and the funds need to be budgeted and provided for alongside other capital and environmental projects Alliance needs to undertake across all its plants. This includes in excess of $20 million of wastewater treatment plant upgrades at Alliance's Lorneville Plant, and work to reduce the amount of fine particulate matter discharged from the Mataura Plant's boiler. The cooperative nature of the company is important in this regard. Money that is set aside for this project is money which cannot be invested by farmers in improving their on-farm environmental management and for that reason also needs to be approached with care.

- There is potential to stage any wastewater treatment plant upgrade whereby installation of tertiary disinfection to address *E.coli* can be done in advance of installing a biological treatment system.
- Due to the FMU process having not yet commenced there is currently uncertainty on the extent of improvement in water quality that will be required in the Mataura Catchment, and uncertainty in how that will be achieved and over what timeframe.
- It is expected to take ES and the Mataura catchment community some time to undertake catchment wide reductions in nutrients so that meaningful improvements in the environment result. It is difficult to justify spending substantial sums of money well ahead of the necessary catchment-wide improvements, if the result is that until the rest of the catchment catches up the environment and Alliance get no meaningful return on that investment and any improvements would be hard to detect.

5.4 SUMMARY

Table 3 below contains a summary of the mitigation, monitoring and reporting measures currently being considered in respect of each actual and potential effect.

For Consultation Purposes

Table 3: **Summary of mitigation, monitoring and reporting measures being considered.**

Actual or Potential Effect Identified	Assessment	Mitigation Options	Monitoring and Reporting
Take and Use of Water			
Potential for fish entrainment in water intake structures.	High sweep velocity reduces the potential for entrainment of juvenile fish compared to many intakes. But some screens are 6mm which is not best practice.	All intakes to be fitted with 3 mm screens or better.	
Reduced flow in the river	The only additional effect of this take on instream flows is it remaining out of the Mataura River's main stem for a further 100 m than it would if the take did not occur and the water were discharged from the hydro race. This is not considered to have any additional or cumulative effects that is more than minor	None required	
Discharge of Cooling Water			
Effects on water temperature and DO levels.	No measurable downstream effect.	None required.	Water temperature in the hydro race as per the existing conditions.

Actual or Potential Effect Identified	Assessment	Mitigation Options	Monitoring and Reporting
Discharge of Waste Water			
Increased microbial contamination downstream (at times) of the discharge point.	While it has been identified that the Plant discharge is having an effect on the levels of *E.coli* in the receiving water downstream of the discharge point, it has been determined that such increases do not necessarily relate to the abundance of zoonotic pathogens or individual illness risk. It is however acknowledged by Alliance that overall *E.coli* levels in the catchment are high, and these need to be improved to achieve consistency with national and regional water quality policy and outcomes for contact recreation in the river.	Alliance is still refining the options to address this matter in its applications. Alliance has investigated options to reduce *E.coli* concentrations in its discharge. This would require installation of a UV treatment system at the Plant at a cost of approximately $4.1 million, and additional annual operational expenditure of $230,000.	Monitoring of discharge quality and receiving river environment as part of the ongoing consent obligations.
Water temperature, BOD_5, DO, pH levels, turbidity, colour and clarity, foams and scums	No apparent downstream adverse effect.	None required, however some mitigation options reduce BOD in the discharge.	Monitoring of discharge quality and receiving river environment as part of the ongoing consent obligations.
Amm-N and Nitrate N levels downstream of the discharge point which could cause toxicity effects to biological resources.	There is an increase in Amm-N levels downstream of the discharge, however this is not considered to be of such significance that toxicity	None required	Monitoring of discharge quality and receiving river environment as part of the ongoing consent obligations.

Actual or Potential Effect Identified	Assessment	Mitigation Options	Monitoring and Reporting
	of aquatic species present in the river is likely to occur.		
High nutrient (TN / TP / Amm-N / DIN / DRP) levels downstream of the discharge causing increases in nuisance algae and eutrophication.	Monitoring data shows evidence that the discharge from the Plant is elevating Amm-N and TN concentrations in the immediate vicinity downstream. The Plant's discharge will also be contributing to overall catchment loading of other nutrients downstream of the discharge. The lack of nuisance algal growths in the periphyton surveys indicates the discharge is unlikely to be stimulating nuisance algal growths despite the apparent high concentrations.	No adverse effects observed due to the discharge which trigger the need for immediate or urgent mitigation Alliance is still refining the options to address the catchment degradation issue in its applications. As outlined in Section 5.3 reducing Amm-N, TN and *E.coli* in the discharge would likely require the installation of a biological treatment system at a capital cost of approximately $11 - 15 million and additional annual operational expenditure of $530,000 - $790,000.	Monitoring of discharge quality and receiving river environment as part of the ongoing consent obligations.
Altered species composition and biomass of periphyton and benthic invertebrate community.	Overall in terms of nutrients, periphyton and MCI and QMCI the river, upstream and downstream of the discharge appears to be in fair to poor health and a degraded state, but there is no evidence	No adverse effects observed due to the discharge which trigger the need for immediate or urgent mitigation.	Monitoring of discharge quality and receiving river environment as part of the ongoing consent obligations.

Actual or Potential Effect Identified	Assessment	Mitigation Options	Monitoring and Reporting
	linking these stressors to the discharge.	As outlined above and in Section 5.3 Alliance is still refining the options to address the catchment degradation issue in its applications.	
Contribution of contaminants to loads within the Toetoes Estuary.	The contribution of the Plant's discharge to Toetoes Estuary TN loads has been assessed as being 1.1-1.7% and its contribution to TP has been assessed as 0.7-1.3%. The vast majority of TN and TP load entering Toetoes Estuary is derived from other catchment inputs particularly diffuse sources, and in turn even a marked reduction of the Plant's TN and TP loads would have little, if any, detectable effect on the nutrient status of Toetoes Estuary.	No adverse effects observed due to the discharge which trigger the need for immediate or urgent mitigation. Alliance is still refining the options to address the catchment degradation issue in its applications, and this is discussed in more detail in Section 5.3	None.
Effects on fish species – salmonids and native fish.	No evidence of any adverse effects as the River supports a healthy fish population overall.	No adverse effects observed which trigger the need for immediate or urgent mitigation.	None
Effects on recreational fishing	The assessment of effects on recreational use of the Mataura River is currently being completed. The findings of this assessment will form part of the application proper.	No adverse effects observed as yet which trigger the need for immediate or urgent mitigation. Noting in particular the conclusion set out in Section 4.4.4 regarding	TBC

Actual or Potential Effect Identified	Assessment	Mitigation Options	Monitoring and Reporting
	However, work completed thus far shows that the Mataura River downstream of the discharge is currently an outstanding trout fishery, a very popular whitebait fishery and is subject to relatively high use for swimming.	*E.coli* levels and microbial contamination.	
Effects on cultural values and Tangata Whenua.	Alliance has commissioned Te Ao Marama Inc. to complete a cultural impact assessment of the proposed activities. That work is ongoing and will form part of the resource consent applications	TBC	TBC

10

APPENDIX 10

Consultation meeting notes

Alliance Group Limited

Mataura 2019 Reconsenting – Technical Working Party (TWP)

Minutes of Meeting held on 31 October 2017

Mataura Board Room

Attendees:

Te Ao Marama:	Stevie-Rae Blair
Department of Conservation:	Phil Melgren
	Amy Evans
Public Health South:	Kate Marshall
	Renee Brown
Gore District Council:	Ramesh Sharma
	Donique Weatherburn
Hokonui Runanga:	Rewi Anglem

Alliance:

Frances Wise

Doyle Richardson

Jessica McKee

Tony Gilder

Dan Cairns

Consultant:

John Kyle – Mitchell Daysh

Apologies:

Te Ao Marama:	Dean Whaanga
Southland Fish & Game:	Zane Moss
	Jacob Smyth
Southland District Council:	Ian Marshall
Wyndham Angling Club:	Alan Leitch
Federated Farmers:	Darryl Sycamore

Meeting Commenced at 12.30pm

(NOTE: These minutes are to be read in conjunction with the presentation[1] which provides the context around the subsequent discussions outlined below).

1. Welcome and Introductions (Frances Wise)

Frances Wise welcomed everyone to the meeting and asked attendees to introduce themselves to the group.

2. Reason for meeting (Frances Wise)

Frances outlined the purpose of hosting the meeting is to initiate the consultation process relating to the renewal of the three resource consents held by Alliance Mataura (202327 – To discharge wastewater to the Mataura River, 204126 – To take water from the Mataura River, 204125 – To discharge condenser cooling water to the Mataura River) which are due to expire in December 2019.

Alliance is planning to take the approach of early engagement with key stakeholders (primarily the TWP) to ensure they are able to present a robust application, with the aim of achieving long term consents. Alliance would like to understand TWP issues, so they can be addressed prior to lodging the application.

Alliance plans to host all future TWP meetings at the Mataura Plant, during normal business hours. The next meeting is planned for November 2017 and will likely include a tour of the Mataura Plant and river monitoring locations.

Frances asked the group if anyone had suggestions for any other interested parties that Alliance should include in the TWP. Ramesh Sharma (Gore District Council) asked if there were any local community boards. It was decided that Alliance would extend an invitation to the Mataura Community Board for future meetings of the TWP.

It was noted that Federated Farmers had been invited to join the TWP, but had declined the invite.

3. AGL Overview

Frances gave an overview of the Alliance Group. The Alliance Group is a meat processing and export company and has eight processing facilities nationwide. It is a farmer owned cooperative, with an annual turnover of $1.4 billion; it has a very small operating profit margin with a 10 million dollar profit for the 2015/16 season. Alliance has been working to try and improve its profit to benefit its supplier shareholders.

The Alliance Group process approximately 30% of New Zealand's sheep & lamb, 10% of the beef and 20% of the venison. Alliance Group employs approximately 4,500 permanent and seasonal staff.

Alliance Group holds an ISO 14001 Environmental Management System accreditation which is subject to external audit.

---

[1] Accompanying presentation titled 'Alliance Group Ltd, Mataura Plant, Re-consenting 2019, Technical Working Party, Meeting 1, 31st October 2017'

4. *Mataura Plant*

The Mataura Plant first operated at the current site in 1892, processing 300 per day. It was constructed at a cost of £13,000. The onsite hydro generation plant supplied electricity to not only the Plant, but also the Mataura township from 1911 – 1932.

A wastewater treatment plant in the form of the DAF (dissolved air flotation) plant was installed in 1978, to treat wastewater prior to being discharged into the Mataura River.

Historically the Alliance Plant has had several owners, with Alliance taking over ownership in 1991. Processing of sheep and lamb (ovine) ceased at the plant at the end of the 2011/12 season. Onsite processing of rendering material ceased in January 2014, when it was transferred to the Lorneville Plant.

The Mataura Plant currently operates for approximately 11 months of the year, employs up to 485 people during peak season and pays out $24,000,000 in wages, $132,000,000 for livestock & transportation.

The site was consolidated following the removal of ovine processing. 1062 cattle are able to be processed through the facility per day, over 2 shifts. The Mataura Plant processes approximately 60% of Alliance's beef. Since the cessation of sheep and lamb processing at the site, the plant now experiences its peak in processing capacity between April – June, compared with the previous peak being January – February. The shift in peak production from summer to autumn months as assisted the plant from an environmental prospective, as the highest discharge volumes/loads to the river now no longer occurs during the low summer river flows.

Removal of sheep and lamb processing and rendering has significantly improved efficiencies, reduced water use and contaminant load. Issues which were resolved were significant reduction in LMW BOD and sulphide discharged and DRP waste stream separation.

Tony Gilder gave an overview of the plant configuration and discussed upcoming projects, which include a pedestrian over bridge and an automated carton sorting system.

5. *Mataura River*

Frances gave a brief overview of the full length of the Mataura River, from the headwaters in the Eyre Mountains to where the Mataura River reaches the coast at Toetoes Harbour. It was noted that it is important that catchment wide issues are considered in the application.

6. *Mataura Plant Resource Consents*

Frances gave an overview of current consent status of resource consents held by the Mataura Plant, including the application which has been lodged to renew the consent for Hydro generation.

Alliance is still considering whether they will add to the re-consenting project an application to renew the Air Discharge consent. The air discharge consent was last renewed in 2015 and the plant at the time was undergoing the major reconfiguration following the removal of sheep and lamb processing. Therefore the plant only applied for five year consent to give them time to access their boiler requirements in the future.

Jessica gave an overview on the recent project which has been carried out to dewater solids from the wastewater treatment process and take them off site to be composted by an external composting operator. Solids from the wastewater treatment process were previously spread onto local farmland as a method of disposal, but this process had issues with finding suitable land to spread during times of extended wet weather. While the discharge of this material to land is beneficial in suitable conditions, it is a good environmental outcome to be able to avoid the discharge during less favourable conditions.

The resource consents the plant is working towards renewing are:

- 202327 – To discharge wastewater to the Mataura River. Discharge of treated wastewater to river; 14,400 m^3/day. Includes low flow contingency plan – 10m^3/s which includes the requirement to get external advice on water conservation measures.

  In the previous consenting round of the above consent, the TWP identified that Dissolved Reactive Phosphorus (DRP) was the contaminant that was agreed as the most relevant for the plant to address. This was included as a consent condition and new discharge limits were eventually achieved.

- 204126 – To take water from the Mataura River. Take water from the Mataura River for meat processing: 35,600 m^3/day based on calculated maximum cooling water take (21,200m^3/day) and discharge volume (14,400 m^3/day). Includes low flow contingency plan – 20m^3/s which involves daily site water use audits by the plant.

  Water is abstracted from the hydro race via 19 pumps. Six pumps deliver water to the ammonia condensers and oil coolers. Four pumps supply water treatment plant – potable water. The remainder of the pumps supply yards, inedible chutes, ring main and wastewater treatment plant, or are spare.

- 204125 – To discharge condenser cooling water to the Mataura River. Discharge cooling water to the Mataura River (21,200 m^3/day)

  The water take and discharge for the cooling water system is based on the pumps, pump theoretical capacity and assumes continuous pumping but excludes the standby pumps.

7. Mataura Wastewater Treatment

The wastewater treatment plant at the Mataura Plant uses primary screening and separation. Screened material is disposed of off-site. The screened wastewater is then dosed with acid and polymer and treated through a series of DAF tanks, suspended solids float to the surface, where they are scraped off.

The 2004 re-consenting required a significant reduction in DRP by 2007 (previous max discharge around 150kg/day, to new consent limit of 14.4 kg/day). The consent limit of 14.4 kg/day was calculated as the maximum the plant would be able to discharge and still allow for the concentration of DRP in the river to remain below MfE guidelines to prevent the growth of periphyton.

In order to achieve the consent limit of 14.4 kg/day of DRP discharged the plant carried out a project to separate the waste streams from the plant into a high phosphorous and low phosphorous stream and the high phosphorus stream undergoes further treatment to remove the phosphorous load. The low DRP concentration took longer than hoped to achieve, with the removal of sheep and lamb eventually enabling full compliance.

Donique Weatherburn (Gore District Council) queried whether there were two limits for the different treatments. Frances advised that there was a combined limit.

Frances and Jessica explained photos in the presentation of the wastewater treatment plant and the cooling water discharge.

8. Compliance

Jessica explained the monitoring/sampling locations the plant uses for routine compliance monitoring, annual biological assessments conducted by an external consultant on behalf of Alliance and annual Dissolved Oxygen (DO) monitoring location. The location of the DO sonde for DO monitoring was identified during the previous consenting process, as the location in the river downstream of the Alliance discharge that had a DO sag.

Frances explained how the plant had performed in relation to their compliance requirements for the period of the current consents. Compliance with discharge volume has been good. Discharged volume has reduced with the change of processing at the plant. Early on in the consent, the plant had issues with BOD. This has improved, but the plant still experiences the occasional non-compliance, generally relating to BOD concentration, there was 1 concentration exceedance for the 2016/17 season. Historically the plant experienced minor issues with sulphide concentration, this has not occurred since pelt processing ceased. The plant has had the occasional ammonia exceedances, which have largely been unexplained; there have been none this season. Occasional exceedances for total suspended solids, none this season.

The plant had significant and frequent non-compliances for DRP for the first 2 years of the new DRP limit, then experienced occasional non-compliances for the next 3 years, has been fully compliant for the last 5 seasons.

Frances showed a graph which demonstrated the significant reduction in seasonal mean DRP since 2004. Frances then showed a graph which showed the reduction in seasonal mean BOD since 2004.

9. *Receiving environment*

Compliance with receiving water quality since 2004 has been; no compliance issues against Class D, WCO, and RWP (with the exception of e-coli). No issues pH or temperature. No issues with downstream DO monitoring. Monitoring has shown a trend of measurable but slight downstream increases in TP, DRP, Amm-N, NOX, TSS.

When assessing the receiving water quality against the NPS

- NPS ammonia-N:
  - Annual median meets the "A" attribute state upstream and downstream
  - Annual maximum meets the "A" attribute state upstream and "B" attribute state downstream
- NPS nitrate:
  - Annual median and 95%ile meets the "A" attribute state upstream and downstream
- NPS Dissolved Oxygen (at Chalmers Rd)
  - Meet the "A" attribute state criteria
- E coli:
  - SFRG gives a poor result both upstream and downstream, monitoring shows increases in e-coli downstream
  - Based on summer 16/17 monitoring only (where 20 samples are taken), NPS "E" state (both annual median and 95% ile), upstream and downstream

Frances showed graphs of the seasonal means for DRP and Nitrate in the receiving water and commented that while the in-river DRP concentrations generally exceeded the ANZECC guideline value of 0.010, Alliance's contribution to the in-river DRP concentration was quite small. Alliance's contribution to the in-river nitrate concentration is also very small as nitrate is not usually a contaminant of concem in meat work's wastewater.
Frances discussed investigations which were required to be carried out as part of the current consent requirements was for the plant to investigate the possibility of Disinfection and Low Molecular Weight BOD.

Disinfection was investigated, trialled and reported. Difficulties with transmissivity of especially in the wastewater stream which has the high phosphorus loading (also has the highest e-coli load), which means UV disinfection would not be able to be effective without some form of additional treatment.

- Renee Brown (Public Health South) asked if the turbidity was still high in the wastewater discharge following the treatment process. Frances responded that yes it was still an issue after the treatment process.
- Ramesh Sharma from Gore District Council asked if the plant had considered colour reduction in the wastewater discharge. Frances responded that it has been considered but is not likely to resolve the issue.

An investigation into Low Molecular Weight BOD in the wastewater discharge was carried out and reported to Environment Southland. Low Molecular Weight BOD (LMW BOD) promotes growth of sewage fungus in the river. Historically sewage fungus was an issue downstream of the discharge, during periods of extended low flow, but sewage fungus has not been present in recent years (since 2012 when it was found upstream as well). The investigation found no real solution for removing LMW BOD. The issue has since resolved itself with removal of sheep and lamb processing and rendering from the site.

Frances described how the plant water take was reported to Environment Southland on an annual basis. The plant is currently consented to take 21,200m^3/day. The plant is consented to discharge 14,400m^3/day of treated wastewater, for the previous season the maximum the plant discharged was 5,800m^3/day.

Frances showed two photos of the riverbed downstream of the discharge, a historic photo and one from recent years, to show the improved in the health of the river bed as a result of the improvements in wastewater discharge.

We have extensive biomonitoring information and the conclusions from an early survey and the most recent survey were discussed, extracts from both reports below.

- **2005:** *Changes in the invertebrate community composition and ecological index scores downstream of the discharge are indicative of a nutrient enriching and periphyton growth promoting effect of the discharge*
- **2017:** *The discharge was not stimulating periphyton growths or adversely affecting benthic invertebrate community health at the time of the survey. There is a trend of continued invertebrate community health at sites downstream of the discharge.*

10. Project team

Frances mentioned the members of the project team that would be working on the re-consenting. The project team are:

Name	Organisation	Project Role
Doyle Richardson	Alliance Group	Project Manager
Frances Wise	Alliance Group	Project Leader
Tony Gilder	Alliance Group	Plant Manager
Jessica McKee	Alliance Group	Co-ordinator & site contact
Murray DeGroot	Alliance Group	Plant Engineering Manager
John Kyle	Mitchell Daysh	Regulatory assessment, consenting process advice, preparation of AEE.
Claire Hunter		
Richard Montgomerie	Freshwater Solutions Ltd	Description of the aquatic environment
Dr Mike Fitzpatrick	Freshwater Solutions Ltd	Water quality effects
Dr Mark James	Aquatic Environmental Solutions	Assessment of effects of abstraction and discharges
Azam Khan	Pattle Delamore Partners	Wastewater treatment considerations

Other advisors will be brought in as required.

11. Project Plan
Frances briefly touched on the plan for the coming summer in order to prepare for a consent application. The plant already has extensive records of wastewater and receiving water quality and at least annual ecological monitoring records.

The plant plans to perform an analysis to identify if additional information is required to support the application. The plant intends to carry out any additional monitoring during 2017 / 2018 summer as there will be limited opportunity during 2018 / 2019 summer. This will be circulated prior to the next meeting in late November to be discussed to make sure that as far as is practicable, all issues are addressed this summer.

Alliance aims to have technical reports completed by mid-December 2018 and provide Environment Southland with a draft application by 28th February 2019. The target date for lodging the application is 30th April 2019, with the last date for lodging to application being 6th June 2019. The resource consents are due to expire 6th December 2019.

To date Alliance has held a preliminary meeting with Environment Southland (10th October 2017), during which Alliance presented the project plan.

Alliance intends to host a second TWP meeting the last week in November 2017 and take the TWP meeting on a tour of the site and river sampling locations. Going forward meetings of the TWP will be scheduled as required.

Alliance will engage in consultation with the wider community closer to the time of consent application being due.

12. Key Considerations
Frances presented to the group what Alliance has identified as key elements for consideration as:

- Regulatory requirements, for example, RMA, NPSFWM, RWP (operative), WALP (proposed as yet), NES Water metering, Iwi Management Plan, Gore District Plan, Coastal Plan
- Regulatory compliance (current and proposed)
- Microbiological contaminants
- Cultural Impacts – will speak to Stevie and Rewi separately to this
- Economics
- Consultation Inputs
- Abstraction volume and effects
- Cooling water discharge effects
- Wastewater discharge volume and effects
- Mixing Zone
- If the location of the previously identified Dissolved Oxygen sag is still correct
- Alternative Discharge Receiving Environments
- What mitigations may be required

13. Concluding questions and discussion
Ramesh Sharma (Gore District Council): asked if Alliance had monitored the DO sag?
Frances' response was that the current location of the DO monitoring, was identified during pre-consenting work as the location in the river where a DO sag occurred. But Alliance does intend to investigate that this is still the correct location for DO monitoring to occur. If Alliance identifies a more relevant location then a DO monitoring sonde will be placed in this location for data collection.

Ramesh Sharma (Gore District Council): asked if Alliance had decided on draft conditions.

Frances response was that Alliance had not yet decided on draft conditions. John Kyle added that Alliance will carry out river monitoring over this coming summer period and with that information, and after a regulatory review will begin to look at drafting consent conditions.

Ramesh Sharma (Gore District Council): asked why Alliance would need to change their consent conditions from the current state, as they had shown improvements, so why was there a need to change.
John Kyle responded that since there was an ever changing regulatory planning landscape, which has changed significantly since the current consents were granted, Alliance fully expects that they will not be able to gain consents with all the same conditions.

Renee Brown (Public Health South) asked if the plant was still planning to investigate the possibility of e-coli disinfection on the wastewater discharge and altemative receiving environments for the wastewater discharge. Frances's response was, yes Alliance was aware of the issue regarding disinfection and would assess the opportunity for a different receiving environment. Alliance is currently not aware of any practicable options for altemative discharge environments.

Phil Melgren (DoC) asked about Term. Alliance responded that in order to give the plant certainty going forward, the maximum term possibly (35 years) will be applied for.

It was reiterated by Alliance that the TWP involvement had worked well for the recent Lorneville re-consenting and a good working relationship was established, which allowed for issues to be considered and addressed in the lead up to the formal application process. The process enabled all parties to properly understand the nature of the applications, the resulting effects and the mitigation proposed by Alliance to address these effects.

14. Where to next?
Frances said that Alliance plans to host another meeting of the TWP near the end of November. It will include a site visit, including the locations of water take abstraction, wastewater discharge and river monitoring locations. Water Scientist – Mark James will discuss with the TWP what additional information needs to be obtained and the proposed summer monitoring programme for the 2017/18 season. A copy of the proposed 2017/18 summer monitoring programme will be distributed, prior to the next meeting. Alliance would welcome any input into the proposed monitoring programme.

Meeting closed at 13:55pm

Next meeting 29/11/17

Alliance Group Limited

Mataura 2019 Reconsenting – Technical Working Party (TWP)

Minutes of Meeting held on 29 November 2017

Mataura Board Room

Attendees:

Te Ao Marama:	Stevie-Rae Blair
Department of Conservation:	Amy Evans
Public Health South:	Kate Marshall
	Renee Brown
Gore District Council:	Donique Weatherburn
Southland Fish & Game:	Jacob Smyth

Alliance:

Frances Wise
Doyle Richardson
Jessica McKee
Tony Gilder
Murray DeGroot
Danny Hailes

Consultants:

John Kyle (Mitchell Daysh)
Mark James (Aquatic Environmental Sciences)

Apologies:

Te Ao Marama:	Dean Whaanga
Southland Fish & Game:	Zane Moss
Southland District Council:	Ian Marshall
Hokonui Runanga:	Rewi Anglem
Department of Conservation:	Phil Melgren
Gore District Council:	Ramesh Sharma
	Matt Bayliss
Alliance Group Ltd:	Kerry Stevens

Note: the Wyndham Angling Club has tendered their resignation from the Mataura Plant Technical Working Party.

Prior to the commencement of the TWP meeting, the attendees were taken on a tour of the external areas of the Mataura Plant, that included; the hydro race, routine river water quality sampling location (upstream), cooling water discharge and wastewater discharge points. The attendees were then taken to the upstream biological/black disc/SFRG/E.coli/sewage fungus monitoring site (U2), routine river water quality sampling location (downstream), were shown the vicinity of the downstream sewage monitoring spot, and were then taken to the downstream biological/black disc/SFRG/E.coli/sewage fungus monitoring site (D1). At the downstream (D1) location Mark James gave attendees an overview of what is done during biological monitoring surveys and some of the invertebrates present.

Meeting Commenced at 12.20pm

(NOTE: These minutes are to be read in conjunction with the presentation delivered by Mark James, Aquatic Environmental Sciences Ltd and the November 17 Report by Freshwater Solutions, Alliance Group Ltd Discharge and Mataura River Monitoring Plan which provides the context around the subsequent discussions outlined below).

Welcome (Frances Wise)
Frances Wise welcomed everyone to the meeting and asked if the meeting minutes from the previous meeting of the Technical Working Party (TWP), held on the 31 October 2017 at the Mataura Plant were true and correct. All members of the TWP accepted the minutes as an accurate record of the meeting and no issues were raised. Frances then handed the meeting over to Mark James from Aquatic Environmental Sciences.

AGL proposed Discharge and River Monitoring Plan (Mark James)
The purpose of the meeting is to present to the TWP a proposed monitoring plan for both the discharge and receiving environment to be undertaken over the coming summer. This proposed plan includes additional monitoring over and above the current consent required monitoring and is intended to be a one-off so that Alliance has robust and complete data leading into the reconsenting process.

The monitoring programme is based on monitoring which has been undertaken to date, as part of the current consents, for both the wastewater discharge and the Mataura River. Members of the TWP were supplied with a copy of the monitoring programme produced by Fresh Water Solutions prior to the meeting. A review was carried out of the data already held by the Plant, to help identify any further work which may be required for the reconsenting process.

It is a difficult process assessing what information is required to be gathered as there are a range of standards and guidelines that are still in draft form (i.e. NPS-FM, SRWP and ES Water & Land Plan). Alliance has tried to make sure that it addresses issues that may potentially be raised as a result of the finalisation of these plans and guidelines but will have to maintain awareness as these plans progress.

Background

Issues that need to be addressed in the Assessment of Environmental Effects are:

- Ammonia toxicity
- BOD and dissolved oxygen levels. Bacteria in river use up available oxygen.
- Changes to water clarity and colour in the river.
- Scums and foams in the river
- Microbial components (bacteria). As E.coli is an issue for the Mataura River, Alliance needs to investigate what needs to done for this reconsenting process and other possible pathogens that need to be assessed.
- Nutrient loadings to River of nitrogen and phosphorous
- Nuisance algae
- Changes in invertebrates upstream and downstream of the discharge as invertebrates are an important food source for fish.
- Effects of the discharge on fish and recreation

The monitoring plan intends to address policy and planning changes which have occurred since the last consent and provide relevant and sufficient information to measure potential exceedances and assess health of river and any potential effects.

Mark showed a graph depicting the seasonal mean $cBOD_5$ (kg/day) discharged by the plant since the 2004/05 season to the 2016/17 season. The graph showed the substantial decrease in mean $cBOD_5$ which has been discharged by the plant. There have been further reductions since the removal of sheep and lamb processing from the site.

Mark showed graphs of the seasonal mean Total Kjeldahl Nitrogen and seasonal mean Dissolved Reactive Phosphorus, the latter of which showed a significant decrease in seasonal mean discharged since 2004/05 to the most recent 2016/17 season. Mark also showed a graph showing the seasonal mean E coli discharged by the plant from the 2004/05 to the 2016/17 season which showed variable levels.

Existing monitoring regime for the receiving environment

Mark discussed the existing monitoring regime for water quality and aquatic ecology, monitoring has been carried out upstream and downstream for water quality and at the same 4 sites for biology since 2004. Samples for biology are collected from a 30m reach in riffle habitat at each site, a description of the habitat at each site is recorded, including channel shape, substrate, organic content, shade and habitat score. Assessment is made on periphyton, heterotrophic growths and benthic macroinvertebrates. Dissolved oxygen is monitored at Chalmers Road during summer low flows. Alliance intends to do more research into literature regarding fish populations leading into the consent.

Mark briefly described the Environment Southland river monitoring site, located 200m south of the Mataura River bridge at Mataura. Alliance and Mark have a meeting scheduled with Environment Southland tomorrow (30/11/2017) to discuss Alliance's proposed monitoring plan.

Mark showed a map of the upstream and downstream water quality monitoring locations and the four biological monitoring sites and the location of the dissolved oxygen monitoring.

Mark showed graphs for the accrual period prior to the January 2017 biological monitoring survey, seasonal mean for ammonia comparing upstream and downstream results, seasonal mean for DRP comparing upstream and downstream results. DRP historically showed a considerable difference upstream compared with downstream, but in recent years there are similar levels of seasonal mean DRP upstream compared with downstream.

Mark showed graphs showing results from the biological monitoring for periphyton, macroinvertebrates, and historical trends for QMCI.

Mark showed a slide of both native and introduced fish species which are found in the Mataura River and the species which are found above and below the falls.

Existing monitoring regime for wastewater discharge & proposed additional parameters
Mark discussed the current monitoring protocol for the wastewater discharge. The current routine monitoring on the wastewater includes testing for E.coli, pH, TKN, Ammonia-N, TSS, Total sulphide, DRP, TP and $cBOD_5$. E.coli is commonly tested for, as it is an indicator of bacterial species. Additional parameters which Alliance is proposing to test for are Nitrate and nitrite-N, so that TON can be calculated. Also planning to include DIN, TN and soluble BOD. Also plan to use this information to do CLUES modelling to get a context for what percentage of TN loading in the river Alliance is contributing. Soluble BOD is a potential driver for sewage fungus.

Proposed additional monitoring parameters for receiving environment
Mark discussed the proposed additional monitoring parameters for the receiving environment. Mark clarified that the proposal was for additional monitoring to be carried out during the coming summer months and would not be an ongoing long term monitoring programme. Additional monitoring proposed for this summer includes continuous temperature monitoring upstream and downstream of the water takes and cooling water discharge, DO, $cBOD_5$, and TN weekly, weekly observations of foams and scums, monthly colour assessment, longitudinal E.coli study, monthly turbidity and water clarity and monthly samples from sites U1, U2, D1 and D2 for DIN and DRP.

Alliance is planning to repeat the 2003 longitudinal DO, $cBOD_5$ and temperature survey to assess the location of the DO sag. Mark discussed work that is planned to confirm the mixing zone of the discharge. Work that was carried out at the previous round of consent had the discharge as completely mixed prior to it reaching the bridge. Alliance also plans to carry out a one off test of the wastewater for metals, organo nitrogen and phosphorus pesticides and organics (SVOC and VOC).

The current routine annual biological survey will continue, but depending on river flows up to two extra surveys may be carried out. Depending on flow conditions the additional surveys may comprise periphyton assessments only. A review of fish data will be carried out.

Mark discussed how Alliance intends to carry out further analyses of some key pathogens from upstream and downstream and the discharge, and a longitudinal study in the river for E.coli to assess the effects of the discharge on microbial contamination in the river. The National Policy statement sets out different limits for E.coli than the MfE guidelines for recreational use, which are different again to those in the ES Water and Land Plan and bathing sites. Environment Southland currently has a draft report for a project that was undertaken to assess campylobacter in the Mataura River.

Mark then presented three slides tabling a range of relevant limits for receiving waters.

Discussion
To conclude the presentation Frances Wise asked the TWP for their input into the proposed monitoring plan. Members of the TWP indicated that they were happy with the proposed monitoring plan which had been presented. Jacob Smyth (F&G) commented that the proposed monitoring plan was very comprehensive.

Kate Marshall (PHS) asked if Alliance planned to test for cryptosporidium as there had been recent outbreaks in the Southland region of people taking ill with cryptosporidium. Mark James responded that he will follow up the meeting with some information on how the proposed microbial determinants had been selected.

Jacob Smyth (F&G) asked how the timing of river monitoring was going to be decided. Mark James responded that Alliance and their consultants would look very closely at river flows, rather than selecting dates for the monitoring, as this would give more valuable data. Mark James then added that he and Alliance were scheduled to meet with Environment Southland tomorrow (30/11/2017) to present the proposed monitoring programme for input from ES. Environment Southland carry out routine water quality monitoring on the Mataura River, 200m downstream of the bridge, they monitor E.coli, clarity, TN, TON, ammonia-N, TP and DRP.

Jacob Smyth asked if consideration had been given to mixing zone. Mark James responded that the assessment of the mixing zone for the Mataura Plant discharge would be straight forward in comparison to other sites such as the Lorneville Plant discharge i.e. there is no tidal influence, not a braided river. Alliance needs to confirm that the discharge is being properly mixed in line with current predictions.

Frances Wise advised the TWP that it was anticipated that the next meeting would not be for a few months and likely to be when the summer monitoring programme had been completed. She closed the meeting by asking the members of the TWP if they had any questions to come back to Frances, Doyle or Jessica.

Meeting closed at 13:05pm

ALLIANCE
FARMERS' PRODUCE
SINCE 1948

Alliance Group Limited: Mataura Plant Wastewater Technical Working Party

Date: 31 October 2018

Time: 12.00 pm

Location: Alliance Mataura

Present:

Stevie-Rae Blair	Te Ao Marama
Penny Nicholas	Hokonui Runanga
Kathryn McLachlan	Environment Southland
Graeme McKenzie	Environment Southland
Matt Bayliss	Gore District Council
Alex McKenzie	Gore District Council
Jacob Smyth	Fish and Game
Danny Hailes	Alliance Group Ltd
Tere Ngu	Alliance Group Ltd
Jeff Hosking	Alliance Group Ltd
Murray De Groot	Alliance Group Ltd
Doyle Richardson	Alliance Group Ltd
Renee Murrell	Alliance Group Ltd
John Kyle	Mitchell Daysh
Mark James	Aquatic Sciences

Apologies:

Dean Whaanga	Te Ao Marama
Phil Melgren	Department of Conservation
Amy Evans	Department of Conservation
Mike Durand	Environment Southland
Simon Mapp	Environment Southland
Stephen West	Environment Southland
Matt Russell	Southland District Council
Willie Weise	Alliance Group Ltd
Renee Brown	Public Health South

Introduction

1. Meeting commenced at 12.30 pm following lunch. Doyle Richardson (DR) welcomed everyone to the meeting, acknowledged apologies, introduced attendees and outlined the meeting.

Purpose of the Meeting

2. The purpose of this fourteenth annual meeting was to receive reports, review results, initiate meetings and recommend reviews of conditions if necessary in relation to Consent No. 202327.

Update on the Mataura Plant

3. Danny Hailes (DH) presented an update on Mataura Plant activities including the Health and Safety journey and stats

4. 142,056 cattle processed, eclipsed previous plant record of 124,418 set in 2016/17 season.

5. New plant manager to start 1 December 2018 – Melonie Nagel

Annual Monitoring and Review Summary

6. DR presented the 2018 Annual Monitoring and Review Report. The report had been pre-circulated to Technical Working Party members.

Treated Wastewater Monitoring

7. BOD5 and TSS non-compliances and associated actions were discussed by DR and Renee Murrell (RM)

8. Slight increase on mean e.coli, CBOD5, NH4-N, TSS, TKN, TP, total sulphide concentrations and cBOD5.

9. Full compliance had been achieved with discharged volumes, DRP discharge load, sulphide, and ammonia concentration limits.

10. The annual average discharged DRP loads over the last 6 years have plateaued around 1kg/day. The mean DRP load was similar to last year.

Receiving Water Monitoring

11. JM reported that receiving water monitoring showed full compliance with Mataura Water Conservation Order, Class D Waters and temperature, pH and ammonia standards in the Southland Land and Water Plan (SLWP). There were no observed conspicuous changes in the river as a result of the discharge.

12. Annual median and maximum upstream ammonia concentrations and downstream median ammonia concentrations met the NPSFM "A" Attribute state, maximum downstream was "B".

13. Downstream annual and median 95th percentile met the "A" Attribute state for nitrates. Upstream annual median met the "A" Attribute state and the annual 95th percentile met the "B" Attribute state

Biological Monitoring Summary

14. Conducted by Fresh Water Solutions on the 15th December 2017 following an accural period of 86 days and 16 days of continuous river flow below 40m^3/s
Minimum flow of 17m^3/s for the 90 day period prior to the survey, was at the lower end of the historical range
Median flow of 42 m^3/s flows for the 90 day period prior to the survey, was at the midpoint of the historical range
Outside of the January – April window as follow up surveys were intended for compliance and re-consenting purposes but prevented by regular rain and flushing events. Jacob Smyth (JS) commented that he thought it was more appropriate that it was triggered by flow events rather than time periods.

River conditions during the survey were representative of summer low flow sampling requirements outlined in the consent.

15. DR explained the sampling sites used for both water quality, biological and DO monitoring. DO monitoring site was identified as where the DO sag was experienced, in pre-consenting surveys.

16. Black Disc - All measurements upstream and downstream met MfE guidelines (>1.6m), ranging from 2.88m – 3.05m
The black disc distance decreased slightly downstream of the discharge

17. A data sonde was deployed near Chalmers Road on the Mataura River from mid-January to late January to record temperature and Dissolved Oxygen. The data showed a typical diurnal pattern. All results well above the Class D limit of $5g/m^3$ and were comparable to the previous year. JS queried whether we should actually begin the monitoring of this based on flows as opposed to time of year.

18. Periphyton cover was high at all four of the monitoring sites at the time of the December 2017 survey. Filamentous algae was absent at site U1, sparse at sites D1 & D2 with 9% recorded at U2. All sites were well below the MfE guidelines of 30% cover recommended for the protection of aesthetics, recreation and trout habitat/angling

19. There was no significant difference in mean chlorophyll-a concentrations between upstream and downstream sites. Chlorophyll-a concentrations at all sites were below the MfE guideline ($50mg/m^2$) recommended for the protection of benthic biodiversity and well below the guideline of 200 mg/m^2 recommended for the protection of trout habitat and angling.

20. QMCI results appear to indicate a decrease in water quality but this is not what other parameters are indicating. JS offered that perhaps it was an anomaly as trends indicate an increase in water quality.

21. A total of 42 invertebrates were collected, this is higher than previous surveys. These were dominated by Ephemeroptera (mayflies), Trichoptera (caddisflies) and Diptera (true flies). Deleatidium were by far the most common mayfly taxon recorded across sites.
The chironomids Maoridiamesa and Orthocladiinae were typically the most abundant true flies at sites in December 2017.
Mollusca and Oligochaeta represented less than 3% of the community at all sites.

22. The discharge was not stimulating periphyton growth or adversely affecting benthic invertebrate community health at the time of the survey. There is a continuing trend of improved invertebrate health at sites downstream of the discharge.

Sewage Fungus and LMWBOD

23. Calculated discharged loads of LMW BOD were low during the 17/18 season. No sewage fungus was observed during the eight inspections carried out during river flows less than 30 m^3/s. None has been observed since the 12/13 season when it was observed in very small amounts upstream and downstream of the discharge. DR explained the risk profile for proliferation of sewage fungus maintained as a graph. This demonstrates that the theoretical in-river concentration of LMW BOD

was always below the MfE guideline value of 1 g/m^3 during the 17/18 season but clearly show the period of greatest risk during low flows.

Suitability for Recreation

24. DR explained the background and purpose of the SFRG assessment. Annual summer e coli results are added to the database to derive a Microbiological Assessment Category. With the 2018 results, the derived MAC remains "D" upstream and downstream. (Not to be confused with "D" Attribute state in the NPSFM)

25. A Sanitary Inspection Category was originally derived and when this SIC is combined with the MAC a SFRG is determined. This remains "Very Poor" both upstream and downstream.

26. Downstream e coli concentrations are higher than upstream. Upstream concentrations were higher, and downstream concentrations were lower, than in 2016.

Plant Improvements

27.

- Water Metering Implemented
- Cattle yards re-piped, reduction in water use
- Decanter Odour Issues
- Investigation and corrective actions identified and implemented.
- Wastewater Treatment Plant Improvement
- Polymer dosing unit – all electrics updated
- Adult blood collection
- Baffles on DAF Tanks
- Grit Plant – Redesigned and rebuilt
- Lime dosing process
- $500,000 capital expenditure allocated in this years budget for further wastewater improvements

Consent No 202327 Compliance Summary

28. Alliance summarised the results of 2017 – 18 monitoring as follows:

- *Compliance with treated wastewater discharge consent conditions for the majority of the season*
- *Analytical data for receiving waters below the discharge were fully compliant*
- *Fifth consecutive year since monitoring began that sewage fungus has not been observed at all.*
- *SFRG confirmed as "Very Poor", upstream and downstream – higher E coli concentrations downstream.*
- *Results of the December 2017 biological survey indicate that the discharge was not stimulating periphyton growth of adversely affecting benthic invertebrate community health at the time of the survey.*
- *There is a continuing trend of improved invertebrate community health at sites downstream of the discharge*

Consents

29. Dam and diversion of water – hearing early December

30. Consents expire December 2019

31. 202327 – To Discharge Wastewater to the Mataura River, 14,400 m3/day

32. 204126 – To take water from the Mataura River, 35,600 m3/day (amendments to this consent this year)

33. 204125 – To discharge condenser cooling water to the Mataura River, 21,200 m2/day

Monitoring of the Discharge and Receiving Environment for Re-consenting

34. Monitoring of discharge to continue as per Resource Consent requirements with additional parameters as discussed in Slide 33.

35. Monitoring of the receiving environment which includes additional parameters for re-consenting as discussed in slides 35 and 35. Will analyse for E.coli but it is not e.coli which makes you sick it is campylobacter which is hard to test for. JS queried whether the decrease in e.coli results is due to site processing changes. Alliance staff thought not.

36. There is an increase in ammonia concentrations downstream compared to upstream; all other parameters are fairly consistent between upstream and downstream.

37. Will repeat the 2003 longitudinal DO (add cBOD and temperature) survey at 11 sites (during summer low flow 2018) to investigate oxygen sag which is in the same place as previously assessed – point 9 on Chalmers Road and changes in DO. Added full nutrient suite in 2017/18.

38. Attempt to repeat annual biological survey at least three times over Summer

39. Review fish data and assess whether enough distributional data available

40. In progress is a QMRA Assessment, planning assessment, existing environment report and an assessment of the coal-fired boiler discharge to air.

41. QMRA work to date suggests that the low risk to recreation doesn't reflect the high e.coli concentrations.

42. Still to be completed is:

    - Ecological assessment of effects
    - Cultural heritage impact assessment
    - Recreational assessment
    - Economics assessment
    - Options assessment, existing, GDC and discharge to land
    - Conditions
    - Consultation

Comments and Questions

43. No questions or comments.

Closure

44. Alliance thanked all participants for their attendance.

The meeting concluded at approximately 2.00pm.

Meeting notes by Renee Murrell

Mataura Consenting:
Preliminary meeting with ES 10/10 /2017; 2pm – 3pm

Attendees: Steve West, Alex King (ES): Doyle Richardson, Jessica McKee, Frances Wise (AGL)

- Consents Manager (Michael Durand) did not attend the meeting.
- FW talked through Project Plan (October 2017 Consultation)
- Advised that intention is to continue with the TWP approach for consultation. Will communicate separately with ES.
- SW suggested that Federated Farmers should be included in the TWP as they have been vocal re other consent applications from SDC / ICC.
- SW suggested that consultation should include dischargers down-river – Dongwha, Fonterra and SDC (Edendale)
- SW discussed observed dips in Tuturau flow gauging records – attributed to Alliance. Commented that these dips were observed and accepted at the time the WCO was implemented but considers that acceptance might not be guaranteed this time. (Note that AGL does not believe these dips are attributable to their activities).
- SW asked if the discharged cooling water had de-scalers added to it, or was it just a potential temperature effect. (AGL believes no additives but will confirm)
- Alternative receiving environments need to be well assessed as there will be pressure against discharge to river.
- SW indicated that the key parameter for the Mataura River catchment is as yet undetermined but suggested that it is possible that it might be e coli.
- Future consent should enable / require compliance with future catchment limits but could by way of off-sets.
- AK suggested that having a Cultural Impact Assessment carried out is likely to be valuable.
- AK queried whether sewage fungus / low molecular weight BOD was still an issue. (not since closing of ovine processing / rendering)
- Estuary is likely to be less of an issue than (EG) New River Estuary as it has a through flow. Need to talk to ES (via Rachel Millar, Science Manager) to confirm key contaminant.
- SW / AK consider that the rules in the WALP are most likely to change, not the Policies.
- SW commented that the WALP policies look for avoidance of effects, his interpretation is that this means no change between upstream and downstream – but could address by off-setting if treatment cannot deliver this.
- Understanding annual loads is important as catchment limits will be in this context.
- Discussion re peer to peer conversations re water quality etc. Advised to contact Rachel Millar who will "assign" an ES scientist. Providing a draft summer 17/18 monitoring programme to this person will be useful.
- More SOE information is available than is published – again contact ES for this information.
- ES likely to consider that the Mataura is over-allocated for water abstraction.
- NES for Water Metering will likely need to be addressed.
- SW believes, but is not sure, that the new discharge via the GDC (Mataura Valley Milk) will be within existing consents – but also considers there will inevitably be increased discharged loads.
- SW commented that the WCO states that a discharge should be "substantially free of solids" – wonders if what was acceptable earlier will still be acceptable?
- SW advised that policies at a plan level will be given much more weight by ES than those in the upper level documents.

- Discussed notification in the context of an RMA change around notification of applications in Statutory Mgmt areas – but agreed this is irrelevant as expectation is that the application will be notified anyway.
- SW's interpretation of the catchment limit setting process is that while the "published" date for commencing the Mataura process is 2018, he has been told that this is unlikely to commence until 2020 and still with the expectation that limits are in place by 2025.
- With respect to possible timeframes for any improvements identified as necessary, SW suggested that any actions should be to address the immediate effects. Utilise RMA 105 and 107. Provide strong reasons for any proposed delay in implementing mitigation.
- SW advised that natural character effects around the Falls will be considered. (Only opportunities likely to be by tidying up (painting) the riverside buildings?) AK advised that the Wyndham Angling Club have experience in dealing with natural character aspects.
- Discussion around scums and foams – reference to AGL often being blamed for conspicuous foam. Acknowledgement that it is likely natural / from upstream but expected to be raised as an issue.
- SW emphasized the importance of an economic assessment. Considers that while a lot of people will have an issue with a discharge to the river, few will understand the importance of the Plant to the local / regional economy.
- SW referred to the potential animal welfare impacts in dry / low flow conditions and the need to bring this aspect into the application.
- SW suggested that it might be useful to arrange a site visit / briefing for local media – to assist in getting a positive / informed message delivered.
- Alex King (Alexandra.King@es.govt.nz) is to be the primary contact within ES. Steve (Stephen West stephen.west@es.govt.nz) to be contact if Alex is not available. Alex is keen to have a site visit – AGL will facilitate.

F Wise
11/10/17

Alliance Mataura Re-consenting:

Meeting with Environment Southland; 30/11/17: 9.30 to 11.00 am:

Purpose: To discuss proposed summer wastewater and receiving environment monitoring programme.

Attendees:

- Roger Hodson (ES)
- Karen Wilson (ES)
- Mark James (AES for Alliance)
- Doyle Richardson (Alliance)
- Frances Wise (Alliance)

Key Points:

- Mark talked through the Mataura background data and performance as contained in his presentation given to the Technical Working Party 29/11/17.
- ES monitoring site is on the TLB 200 metres downstream of the Mataura Bridge (Alliance's D1 site). Data in addition to that on the ES website is available – cations, anions, dissolved metals and biology.
- Timing of ES biological monitoring is variable – time based rather than flow. Ecological data is semi-quantitative.
- Re Alliance in-river ammonia graph – Roger noted that was consistent with ES's Gore vs Mataura Bridge monitoring.
- Roger asked if the Alliance biological monitoring sites are similar. Mark responded that the upstream sites and D1 are very comparable, D2 differs – deeper and slower, more run of the river rather than riffle. Mark advised that he needs to look more closely at D2 to better understand data from it.
- Roger noted that there seems to be a move for using run habitat, rather than riffles for periphyton monitoring and that Alliance should consider this. Mark responded that he would but noted the extensive history Alliance has at the existing sites.
- Roger noted that the lower Mataura is on ES/s radar as being close to bottom lines for periphyton. Monthly data are collected at Gore and Seaward Downs. Reasonably new database at Seaward Downs; data are variable but above 200 on one occasion.
- Roger suggested focus on periphyton accrual rates would be useful.
- Discussion around need to get some water quality upstream / downstream data when not discharging.
- Discussion around frequency of clarity and turbidity monitoring – proposed monthly may not be sufficient. Discussion around practicality of frequent (weekly) black disc assessments and inability to measure black disc at water quality sites (where turbidity would most easily be measured). A relationship between clarity and turbidity should be developed if possible. ES advised that they have an easier to transport and use version of the equipment and that they have a local engineering firm make them. Alliance agreed that weekly monitoring would be more appropriate and will revisit this.
- Roger advised that turbidity analysis should be to ISO 7027 standard - referenced National Environmental Monitoring document (?) re turbidity.

- Discussion re FMU compliance approach / monitoring sites – Roger suggested that ES's thinking had not advanced with respect to this.
- Discussion re recently advised cyanobacteria outbreak – at Seaward Downs. Observational rather confirmed by toxicity testing. Had been significant cover (80%?) but has reduced. Cyanobacteria had been an issue in the Mataura from Gore to Seaward Downs last year.
- Roger asked if Alliance had considered deposited sediments - % cover of fines, re-suspendible material. Mark commented that he didn't think this was an issue but could be assessed during the biological monitoring.
- Frances asked who was likely to assess the application – staff or external. Roger couldn't answer – said he would talk to Steve West about this.
- Roger commented that the proposed monitoring looked "pretty comprehensive".
- Roger will provide additional ES data from below the Mataura Bridge to Mark.
- Communications to ES scientists should include both Karen and Roger.

11

APPENDIX 11

Consultation leaflet posted to letter boxes in Mataura Township

ALLIANCE
FARMERS' PRODUCE
SINCE 1948

MATAURA RESIDENTS

RECONSENTING OF ALLIANCE MATAURA PLANT MEETING

Alliance is progressing work on renewing some of its key resource consents for the Mataura Plant. The key consents are the water take permit, cooling water discharge permit and wastewater discharge permit.

You are invited to a meeting at:

7:00 pm Thursday 23 May 2019

Mataura Community Centre
2 McQueen Avenue, Mataura

We are keen to share what we have learnt through technical investigations, what we are proposing to do and advise on the application process going forward. This will also be an opportunity for neighbours to ask questions about the proposal and make comment.

Further summary information will be available at the meeting, or alternatively please contact Doyle Richardson, Group Environmental Manager, on 03 215 6426 or doyle.richardson@alliance.co.nz, if you have any questions in the meantime.

Melonie Nagel
Mataura Plant Manager