Environmental Consultants
PO Box 489, Dunedin 9054
New Zealand
Tel: +64 3 477 7884
Fax: +64 3 477 7691

By Email

17 February 2016

Environment Southland
Private Bag 90116
Invercargill 9840

Attention: Joanna Gilroy

Dear Joanna

RE: ALLIANCE GROUP LIMITED – LORNEVILLE FURTHER INFORMATION REQUEST

Thank you for your letter of 26 January 2016 requesting that further information is required in order to continue processing the resource consent applications being sought by Alliance Group Limited (Alliance) with regard to its Lorneville Processing Plant.

As outlined in the tables below we have endeavoured to provide a response to each request. Aside from some further data analysis with regard to the likely composition of the biosolid material which will be provided by late February, all aspects of the request have been addressed. Given this it would be appreciated if you could confirm that the next step will be the public notification of the applications.

<u>Abstraction of surface water</u>

As indicated in the application documentation a further summer survey of the Oreti River was to be undertaken by Alliance's freshwater advisors, Freshwater Solutions. The purpose of this field study was to complement the desktop study that has been completed in support of Alliance's proposed abstraction from the Oreti River. This survey has been completed and the findings have been incorporated into a revised assessment report which is attached to this response as Attachment A. It would be appreciated if this version of the report could **replace in its entirety Appendix O of the application documentation**. This report has also addressed other aspects of the section 92 further information request as indicated in the table below.

REQUESTED INFORMATION	EXPLANATION	ALLIANCE RESPONSE
A comprehensive assessment of the ecological values of the lower Oreti River.	This is required as there is a lack of information provided on freshwater communities downstream of the existing water take. It is considered appropriate that this information includes results from a field survey.	The report attached by Freshwater Solutions includes an assessment of the findings from the field survey data obtained over the 2015/2016 summer.
Further information on the extent and magnitude of the tidal influence of the Oreti River near the abstraction point and how communities within the tidal reach will be affected by the abstraction during low tide periods.	This information is required as there is insufficient detail on river flow variation downstream of the take to support the conclusion that due to tidal water level fluctuations, communities in only a 1 km length of the river will be affected by the abstraction.	This information is set out in the revised water abstraction assessment which is attached to this response. Refer to section 5.6 in particular.
What are the key spawning periods and migration dates when channel maintenance activities will be avoided.	This mitigation method has been offered. However, no dates have been provided.	The proposed conditions require that the scheduled work on the channel occur outside the period 1 October to 31 August.
An assessment of effects which includes analysis of recent water quality and periphyton data from the Wallacetown Bridge site.	The assessment of effects analysis contained in the application only includes data from 2005-2010. The use of more recent data is considered appropriate in order to describe the current state of the environment and to assess the effects of the activity.	More recent data has been included in the revised assessment which is attached to this response.
Details about, and an assessment of the effects of the proposed activity on preiphyton and benthic invertebrate communities in the area of the take, including 1 kilometre upstream of the abstraction site.	No information has been included in the application on existing periphyton benthic invertebrate communities downstream of the take, or the effect of the activities on these communities. It is considered appropriate that the supplied information includes results from a field survey.	This information has been provided in the revised water abstraction assessment which is attached.

Additional information on the relationship between river flow and abstraction over 2007 to 2014 has been provided within graphs in Appendix 3 of the updated report (November 2015). It is stated in the report that the abstraction represents a very small proportion of river flow throughout the period. However, clarification or alterations to this conclusion is required.	Clarification or the alteration of the statement is required as for a short period in December 2012 the flow in the Oreti River was very low and consequently the take comprised a large proportion of the river flow. This event needs to be identified and discussed in more detail. Other periods which should also be considered include March 2010 and March 2013 when the Oreti River flow was at times around 1 m^3/s and the water take would have represented a considerable proportion of the river flow.	It was identified that there was an error in the graphs presented in Appendix 3, these have since been corrected and are reflective of the actual water flows and Alliance's take. Refer to the revised assessment which is attached.
Further justification to support the conclusion that the tidally affected reach of the Oreti River will not be affected by the abstraction.	Sufficient detail has not been provided to support the conclusion about the effect of the take.	This information has been provided in the revised water abstraction assessment which is attached.
A comprehensive assessment of effects of the take on water quality.	The assessment of effects within the application does not sufficiently support the conclusion that the effects of the abstraction are likely to continue to be less than minor on water quality. The supplied information should include water quality data from downstream of the abstraction point, subsequent analysis of this data as well as an assessment of whether or not the abstraction will exacerbate any water quality issues.	This information has been provided in the revised water abstraction assessment which is attached.

Reasons to support the statement that only a small number of small fish may pass through the screen on the intake structure.	No reasons why it is considered that only a small number of small fish may be entrained have been provided. The supplied information could include information on the investigation that Alliance is undertaking in regards to the fish screen.	This information has been provided in the revised water abstraction assessment which is attached.
Clarification of the rate of take in litres per second.	Two values for the rate of take in litres per second have been provided. Please explain if the rate of take will be 300 litres per second, or 260, or both?	It is confirmed that the proposed abstraction rate is 260 litres per second.

Discharge of wastewater to water and to land

The following response has been prepared in consultation with Alliance's technical advisors Pattle Delamore Partners Ltd (PDP) and Soil Work Limited.

REQUESTED INFORMATION	EXPLANATION	ALLIANCE RESPONSE
Is the aeration loop portion of the treatment system lined and/or sealed? Are there plans to upgrade the lining/sealing at the aerators?	This information is requested as there are concerns regarding the aeration of the system.	The existing aerated lagoon (Loop) has been in service since early 1970's and had additional mechanical aerators installed in February 1999 after the lagoon was desludged. It is not clear that whether the aerated lagoon bed was re-compacted or additional compacted clay put in place after the desludging. The existing aerated lagoon bed is not lined other than natural in-situ material. Given the Loop has been operating for many years, there are no plans to undertake any further remedial lining of the Loop. The aerated lagoon surface area is 9.4 ha and the lining of the lagoon will be a substantial undertaking, albeit at locations where the aerators may be located. Results from the groundwater analysis indicates that there does not seem to be leakage from the lagoon that significantly impacts on the groundwater quality.
Further discussion of: the suction cup sampler results in the Soilworks Report, whether or not the sample design was appropriate and the results reflective of the leached mass from the site.	The use of suction cups samplers for determining nitrogen leaching typically requires multiple replicates for each treatment. The sampling design may result in a risk of underestimation of leached mass. The report also suggests that lateral flow has influenced the suction cup results.	Soil Work Ltd has addressed this request and this response is attached as Attachment B.

An explanation of whether or not the monitoring results in Appendix Q of the AEE for groundwater quality are reflective of the actual effects of the current activity OR results from a newly drilled monitoring bore which is drilled to an appropriate depth to monitor the effects of the activity.	Table 1 in Appendix Q shows both the BHB and BHD are screened deeper that the top of groundwater. Therefore, they may not be intercepting any contaminant pulse should there be stratification occurring. Any response should consider the driller's log for BHD which shows the screen is above the water level.	The monitoring results are reflective of the actual effects. The shallow groundwater in the vicinity of the Makarewa River seem to be affected by the tidal movement in the river. During the installation of BHB on 4 November 2014, the driller indicated that water level in the bore was 4.0 m bgl. Based on this information, the bore was screened between 2.0 m bgl to 8.4 m bgl. Subsequent measurements on 5 November 2014 showed the water level was 1.3 m bgl which is above the top of the screen. The groundwater levels in BHD fluctuate due to tidal effects and changes in water level in the Makarewa River. Based on water levels measured during the piezometric surveys and groundwater quality sampling rounds undertaken in December 2014 and March 2015, the overall range of fluctuations in BHD are between 0.78– 1.24 m bgl. Therefore, groundwater levels in BHD fluctuate above and below the top of the screen depending on the water levels in the Makarewa River. However, any contaminants migrating from the ponds will preferentially move along the more permeable sand and gravel strata which are covered by the screened zones of both BHB and BHD. Consequently these bores can be expected to show the effects of any contaminants migrating from the ponds. There is no indication that the screening of these bores would prevent the indication of any water quality effects emanating from the wastewater treatment ponds.

Confirmation of the direction of flow of groundwater near the treatment ponds.	This is required because in the groundwater and surface water monitoring report (Appendix Q) it is stated that groundwater is flowing in a general west to south west direction. However, piezometric contour maps show that groundwater flow in the vicinity of the ponds is flowing to the northwest. Therefore, it cannot be concluded that the monitoring bores are downgradient of the ponds, with the Makarewa River being directly downgradient.	The piezometric contour maps in the PDP report show that groundwater flows in a general south west / westerly direction away from the Lorneville Plant toward Bateman's Drain and the Makarewa River. Groundwater flow in the vicinity of BHA appears to be to in a northwest direction, due to a localised drainage effect on the groundwater caused by Boiler Ditch. The groundwater flow affected by this drainage can be expected to seep into Boiler Ditch. Ultimately it is expected that any pond seepage will enter the Makarewa River. At all times, water levels in the wastewater ponds are higher than the surrounding groundwater levels and the water levels in the Boiler Ditch which flows between the groundwater monitoring bores and the waste water ponds. Consequently, there is always a hydraulic gradient from the wastewater ponds to the groundwater and boreholes BHB, BHC and BHD allow sampling of the groundwater closest to the ponds, other than the groundwater that drains directly from the ponds into the Boiler Ditch and the Makarewa River.

An assessment of the effects of the discharge to water on actual and potential recreational users of the Makarewa River.	The report 'Assessment of the Receiving Environment for Alliance Lorneville's Treated Wastewater Discharge' does not contain targeted information specific to the Lorneville plant discharge. The information is too generic and the effects of the discharge are not addressed in sufficient detail.	Consultation with actual and potential recreational users and stakeholders has occurred and this is documented in the Consultation Report attached as Appendix B to the AEE. The AEE also reports that consultation with key stakeholders including Te Ao Marama, Southland Fish and Game, DoC, Public Health South and the Wallacetown Community Board who also represent recreational user groups has also occurred. No significant recreational issues were raised by these stakeholders. Consultation with recreational individuals (eelers and whitebaiters) has also occurred. Comments received via this process indicate that the lower Makarewa River still supports a reasonable eels and whitebait fishery and access appears to be the most significant constraint with regard to recreational fishing in the area. Those that use the area did not identify any specific issues or effects associated with the Plant discharge on these resources.

Discharge of biosolids and monofill

The following response has been prepared in consultation with Alliance's technical advisors Pattle Delamore Partners Ltd (PDP).

REQUESTED INFORMATION	EXPLANATION	ALLIANCE RESPONSE
A description of any treatment applied to the WAS and SYS other than dewatering.	From the report in Appendix X it is not clear if any other treatment is proposed.	The proposed treatment is the mechanical dewatering of the waste activated solids (WAS) and stockyard solids (SYS). In the event there is an objectionable odour or potential to create objectionable odour, then hydrated lime will be added to the surface of the solids deposited in the monofill. For the WAS intended for land disposal, hydrated lime will be added in the event there is a risk of odour generation at the time of disposal. There is no additional treatment proposed for the stockyard solids prior to deposition onto land.
Appendix J and S outline expected characteristics of the WAS/SYS based on results achieved at a similar Alliance site. However, no information is given as to how these results are achieved.	If the results from the Alliance Pukeuri site are to be used to infer that the biosolids are likely to meet the relevant guidelines then please explain how the results for the Pukeuri site have been achieved.	The Pukeuri plant thickened waste activated sludge was a grab sample collected from the sludge holding tank at approximately 2% non-dewatered solids on 10 September 2014. The biosolids characteristics were then assessed based on expected solids content of 18% solids following dewatering. The stockyard solids characteristics are based on literature data on animal size, based on an estimate of the amount of faecal material evacuated during holding time in the sheepyards.

What systems will be in place to detect leakage from the ponds (especially A1 and B2)? Will any remediation work be undertaken prior to the use of the ponds as monofill sites?	As the ponds are disused the naturally formed liner cannot be guaranteed. Therefore, please outline the process that will be in place to detect, or monitor for any leakage.	The ponds nominated for use biosolids monofill cells in future are currently not in active use and are only used as temporary overflow ponds in the event they are required. However, incident rainfall on top of the ponds and some localised site stormwater drains in these ponds and the ponds are mechanically pumped out when required. When establishing the cells for use as monofill, an integrity check for the in-situ clay liner will be undertaken to ensure that the natural clay/silt liner is of a minimum 300 mm thickness. Further remedial works will be undertaken to ensure that a natural clay seal in maintained prior to deposition of biosolids. During monofill use, the deposited material will be dewatered and very likely to shed rain water to a collector sump. Since the ponds are located adjacent to other lagoons, no active leak detection systems are proposed.
Are there likely to be any sources of mercury or organics in the biosolids? Are there any pathogens specific to the waste stream which may affect human health? Are there any risks of Salmonella as a result of the discharge of biosolids?	These have not been covered in the assessment of effects, specially the report in Appendix J.	There are no intentional likely sources of mercury generated from the process liquid waste streams at the site from the meat processing and rendering plant. There may be mercury in the coal feedstock, however, it is expected that mercury may be lost as a volatile compound in the exhaust gases. It is likely that there may be very low amounts of mercury in the hydrated lime utilised at the fellmongery, but the concentrations are expected to be extremely low.

		Similarly organics are expected to be at very low levels. For microbial contaminants, a screening indication for *E. coli* was provided. It is not likely that there is any risk of Salmonella present in the biosolids as the wastewater is treated through anaerobic and aerobic processes. However, there may potentially Salmonella present in stockyard solids in the event infected animals are sent for slaughter. Analysis of the biosolids generated at Alliance's Pukeuri Plant and stockyard solids from Lorneville plant are being completed to assist in informing a more detailed response to this request. This is currently being completed and the results will be provided to Environment Southland as soon as they are available, anticipated to be by the **end of February**.
What is the loading/mass of material that is expected to be applied to the application site? What is the minimum land area that will be needed annually and what return interval will there be for repeat applications?	This information is needed in order to inform the assessment of effects of the activity.	As outlined in the proposed conditions relating to the discharge of biosolids to land the following parameters will be adhered to: • Annual loading rate of no greater than the plant available nitrogen (PAN) rate of 140kg N/ha/yr or 250kg N/ha/yr. • The loading rate of 250 kg total nitrogen per hectare per year (kg N/ha.yr) is approximately 23 tonnes / ha /yr of dewatered biosolids at 18% solids content. • This shall be applied in no less than two applications per year. The land area available for the application of biosolids is shown in Figure 8 of the AEE. This equates

		to approximately 180 ha of land that could be utilised for biosolids disposal. It is envisaged that a gross dewatered solids loading rate is likely to be around 23 tonnes per hectare per year. Based on 6 – 7 months of production processes and corresponding wastewater generation, it is likely that up to 3 - 4 separate discrete deposition events will be undertaken to accumulate to an annual total of 23 gross tonnes a hectare. This means that up to 3 - 4 ha per day would be utilised per day with a likely return period of 6 – 8 weeks.

Discharge to Air

With regard to the request for information relating to the discharge(s) to air applications, Golder Associates has provided a response to the following matters and this is attached as Attachment C to this letter. A summary of that response, and some additional information is however provided in the table below.

REQUESTED INFORMATION	EXPLANATION	ALLIANCE RESPONSE
A description of the sensitivity of the receiving environment, primarily the rural land immediately east of the discharge that is affected by the highest PM_{10} and SO_2 concentrations (exceeding guidelines). What is the potential for the use of this land to change?	Whilst the land is rural what is the potential for land use changes and for this area to be affected by the discharge of PM_{10} and SO_2 in excess of the relevant guidelines. Further, the use of this land as a buffer is a key mitigation measure for the discharge to air permit.	The land directly to the east of the Plant is zoned for rural purposes in accordance with the Southland District Plan. The Southland District Plan has recently gone through a public review, notification and hearing process and this land zoning was unchallenged by either the existing land owner or adjacent parties (i.e. Alliance Group Limited). Most of the provisions relating to the rural zone are now operative, and given that the Plan has only recently gone through substantial change it is reasonable to presume that this rural zoning will remain for the foreseeable future (at least 10 years until the next District Plan review). The primary purpose of the rural zone is for farming purposes. One principal dwelling per allotment is permitted in the rural zone, with additional dwellings permitted depending on the size of each allotment for the use of staff. Residential dwellings already exist on the properties that are immediately adjacent to the Lorneville Plant (refer Figure 4 of Appendix M of the AEE). The permitted activity rules also require that any dwelling is setback at least 150m from the property boundary of any adjacent wastewater treatment plant. Any further development of residential or other sensitive type land use activities would therefore

		trigger a consenting obligation under the Southland District Plan. It is therefore unlikely that any further intensification of residential development or other sensitive land uses will occur on these sites. In addition, it is noted that these sites are bounded by an existing industrial activity which is zoned accordingly in the Southland District Plan. Therefore any proposals to further develop these sites for more sensitive land use activities would need to consider the effects of doing so on the Lorneville Plant. Policies in both the Southland District Plan and regional plans seeks to avoid, remedy or mitigate reverse sensitivity effects so it would be required to demonstrate that this had been achieved should any further development of a residential or other sensitive nature occur in these areas.
A description of any anticipated plant expansion and whether or not the supplied modelling reflects the actual and likely effects of the proposed activity over the term of the consent. Or is it likely that the emissions from the site will remain at the status quo (as modelled) for the requested 35 years?	The emissions profiles used for modelling reflect current steam use. However, they do not allow for any expansion of the plant or increase in use of the current systems.	The coal fired boiler (CFB) steam output profiles used to define the air emission profiles were based on the 2013/2014 processing season when the new rendering plant was fully commissioned. The proposed ambient PM_{10} percentile concentrations limits are therefore based on the current processing rates, plant design and associated CFB operating profiles. The proposed conditions of consent will require Alliance to achieve these limits, including a requirement to reduce PM_{10} within five years of the consent being granted. Alliance will need to manage its processing activities and/or controls on the CFB so as to achieve these limits for the duration of the consent.

Inclusion of an annual check on the hydrolyser exhaust gas extraction to the boiler, or an explanation as to why the applicant considers this unnecessary.	It is considered appropriate that an annual check on extraction is included as this is the primary method of control for hydrolyser emissions.	Section 5.3 of the odour mitigation report (Appendix R to the AEE) recommends annual checking of the blood dryer's exhaust air extraction system that discharges this odorous stream through the CFB primary combustion air system. It is considered reasonable for Alliance to include the hydrolyser exhaust extraction as part of this annual check, especially as it is part of the same extraction and combustion system that targets the blood dryer.
Clarification of whether or not the meal room and loadout areas are the only direct discharges of odour on the site.	It is indicated that the meal room and loadout areas are the only source of direct odour discharges on site. However, in the background odour report odours directly attributed to rendering are noted as being detected beyond the boundary.	The meal room is the only rendering building that has its air directly vented to the atmosphere. However, historically there are reasons why rendering odours have been noticed beyond the site boundary. During the commissioning phase of the new rendering plant there were issues of odour, however these emissions are now effectively contained. Raw material odours associated with unloading operations at the new raw material reception building were also suspected of causing some rendering offal type odours beyond the site boundary, however the new extraction system which was installed in 2015 has controlled these emissions appropriately. The Golder Associates Report (Appendix F to the AEE) also observes that sulphide odours associated with the fellmongery wastewater are likely to have been noticed on certain occasions during the last few years, and some of these are likely to have been attributed by the community to the rendering plan operation.

We trust that this information will enable the continuation of the processing and public notification of the various consents. Should you wish to discuss or have any queries please do not hesitate to contact the undersigned directly.

Yours sincerely,
MITCHELL PARTNERSHIPS LIMITED

CLAIRE HUNTER

Email: claire.hunter@mitchellpartnerships.co.nz

cc: Frances Wise Alliance Group Ltd

Enc

ATTACHMENT A

Freshwater Solutions – Water Abstraction Assessment

TO REPLACE APPENDIX O

report

February 2016

Assessment of Effects of Alliance's Water Abstraction from the Oreti River

Submitted to:
Alliance Group Ltd

fresh water solutions
environmental consultants

Table of Contents

Index to Figures

Index to Tables

Appendices

1.0 Introduction

Alliance Group Limited (Alliance) is seeking to lodge applications for new resource consents to abstract water from the Oreti River for its Lorneville Plant in 2015. Water Permit 203358 is for the abstraction of water. Alliance is seeking resource consents to continue to abstract the same total daily volume (up to 22,500 m^3/s/day) at the same maximum rate (260 L/s). Land use consent 201227 allows Alliance to disturb the bed of the Oreti River to remove sediment for the purposes of maintaining the intake channel. This report assesses the effects of the water abstraction and maintenance of the intake channel. Raineffects Ltd were responsible for the hydrological assessment that forms part of this report. This report includes additions and amendments to the original report following comments from Ryder Consulting Ltd and Section 92 Request from Southland Regional Council (dated 26 January 2016).

While not subject to any minimum flow conditions on the existing permit, there is a requirement to introduce water conservation measures when flows become low in the river at the Wallacetown water level recorder. As a response, Alliance has to prepare a low flow contingency plan. This plan requires that water conservation measures commence at 50% below the 7 day mean annual low flow (7DMALF) and further measures when flows fall to 39% of the 7DMALF. The Alliance water take is located approximately 1 km downstream of the Riverton-Wallacetown Highway Bridge (Figure 1).

2.0 Assessment Methodology

2.1 Background

There is a growing trend in flow assessments away from simply setting a minimum flow towards recognising the importance of ecological flows including the strong influence that flow variability has on in-stream communities (MfE 2008). The selection of an appropriate in-stream flow assessment methodology depends on a range of factors including aquatic biological community values and management objectives. Factors that were considered in this assessment included:

- Spawning and rearing habitat.
- Habitat for food sources.
- Adult habitat and cover.
- Access to spawning and rearing areas.
- Passage for adults and juveniles.
- Water quality and temperature.

A desktop approach to the assessment of effects was applied for the following reasons:

- The small size of the take relative to the large flow in the river.
- The short section of non-tidally influenced river (~400 m) potentially affected.
- Insensitivity of the lower Oreti River due to channel morphology and tidal influence.
- Very minor effects that the abstraction has on key environmental flow characteristics due to the following:
  - Duration of minimum flow.
  - Accrual period length.
  - Small and medium flood frequency.

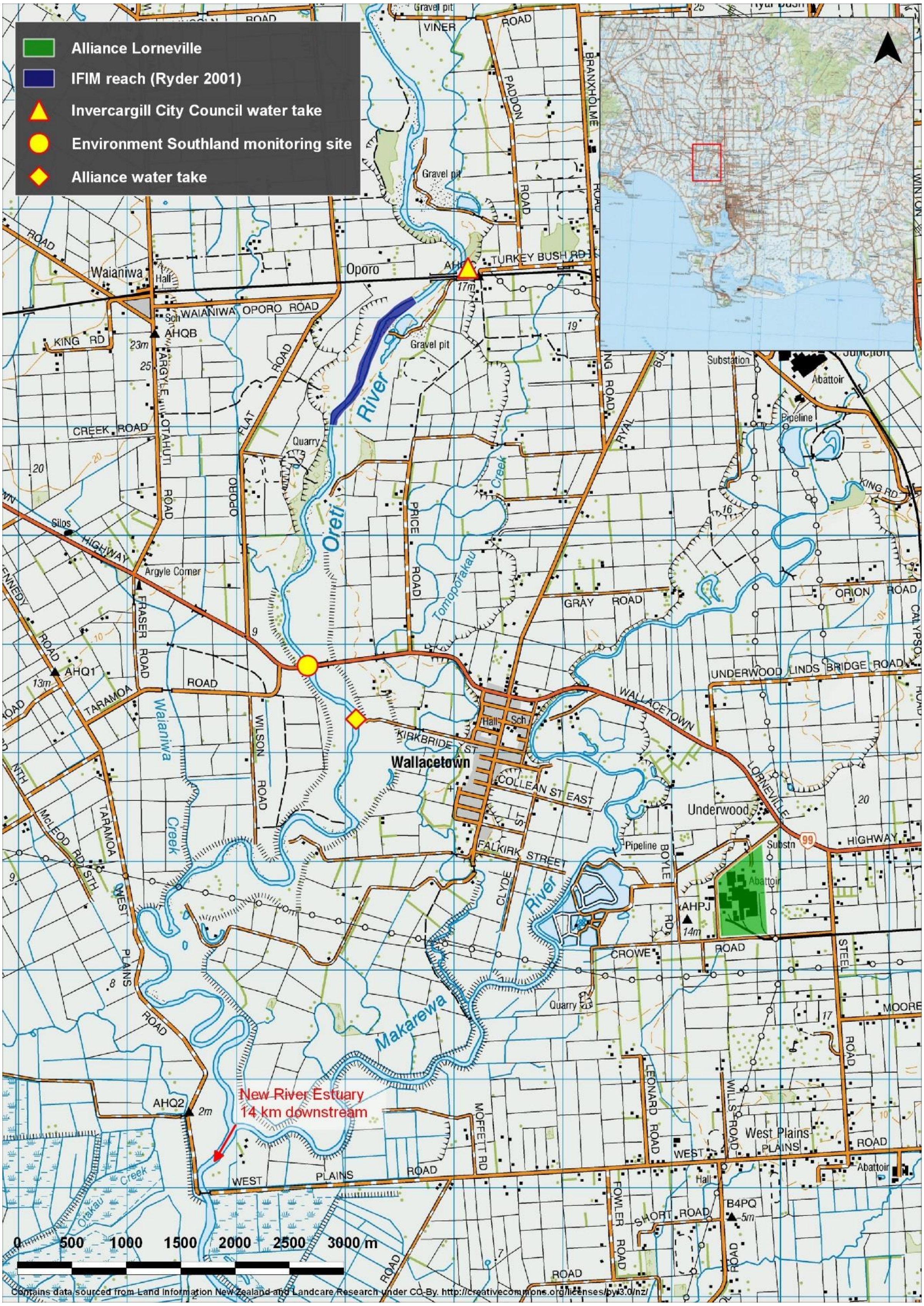


Figure 1: Location of water take.

Following a review by Ryder Consulting Ltd, Alliance opted to undertake a survey of periphyton and benthic invertebrate communities immediately upstream and downstream of the abstraction.

2.2 December 2015 Survey

Four sites were sampled during a survey carried out on 8 December 2015. There are two upstream sites (U1 and U2) and two downstream sites (D1 and D2). Sampling site details are provided in Table 1 and locations shown in Figure 2. Sites with very similar habitat (substrate size distribution, depth and velocity) were selected to minimise the effect of habitat differences on biological sampling results. All sites were located on the inside bend of the river where shallow gently sloping gravel beaches had formed and where the effects of any changes in water level associated with Alliance's take would be expected to be greatest. A 30 m survey reach within riffle habitat was identified at each site and was where all water physico-chemistry, habitat, periphyton and invertebrate data was collected.

Table 1: Sampling sites.

Site	Location	NZTM Easting	NZTM Northing	Description
U1	Upstream	1235863.943	4858530.071	300 m upstream of abstraction channel
U2	Upstream	1235993.385	4858473.116	225 m upstream of abstraction channel
D1	Downstream	1235925.212	4857643.821	725 m downstream of abstraction channel
D2	Downstream	1235937.293	4857467.779	800 m downstream of abstraction channel

2.3 Water Quality

Physico-chemical parameters (temperature, dissolved oxygen, pH and conductivity) were made using calibrated handheld meters and a water sample was collected from each site on 8 December 2015 and analysed for the following:

- Total nitrogen.
- Total ammoniacal nitrogen.
- Total Kjeldahl nitrogen.
- Ammoniacal nitrogen.
- Nitrate nitrogen.
- Nitrite nitrogen.
- Dissolved inorganic nitrogen.
- Total phosphorus.
- Dissolved reactive phosphorus.

2.4 Aquatic Habitat

Aquatic and riparian habitat was assessed at each site. The following data was recorded from the same riffle habitat where periphyton and invertebrate samples were collected:

- Channel width (m) – visual estimate.
- Water depth (m) – five measurements at each site.
- Streambed substrate – percent boulder, cobble, gravel, sand/silt.

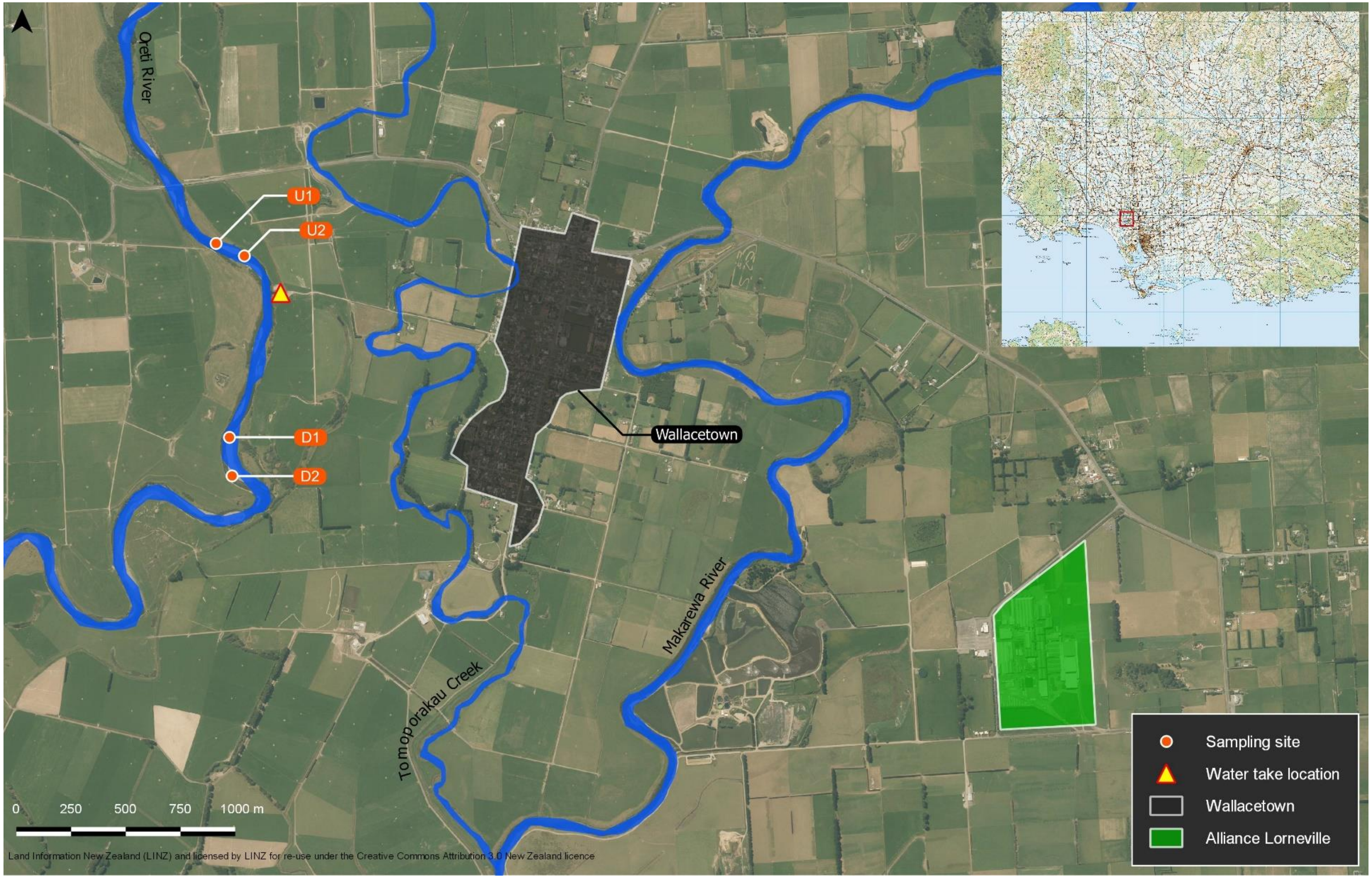


Figure 2: December 2015 sampling site locations.

2.5 Periphyton

Visual Assessment

Periphyton cover was assessed at each site using the Rapid Assessment Method (RAM 1) outlined in Biggs and Kilroy (2000). Periphyton cover was recorded at five points along four transects within riffle habitat where periphyton and invertebrate samples were collected. Periphyton cover results were compared with the Ministry for the Environment (MfE) and Environment Southland guidelines for diatom and filamentous green algae cover. MfE guidelines are outlined in Biggs (2000) (Table 2). Environment Southland guidelines for periphyton cover are the same as recommended by the MfE (i.e., <60% cover of diatoms and <30% cover of filamentous algae). Samples for the analysis of chlorophyll-*a* and ash free dry weight (AFDW) biomass were not collected during the December 2015 survey as there was virtually no algal material to collect and sampling would not have provided meaningful or reliable results.

Table 2: MfE guidelines for periphyton growing in gravel/cobble bed streams.

Value to protect	Item	Diatoms	Filamentous algae
Aesthetic/recreation [1]	Maximum cover of visible stream bed	60% >3 mm thick	30% >20 mm long
	Maximum AFDW (g/m^2)	N/A	35
	Maximum chlorophyll-*a* (mg/m^2)	N/A	120
Benthic biodiversity	Maximum chlorophyll-*a* (mg/m^2)	50	50
Trout habitat & angling	Maximum cover of whole stream bed	N/A	30% >20 mm long
	Maximum AFDW (g/m^2)	35	35
	Maximum chlorophyll-*a* (mg/m^2)	200	120

Note: [1] Refers to the period between 1 November and 30 April.

2.6 Benthic Macroinvertebrates

Five benthic macroinvertebrate samples were collected from each site using a Surber sampler (0.1 m^2 area; 500 µm net mesh) and following Protocol C3 for quantitative hard-bottomed river sampling outlined in Stark et al. (2001). Samples were preserved in 70% ethanol and identified by an experienced taxonomist using Protocol P3 (full count with sub-sampling option) from Stark et al. (2001).

Biological indices and metrics calculated from invertebrate data to assess community health and indicative habitat and water quality included taxa number, EPT taxa number, %EPT values and Quantitative Macroinvertebrate Community Index (QMCI). Macroinvertebrate Community Index (MCI) values are not presented as the QMCI is more relevant when assessing potential effects when quantitative data has been collected. A brief description of each of the metrics/indices used in this report is presented below:

- *Community composition* – relative abundance of the main taxonomic groups making up the macroinvertebrate communities recorded from each watercourse. Can be used to provide a general indication of stream health based on the relative proportions of water and habitat sensitive and tolerant taxonomic groups.
- *Taxa number* – a measure of the overall health of the macroinvertebrate community and of habitat and water quality. In general, high taxa number can be an indication of a healthy waterway. The number of taxa can be highly variable and can fluctuate

depending on many factors including habitat, water quality and sampling effort.

- *EPT taxa number* – a measure of the overall health of the community and of habitat and water quality. A community that has a higher number of water and habitat sensitive taxa from the groups Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) (EPT) indicates a healthy community and stream.
- *Percent EPT (%EPT)* – another measure of suitability of the waterway for supporting water and habitat sensitive taxa. A benthic macroinvertebrate community that has a higher percentage of water and habitat sensitive taxa from the EPT groups indicates a healthier waterway.
- *Macroinvertebrate Community index (MCI)* – the MCI is a presence/absence based index for measuring stream health and in particular organic enrichment. Individual taxa scores range from 1 (pollution tolerant) to 10 (highly pollution sensitive). MCI scores range from <80 (poor) to >120 (excellent) and are interpreted following the guidelines in Table 3.
- *Quantitative Macroinvertebrate Community Index (QMCI)* – the QMCI is a quantitative variant of the MCI and is used for measuring stream health and in particular organic enrichment. Individual taxa scores range from 1 (pollution tolerant) to 10 (highly pollution sensitive). QMCI scores range from <4.00 (poor) to >6.00 (excellent) and are interpreted following the guidelines in Table 3.

Table 3: QMCI classes and indicative stream health (Stark and Maxted 2007).

Stream health	Descriptions	MCI	QMCI
Excellent	Clean water	>120	>6.00
Good	Doubtful quality/possible mild pollution	100–120	5.00–5.99
Fair	Probable moderate pollution	80–100	4.00–4.99
Poor	Probable severe enrichment	<80	<4.00

2.7 Statistical Analysis

Statistical analysis was carried out on macroinvertebrate metric/index variables (taxa number, EPT, %EPT and QMCI). All variables were checked for normality prior to formal comparisons using the Shapiro Wilks W-test. All data conformed to normality assumptions. Differences between sites and locations were analysed using a nested ANOVA model with sites (U1, U2, D1 and D2) nested within location (upstream and downstream). If significant differences were detected between nested sites or between locations, a Tukey's HSD mean comparison test was performed to determine where differences occurred. All statistical significance was determined at the 0.05 level. Statistical analyses were undertaken using RStudio (RStudio Inc. 2009, vers. 0.98.501).

2.8 Assessment of Effects Approach

Potential effects of the abstraction were assessed using the following information:

- River flow record.
- Water quality and ecological information collected by Environment Southland.
- Water quality guidelines set out in the Environment Southland Regional Plan.
- Nutrient and flow guidelines in the MfE periphyton guidelines (Biggs 2000).

- Aquatic habitat assessment upstream of the Riverton-Wallacetown Highway Bridge (Ryder Consulting 2001; see Figure 1 for survey location).
- Results of a water quality and ecology survey of the Oreti River immediately upstream and downstream of the water take on 8 December 2015.

The focus of this assessment is on assessing the potential effects that the maximum total daily volume and maximum rate of abstraction has on low flow, accrual period length, flow variability and the consequent effects on water quality, biological communities and recreational values. Low or minimum flows set the amount of habitat potentially available for use by biological communities while flow variability is a critical element in determining water quality, periphyton and benthic invertebrate community health, as well as potentially influencing native fish and trout populations. Biologically important components of a river's hydrological regime are:

- Magnitude and duration of minimum flow.
- Magnitude, frequency and duration of flushing flows.
- Magnitude, frequency and duration of flood flows.

The ecologically relevant flow statistics in this assessment focused on the magnitude and duration of minimum flows and the magnitude, frequency and duration of ecologically relevant flows as these are directly relevant to assessing the effects of the abstraction. Flow statistics calculated in this assessment were:

- Mean Annual Low Flow (MALF).
- Number of days at or below MALF (natural simulated vs actual).
- Number of FRE1.5 (flow 1.5 times annual median flow), FRE2 (flow two times annual median flow), and FRE3 (flow three times annual median flow) events (natural simulated vs actual).
- Number of 20+ day, 30+ day, 40+ day, 50+ day 75+ day and 100+ day accrual periods (periods between FRE events) (natural simulated vs actual).

These flow statistics have been used along with published water quality and ecology data collected from close to the abstraction point to assess the effects of the take. Potential effects of the intake channel maintenance were assessed using the following information:

- Observations by Alliance staff of fish within the water treatment system.
- Visual observation of the habitat within the intake channel.
- Known fish migration timing and behaviour.
- The nature, extent and frequency of the intake channel cleaning activities.

3.0 The Oreti River and Abstraction Channel

3.1 Physical Description

Abstraction Channel

The water take is via a pump located at the end of a 45 m long artificial intake channel located on the true-left bank of the river. Views of the artificial intake channel and water take structure are shown in Figure 3 to Figure 6.

Figure 3: View of the Alliance water take from the Oreti River.

Figure 4: View of the Alliance water take and Wallacetown Highway Bridge.

Figure 5: View of the artificial channel from which Alliance takes water.

Figure 6: View of the Alliance water take structure.

Oreti River

The Oreti River is approximately 195 km long and has a catchment area of 3,400 km^2 (Ryder Consulting Limited 1995). The headwaters of the Oreti River are located in the Mavora Lakes and Eyre Mountains (Figure 7). Figure 7 shows the catchment area to the Wallacetown flow gauging site (black line) and the remaining catchment area to the estuary before it discharges into Foveaux Strait (red line).

Land use in the middle and lower reaches are dominated by sheep, cattle and deer farming. The Oreti River discharges into the New River Estuary near Invercargill City. The tidal influence (length of river where water level is influenced by the tide) extends 25.7 km up the Oreti River from the New River Estuary to approximately 1 km downstream of the Wallacetown Bridge (Chris Jenkins, pers. comm.). The extent of the tidal influence (water level fluctuation not salt water intrusion) is therefore from approximately 400 m downstream of the Alliance abstraction point to the estuary. Within the tidal reach, the Makarewa River joins the Oreti River. The Waikiwi Stream joins the Oreti River further downstream from the Makarewa and Oreti River confluence.

The Oreti River catchment downstream of Wallacetown has a maximum elevation of approximately 640 m. The lower Oreti River is characterised by a single channel and point bar dominated gravel-bed reach in the area between the Branxholme Railway Bridge and the Riverton-Wallacetown Highway Bridge (Ryder Consulting Limited 2001). Further downstream, the Oreti River naturally meanders within a single channel characterised by a series of long runs, shallow pools and occasional riffles.

The catchment area downstream of the Alliance intake is very substantial and it comprises about 40% of the total catchment area from the headwaters to the sea (Table 4). Compared to the upstream area, there is no significant high elevation areas for significant rainfall to occur.

The catchment to Wallacetown is long and relatively narrow. It contains a variety of landscapes including the mountainous headwaters with a maximum elevation of 2,035 m, the Five Rivers and Mossburn Plains, the lower hills surrounding the river as its travels from the Mossburn Plains to the Southland Plains, and the flat Southland Plains areas to the sea.

The catchment area downstream of Wallacetown is 1,379 km^2 and has a maximum elevation of about 640 m. This downstream catchment area has considerable importance as will be shown later in this report. The Makarewa River catchment which makes up most of this downstream area has an area of 1,127 km^2 to its confluence with the Oreti River. This confluence is about 9 km downstream of the Alliance intake on the Oreti River.

Table 4: Oreti Catchment areas.

Catchment	Area (km^2)
Oreti to Wallacetown	2,201
Oreti to Outlet	3,580
Total Area Downstream of Wallacetown	1,379
Makarewa Catchment	1,127

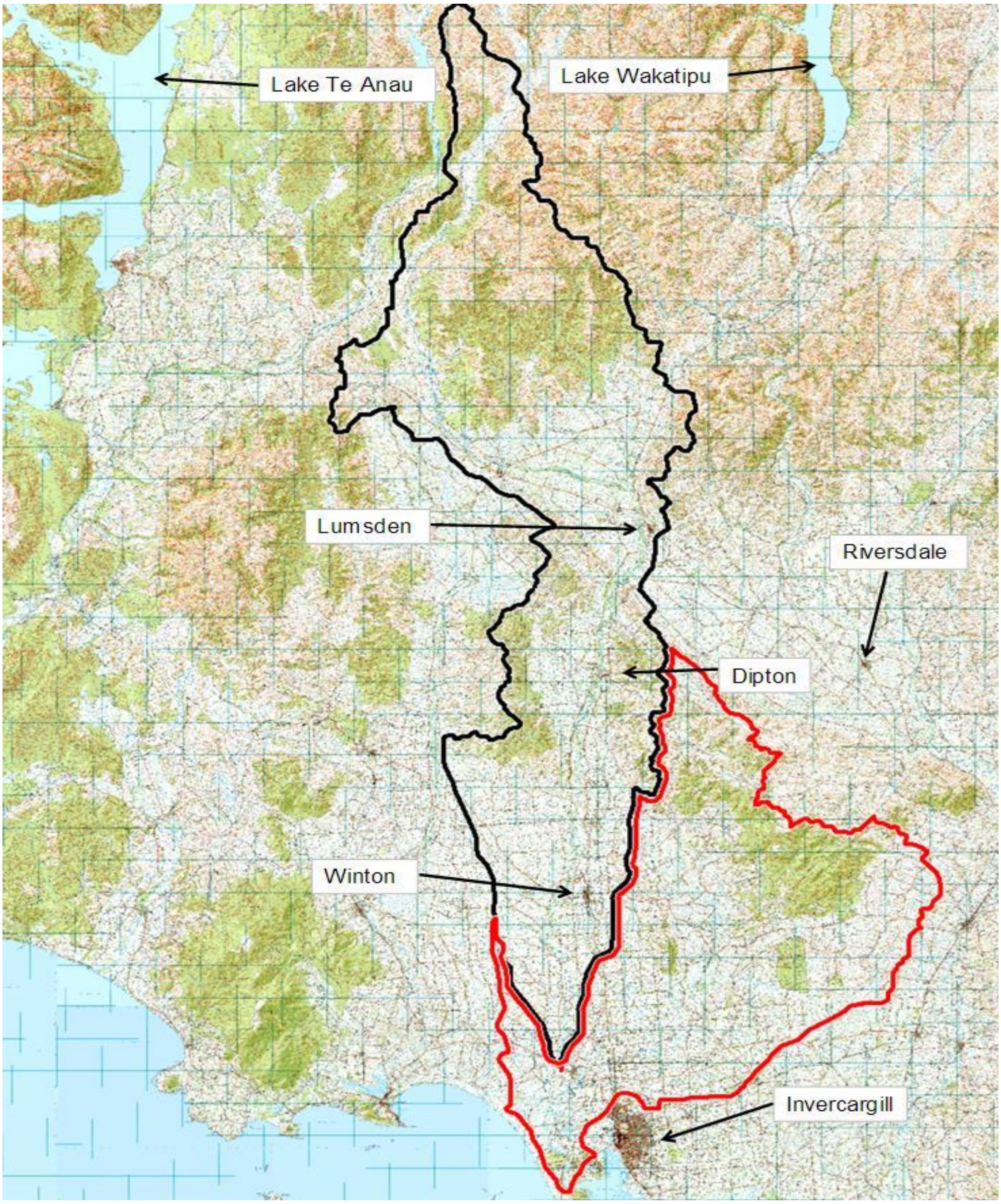


Figure 7: Oreti River Catchment.

3.2 Rainfall

Mean annual rainfall in this catchment varies from about 2,500 mm in the Oreti headwaters to around 750 mm near Lumsden. A review of rainfall annual distributions from 14 rain gauges both within and in close proximity to the Oreti Catchment shows that rainfall annual totals decrease with distance from the mountains to about Lumsden. Note that there are no rain gauges in the headwaters of the Oreti Catchment so rain gauges on either side of the catchment's headwaters have been used. The seasonal pattern is rainfall is generally lowest in February, July, August and September and highest in January, March, October and December (Figure 8).

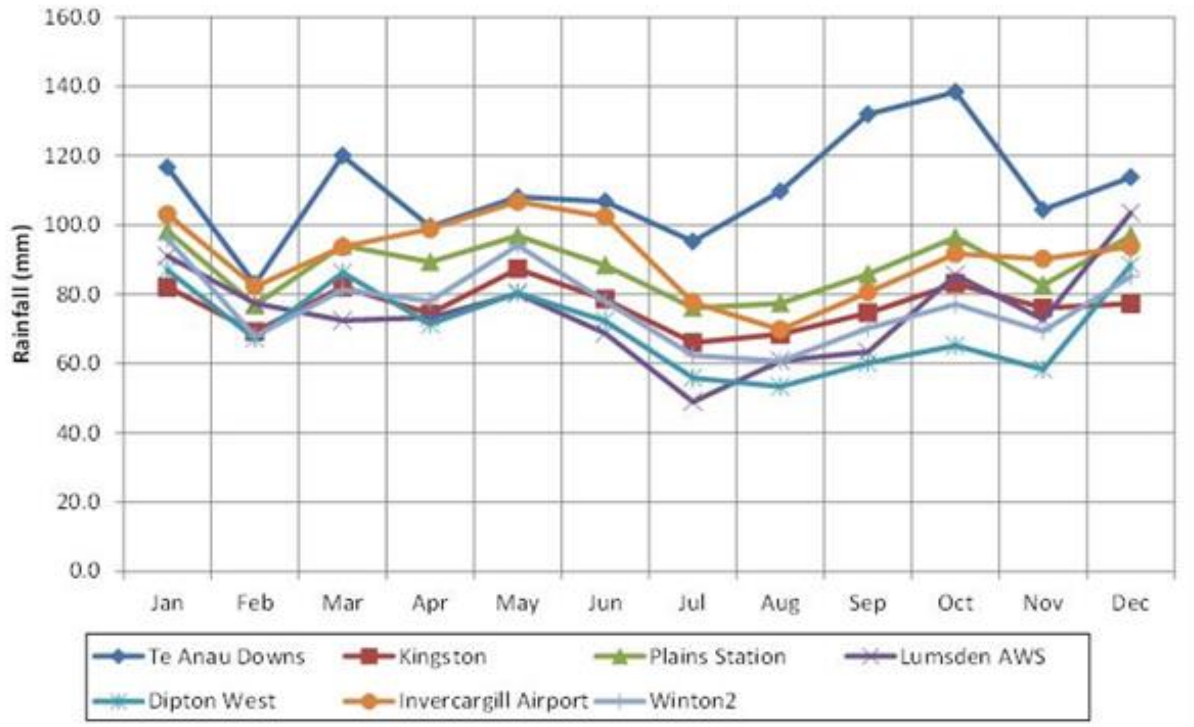


Figure 8: Monthly average rainfalls for various sites.

3.3 Hydrology

Tidal Effects

In the Oreti River, the tidal influence begins about 400 m downstream from the abstraction point. At this point on the river, the tidal influence will be minimal and essentially the flows will be as measured at the Wallacetown site less the Alliance abstraction.

With distance downstream, the effect of the tide will increase causing a slowing of the water velocity and an increase in water level. The incoming tide will result in higher water levels for varying periods of time either side of high tide. This time period of higher water levels will increase with distance downstream. As the tide goes out, the ponding of water will decrease so there is increasingly less water as low tide approaches. Note that flows will never be less than what is flowing in from upstream. The further downstream from the Alliance intake, the greater the tidal effect until a point is reached where the incoming tide will overwhelm the water flowing downstream and cause water to flow back upstream until high tide is reached. Once flow begins to be added to the river from downstream, then extra water is then in the system and the 7DMALF is compromised and is no longer applicable.

The tidal influence (length of river where water level is influenced by the tide but not salinity) extends 25.7 km up the Oreti River from the New River Estuary to approximately 1 km downstream of the Wallacetown Bridge (Chris Jenkins, pers. comm.) or approximately 400 m downstream of Alliance's abstraction. The extent of saline influence during high tide extends beyond the Ferry Road Bridge approximately 10 km upstream of the New River Estuary (Hicks et al. 2013). The Makarewa River joins the Oreti River some 10 km downstream of the Wallacetown Bridge with the Waikiwi Stream also joining before it discharges into the New River Estuary.

Flow Statistics

There is a continuous flow record for the Oreti at Wallacetown from 1 July 1977 to 31 August 2015. There are some gaps in this record but none of the gaps are big enough to prevent the use of any of the data in any one year. The ratings for this record have been recently reviewed over the entire record by Environment Southland and significant changes on earlier records have occurred. The flow statistics for the full record at Wallacetown is presented in Table 5.

Table 5: Measured flow statistics for the Oreti River at Wallacetown (1977–2015).

Site	Flows (L/s)					Specific discharge (L/s/km^2)	No. of events/yr		
	Mean	Median	Max	Min	7DMALF		FRE1.5	FRE2	FRE3
Wallacetown Actual	40,060	27,540	1,407,880	2,600	7,380	18.2	10.9	10.5	8.6

Note: Statistics are from the measured flows after irrigation and water supply abstractions upstream of the recorder site. Mean flow is the average flow over the entire period of record. Median flow is that where 50% of all measured flows are above this flow and 50% of them are less than that flow. Max is the maximum instantaneous flow measured at the recorder site. Minimum flow is the minimum instantaneous flow measured at the recorder site. 7DMALF is the average lowest flow measured over seven days and is calculated from the lowest flow averaged over 7 days in each year of record. Spec. disch. Is the specific discharge for the flow at the Wallacetown recorder. It is calculated by dividing the mean flow by the catchment area. FRE1.5, FRE2, and FRE3 are environmental flows which are calculated by counting the number of times daily mean flows are in excess of 1.5, 2 or 3 times the median flow in any one year. These flows will be discussed in more detail later in the report.

Natural Flows

The Regional Water Plan for Southland, March 2010 generally requires naturalised flows to be used for hydrology statistics when applying for abstraction permits (Glossary page 16 ‘Mean Annual Low Flow MALF)’ and footnote 41 and Glossary page 18 ‘Natural mean Flow’: and footnote 42). The footnote is common to both and it states: ‘Naturalised through the incorporation of the total volume of water allocated through current resource consents. It includes the stream depletion effect of each consented groundwater abstraction greater than 2 L/s with a direct, high or moderate degree of hydraulic connection in accordance with Policy 29 “Stream Depletion Effects’.

Raineffects Limited prepared a hydrology report in late 2012 for the Castlerock Farming Limited application to abstract surface water from the Oreti River. This application was to take water just downstream of Lumsden. As part of that assessment of effects, flows at Wallacetown were naturalised and analysed. The relevant sections of that report are included in this report as Appendix 1 (4.3 Natural Flows) and Appendix 2 (5.1.2. The Model).

As of 2 October 2012, the total calculated consented abstraction from the catchment was 1,528 L/s. Updated abstraction data have still to be received from Environment Southland and this can be incorporated into this report when it is received if required. The total of 1,528 L/s includes the Invercargill City Council (ICC) abstraction which has a maximum consented abstraction rate of 720 L/s. This abstraction has been occurring since before records began at Wallacetown in 1977. Available use records show that abstraction under this consent was about 370 L/s from 1977 to 2003 and about 300 L/s since then.

The total of 1,528 L/s also includes the Alliance abstraction of 260 L/s but it is downstream of the Wallacetown recorder so is not part of any naturalising of flows.

Of the other abstractions included in that total, some had not yet been exercised, some are groundwater abstractions with no connection to the Oreti River, and there are four abstractions totalling 35.5 L/s which may have impacted on the flow record at Wallacetown. Because they are groundwater abstractions and the total abstraction is less than 1% of the usual low flows at Wallacetown, it will not be measureable or detectable. Therefore the only significant abstraction that needs to be accounted for in flow naturalisation at Wallacetown is the ICC abstraction.

It was noted earlier that this abstraction was about 370 L/s from 1977 to 2003 and 300 L/s after that. These flows can be added back into the Wallacetown daily flow record and statistics derived from that amended record. Details of these calculations are included in Appendix 1 and 2.

Table 6 shows the modified flow statistics with the actual flow statistics included for comparison. Because the Alliance abstraction is almost immediately downstream of the Wallacetown recorder, the actual and naturalised flows will apply to that abstraction site. Table 6 shows that naturalising the Oreti River flow at Wallacetown results in a 1% increase in the mean flow and specific discharge and a 2% increase in median flow. There is a 4% increase in the 7DMALF value and the measured minimum flow would increase by 12% from 2,600 L/s to 2,970 L/s.

Table 6: Measured and naturalised flow statistics for the Oreti River at Wallacetown.

Site	Flows (L/s)					Specific discharge	No of events/yr		
	Mean	Median	Max	Min	7DMALF	($L/s/km^2$)	FRE1.5	FRE2	FRE3
Wallacetown Actual	40,060	27,540	1,407,880	2,600	7,380	18.2	10.9	10.5	8.6
Wallacetown Naturalised	40,410	28,160	1,408,180	2,970	7,700	18.4	10.8	10.4	8.4

Monthly and Annual Flow Patterns

The lowest flows are most likely in late summer to early autumn and late spring while highest flows can be expected in winter and early spring (Figure 9).

The monthly average rainfall totals from Figure 8 along with the average monthly flows from Figure 9 are presented in Figure 10.

Rainfall and flow maxima are generally not in phase with each other (Figure 10). This will be due to several reasons including:

- The climate of the headwaters is different to that of the downstream catchment and the flows reflect that.
- Seasonal snow accumulation and timing of melting in the catchment's headwaters is different to that of the more downstream catchment where on lower ground there will be no snow accumulation.
- Many sites show similar rainfall totals in summer and at other times of the year. There will be more runoff from the same rainfall total in winter compared to summer due to different temperatures and therefore evapotranspiration rates.

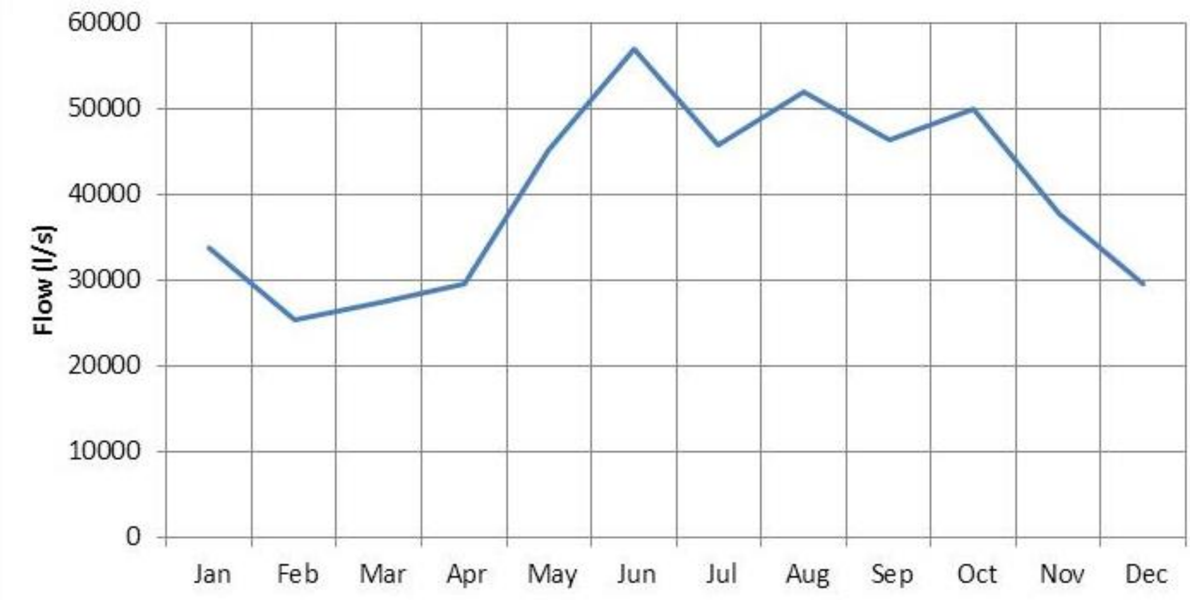


Figure 9: Monthly flow pattern for the Oreti River at Wallacetown.

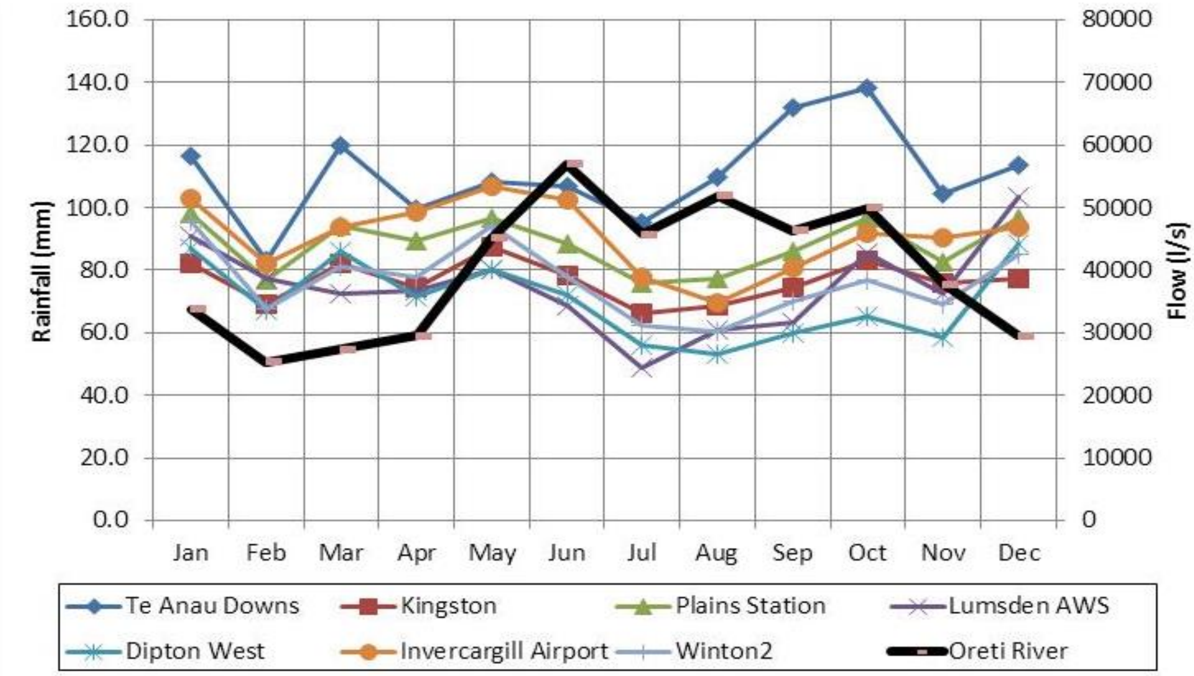


Figure 10: Average flows at Wallacetown and various average rainfalls.

Floods

Floods occur occasionally in the Oreti River. Floods can be 'up-river' floods which are generated in the catchment's headwaters but there is little or no contribution from the downstream catchment. In this case, flood peaks tend to reduce with distance downstream and this shows in the flow records for the upstream site at Lumsden and the downstream Wallacetown recorder site.

The biggest floods are usually generated by catchment-wide heavy rainfalls and these usually show a flow increase between the Lumsden and Wallacetown recorders.

Because the catchment between Lumsden and Wallacetown does not have any large tributaries, floods generated in the lower catchment only from more coastal rainfalls are not so significant although the Makarewa River can contribute significant flow downstream of the Wallacetown site.

7 Day Mean Annual Low Flow (7DMALF)

The Environment Southland website lists the 7DMALF for the Oreti River as 7,785 L/s which is very close to the naturalised 7DMALF of 7,700 L/s (see Table 6). The calculated 7DMALF for the period of record being used for this report (5 October 1977 to 31 August 2015) is 7,380 L/s. Following a review by Ryder and Associates Ltd we have included the 7DMALF using Environment Southland and the naturalised flow record. Unlike floods, low flows result from the whole catchment being relatively dry with limited runoff.

In most years, there are no flows less than 50% and 39% of the 7DMALF (7,785 L/s) that trigger the need for conservation measures under Alliance's current consent (Table 7).

Table 7: Summary of conservation measures under current consent.

Year	Days <50% of MALF	Days <39% of MALF
1978	23	7
1981	18	0
1990	3	0
1999	20	0
2001	10	0
2013	7	0

In February/March 1978, using the Environment Southland estimate of 7DMALF there was a 33 day period when flows were below 50% of 7DMALF (7,785 L/s). There was a period of 11 consecutive days from 13 to 23 February and a period of 12 consecutive days from 9 to 20 March. Flows rose and fell in the intervening 13 day period. There was a 6 day consecutive period from 14 to 19 March when flows were below the 39% of 7DMALF flow.

In 1981, 10 of the 18 days were consecutive from 9 to 19 February and there was a 5 day consecutive period from 2 to 6 March. Note there were no days below the 39% of 7DMALF flow in 1981.

In 1999, 18 of the 20 days were consecutive from 13 February to 2 March. There were no days below the 39% of 7DMALF flow.

In 2001, there were 10 consecutive days of flows below 50% of 7DMALF. These occurred from 19 to 28 March. There were no days below the 39% 7DMALF flow.

In 2013, there were consecutive days of flows below 50% of 7DMALF from 13 to 17 March. There were no days below the 39% of 7DMALF flow.

Summary

The key findings from the analysis of hydrology in the Oreti River based on flow data from the Wallacetown recorder were:

- Mean flow: Measured = 40.06 m^3/s; Naturalised = 40.41 m^3/s
- Median flow: Measured = 27.54 m^3/s; Naturalised = 28.16 m^3/s
- Minimum flow: Measured = 2.60 m^3/s; Naturalised = 2.97 m^3/s.
- 7 Day Mean Annual Low Flow: Measured = 7.38 m^3/s; Naturalised = 7.70 m^3/s.
- FRE3 (number of flow events/year exceeding 3 times annual median flow): Measured = 8.6; Naturalised = 8.4.

The analysis of monthly and annual flow patterns showed that the lowest river flows occurred in December, February, March and April and the highest flows in winter and spring.

In most years, there are no flows less than 50% and 39% of the 7-day MALF that trigger the need for conservation measures under Alliance's current consent.

4.0 Water Quality and Ecology

4.1 Water Quality

Environment Southland Data

Environment Southland has monitored water quality in the Oreti River upstream of Alliance's water take at the Riverton-Wallacetown Highway Bridge since 2000. There is no water quality data available for the Oreti River downstream of Alliance's take. The Riverton-Wallacetown Highway Bridge site is classified by Environment Southland as 'lowland hard bed'. The site is approximately 10 km upstream of the confluence with the Makarewa River and 1 Km upstream of Alliances take. The following key points summarise water quality data collected by Environment Southland at the Riverton-Wallacetown Highway Bridge site between 2005 and 2010 and reported in Environment Southland (2012) (the most recent state of the environment report available):

- The DRP guideline of <0.01 g/m^3 used by Environment Southland (2012) was breached during 14% of sampling occasions between 2005 and 2010.
- The nitrate-nitrite guideline (<1.7 g/m^3) used by Environment Southland (2012) was breached on 24% of sampling occasions between 2005 and 2010.
- The unionised ammonia guideline (<0.034 g/m^3) used by Environment Southland (2012) was not breached between 2005 and 2010.
- The visual clarity guideline (>1.6 m) used by Environment Southland (2012) was breached on 26% of sampling occasions between 2005 and 2010.
- The faecal bacteria guideline (<1,000 cfu/100 mL) used by Environment Southland (2012) was breached on 18% of sampling occasions between 2005 and 2010.
- The temperature (<23°C and trout spawning temperature guideline (<11°C) used by Environment Southland (2012) were breached on 2% of sampling occasions

between 2005 and 2010.

The most recent 5 year trend data (median) from the Land Air Water Aotearoa (LAWA) website for Southland Regional Council collected data for the Riverton-Wallacetown Highway Bridge Site are:

- E-coli = 123n/100mL.
- Black disc (clarity) = 2.1 m.
- Turbidity = 2.6 NTU.
- Total nitrogen = 1.14 g/m^3.
- Ammoniacal-nitrogen = 0.006 g/m^3.
- Total phosphorus = 0.013 g/m^3.
- Dissolved reactive phosphorus = 0.006 g/m^3.

None of the parameters monitored by the Southland Regional Council at the Riverton-Wallacetown Highway Bridge Site and presented on the LAWA website showed any trend in the last 5 years.

December 2015 Data

All water quality parameters were very similar among sites (Table 8) and below the relevant Southland Regional Water Plan water quality guidelines.

Table 8: Oreti River water quality on 8 December 2015.

Parameter	D1	D2	U1	U2
Temperature (°C)	12.6	12.6	13.6	13.6
Dissolved oxygen	10.4	10.4	10.0	10.0
pH (pH units)	8.1	8.1	7.7	7.7
Conductivity (mS/m)	54.0	52.0	63.0	62.0
Ammoniacal Nitrogen	<0.01	<0.01	<0.01	<0.01
Nitrite Nitrogen	0.002	0.002	0.003	0.003
Nitrate Nitrogen	0.57	0.57	0.58	0.58
Total Nitrogen	0.72	0.76	0.73	0.72
Total Kjeldahl Nitrogen	0.15	0.18	0.15	0.14
Dissolved Inorganic Nitrogen	0.58	0.59	0.59	0.59
Total Phosphorus	0.009	0.006	0.009	0.10
Dissolved Reactive Phosphorus	0.007	0.007	0.007	0.007

Note: All units (g/m^3) unless stated.

4.2 Aquatic Habitat

Background Data

The Oreti River is a cobble and gravel dominated hill-fed river. The section of the Oreti River at the Alliance water take and downstream flows as a mostly single thread meandering channel. The river between the Wallacetown Highway Bridge and the Makarewa River confluence is constrained between steep banks with occasional wider sections where beaches and riffles have formed (Figure 11 and Figure 12). River bed sediments in the reach immediately above and below Alliances water take are dominated by coarse and fine gravels (Figure 13 to Figure 16) and further downstream (immediately upstream of the Makarewa River confluence) by coarse and fine sands. The increase in finer substrates downstream reflects the increasing influence of the tide on water velocity (Figure 11).

Figure 11: View of Oreti River downstream of the Alliance water take.

Figure 12: View of Oreti River approximately 5 km downstream from Alliance take.

December 2015 Results

A view of the habitat at Sites U1, U2, D1 and D2 during the December 2015 water quality and biological survey are shown in Figure 13 to Figure 16. Aquatic habitat was similar among sites and characterised by a predominance of gravels, small cobbles and sand, moderate water velocities (0.4–0.9 m/s) and mean depths at each site ranging from 0.29 m at Site U2 to 0.41 m at Site D2.

Figure 13: View of Oreti River at Site U1 in December 2015.

Figure 14: View of Oreti River at Site U2 in December 2015.

Figure 15: View of Oreti River at Site D1 in December 2015.

Figure 16: View of Oreti River at Site D2 in December 2015.

4.3 Periphyton

Background Data

Water quality and aquatic habitat conditions in the Oreti River at and upstream and downstream of the Riverton-Wallacetown Highway Bridge are suitable for supporting healthy periphyton communities. The following key points summarise ecological data collected by Environment Southland on the Oreti River immediately upstream of the Riverton-Wallacetown Bridge between 2005 and 2010 (Environment Southland 2012):

- Chlorophyll-*a* concentrations at the Riverton-Wallacetown Bridge exceeded the MfE guideline for filamentous algae in Biggs (2000) and the Environment Southland standard in the Regional Water Plan for filamentous algae of 120 mg/m^3 on 40% of occasions.
- AFDW of periphyton recorded at the Riverton-Wallacetown Bridge met the MfE guideline of <35 g/m^3 on all sampling occasions.

Chlorophyll-*a* concentrations at the Riverton-Wallacetown Bridge site has remained below the MfE guideline for filamentous algae in Biggs (2000) and the Environment Southland standard in the Regional Water Plan for filamentous algae between 2011 and 2014.

Nuisance algal growths such as cyanobacteria mats occur in the Oreti River during stable summer low flows. Didymo is present in the Oreti River but is not understood to form extensive mats in the lower river.

Cyanobacteria species such as *Phormidium* can form extensive mats in the lower Oreti River around Wallacetown during summer low flow conditions. The consumption of cyanobacteria can be toxic to animals and humans and has been responsible for dog deaths in Southland. Cawthron (2010) reported that flow is negatively correlated with cyanobacteria mat growth and that an increase in flow results in a decrease (or total removal) of cyanobacteria mats. Although extensive cyanobacteria mats have formed across a range of river water temperatures in Southland (Cawthron 2010), nuisance growth generally occurs during warm summer months and at times of low flow.

The lack of shallow riffle areas with stable large cobble substrates downstream of the abstraction point is likely to limit the diversity and abundance of periphyton and reduce the likelihood of nuisance algal growths occurring downstream of the abstraction point due to flow related effects.

December 2015 Results

The periphyton communities recorded at all sites during the December 2015 survey were totally dominated (100% cover) by thin diatoms (<0.3 cm thick) with no filamentous green algae or other nuisance growths recorded. Streambed cover by diatoms/cyanobacteria (>0.3 cm thick) and filamentous algae (>20 cm long) were well below the respective MfE and Environment Southland guidelines (<60% cover and 30% cover respectively) at all sites during the December 2015 survey. Visual observations indicated that chlorophyll-*a* and AFDW was very low and well below the relevant guidelines at all sites.

4.4 Benthic Invertebrates

Background Data

Water quality and aquatic habitat conditions in the Oreti River immediately upstream of the Riverton Highway Bridge are suited to supporting a moderately healthy benthic macroinvertebrate community. The median MCI score at Wallacetown Bridge between 2005 and 2010 was 95 and above Environment Southland's hard-bottomed lowland stream threshold of 90 on all sampling occasions. The benthic invertebrate community recorded at the Wallacetown site was dominated by the mayfly *Deleatidium* and Elmidae beetles (Kingett Mitchell 2005). The median MCI score at the Wallacetown site decreased from 101 (between 1996 and 2004) to 95 (between 2005 and 2010) and is mostly likely attributed to upstream land use intensification and declining water quality over this period. The MCI score in 2011, 2012 and 2013 were 94, 99 and 91 respectively. Data for 2014 and 2015 was not supplied by the Southland Regional Council.

The lower Oreti River in proximity to and downstream of Alliance's abstraction point is suited to supporting a range of water and habitat tolerant and sensitive taxa. Taxa tolerant of fine sediments and slow flowing water including cased caddis, snails, worms and chironomids likely to occur in the slow flowing areas. Sensitive taxa are more likely to occur in the shallow cobble dominated riffles. The lack of shallow riffle areas in the strongly tidally influenced section of the river is likely to limit the diversity of the benthic invertebrate community with the community in that section of the river likely to be dominated by water and habitat tolerant taxa.

December 2015 Results

The relative abundance of the major benthic invertebrate groups was similar among sites with the community dominated by ephemeropterans (mayflies) and oligochaetes (worms) at all sites (Figure 17). The relative abundance of mayflies and worms at Sites D1 and D2 was slightly lower and higher respectively compared to Sites U1 and U2 (Figure 17). The slightly higher relative abundance of oligochaetes at the downstream sites is most likely to be related to a decrease in the gradient of the river and an increase in the proportion of depositional zones preferred by oligochaetes.

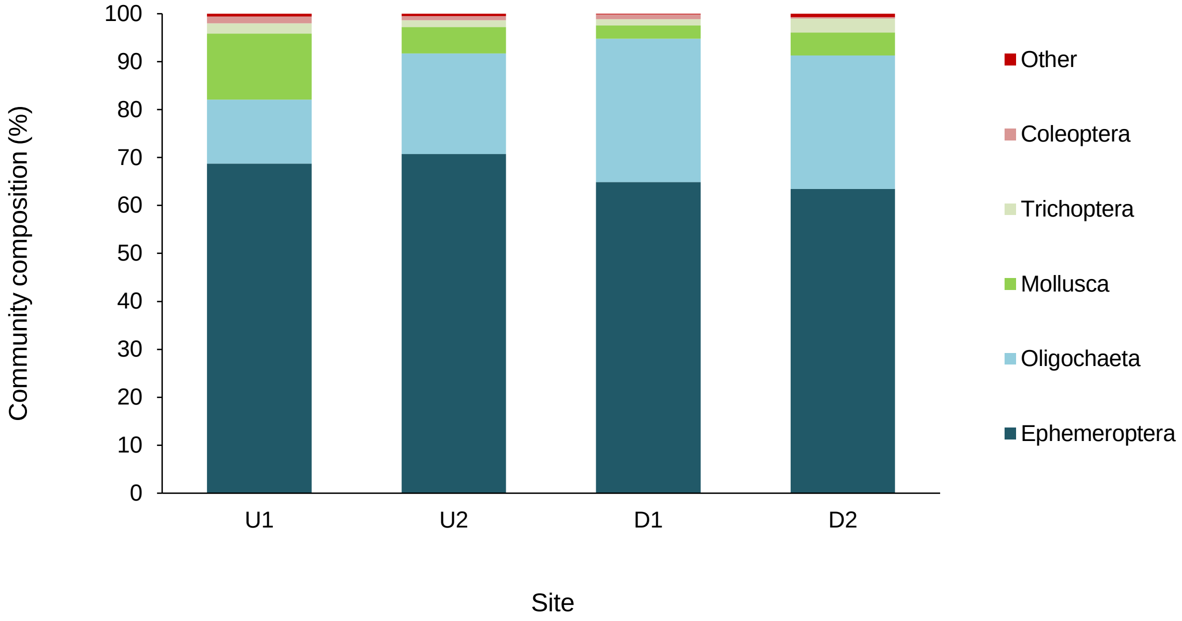


Figure 17: Relative abundance recorded in December 2015.

Mean taxa number ranged between 9 ± 1.3 at Site D1 and 10 ± 0.8 at Site D2 (Figure 18) and was similar between sites and between upstream and downstream locations (p >0.05).

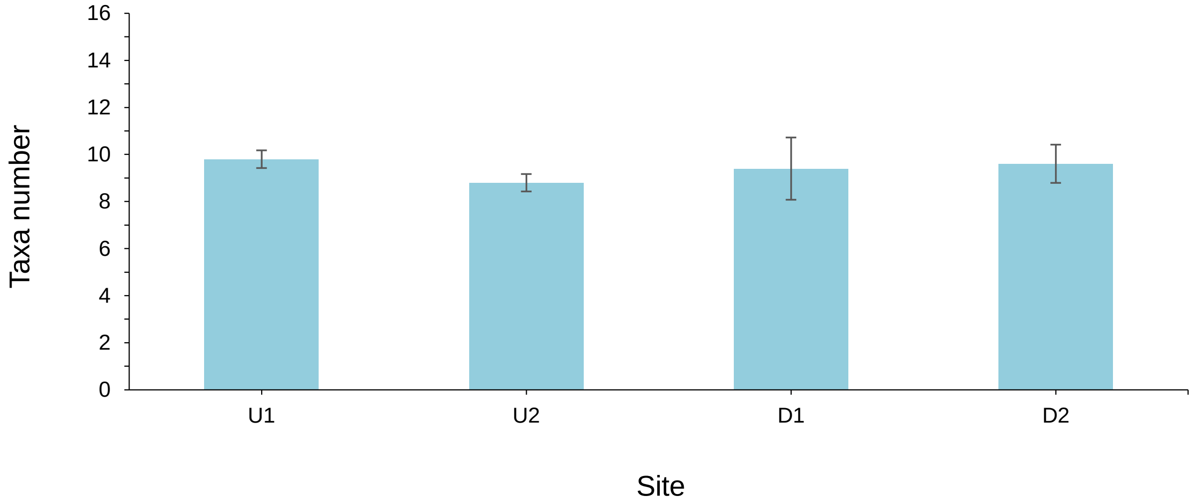


Figure 18: Mean total taxa number recorded in December 2015.

Mean EPT taxa number was low and ranged between 4.2 ± 0.5 at Site U1 and 5.2 ± 0.7 at Site D2 (Figure 19). There was no significant difference in mean EPT taxa number between sites or between upstream and downstream locations (p >0.05).

The mean number of EPT taxa recorded downstream (mean = 5.0) was however slightly higher than that recorded upstream (mean = 4.2). The EPT fauna recorded at upstream and downstream sites was generally similar with *Deleatidium* (mayfly), *Aoteapsyche* (caddisfly) and *Pycnocentrodes* (caddisfly) recorded across all sites and in most replicate samples. *Deleatidium* was the only mayfly recorded at sites during the survey. EPT taxa recorded upstream but not downstream were *Ecnomina* and *Polyplectropus* caddisflies whilst EPT taxa recorded downstream but not upstream were *Costachorema*, *Plectrocnemia* and *Psilochorema* caddisflies. These taxa were also recorded in low numbers (typically a single individual) and only in 1–2 replicate samples.

Overall, EPT taxa richness at upstream and downstream sites was similar with differences between sites influenced by the occasional presence of certain caddisfly taxa in low numbers in a few replicate samples.

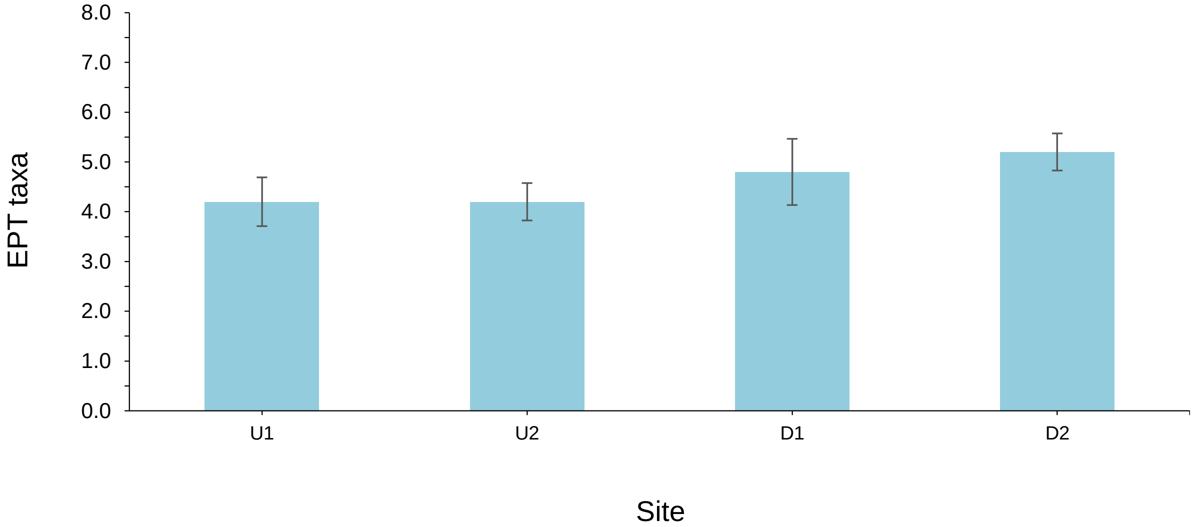


Figure 19: Mean EPT taxa number recorded in December 2015.

Mean percent EPT was high at sites and ranged between 61% ± 5 at Site D1 and 72% ± 7 at Site U2 (Figure 20). There was no significant difference in mean percent EPT values detected between sites or between upstream and downstream locations ($p > 0.05$).

Although not statistically significant, mean percent EPT was higher upstream (mean = 72%) than downstream (mean = 63%). The lower mean percent EPT value for the downstream location (Sites D1 and D2) compared with upstream (Sites U1 and U2) was not related to a decrease in EPT abundance (upstream = 3,413 individuals vs. downstream = 3,309 individuals) but rather an increase in Oligochaeta (worm) abundance at downstream sites (upstream = 912 individuals vs. downstream = 1,776 individuals) meaning EPT taxa represented a smaller proportion of overall community abundance downstream.

The similar abundance of EPT taxa upstream and downstream indicates the water take was not resulting in a decrease in the actual abundance of water and habitat sensitive taxa. The reason for the increase in the proportion of Oligochaeta making up the downstream communities is unknown and may be related to habitat factors such as an undetected minor increase in interstitial silt or fine detritus making up the streambed substrate.

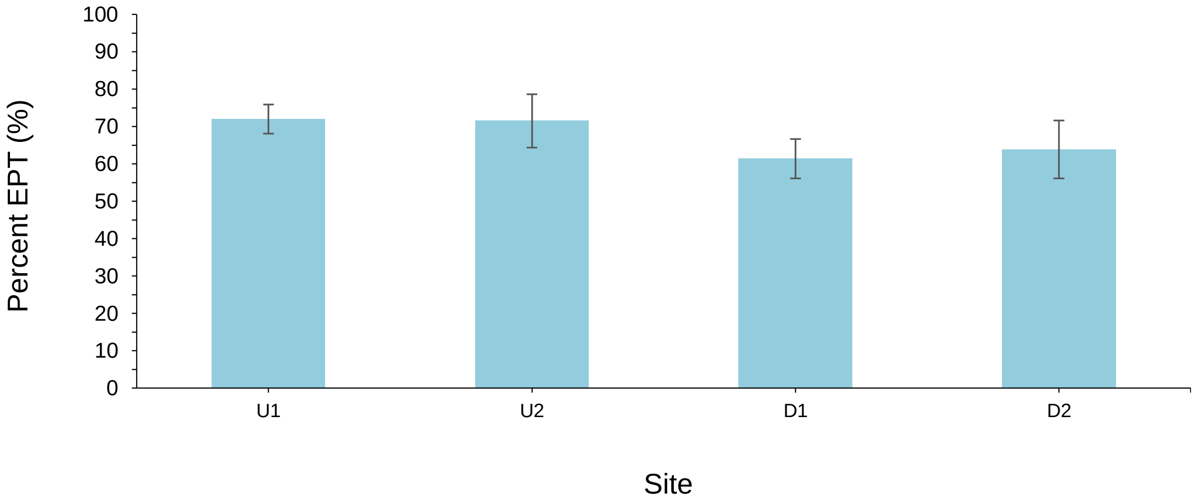


Figure 20: Mean percent EPT recorded in December 2015.

Mean MCI scores were similar across sites and ranged between 96 ± 4 for Site U2 and 102 ± 2 for Site U1. There was no significant difference in mean MCI score between sites or between upstream and downstream locations ($p > 0.05$). The similarities between mean MCI scores across sites indicates there was not a decrease in the number of water and habitat sensitive taxa downstream of the water take. Mean MCI scores for Sites U2 and D2 placed these sites in the 'fair' water quality class whilst mean MCI scores for Sites U1 and D1 placed these sites in the 'good' water quality class (Figure 21). Mean MCI scores for all sites were above Environment Southland's hard-bottomed lowland stream threshold of 90.

Mean QMCI scores ranged between 5.4 ± 0.4 for Site D1 and 6.4 ± 0.2 for Site U1 (Figure 22). There was no significant difference detected between sites or between upstream and downstream locations ($p > 0.05$). Although there was no statistically significant difference detected between upstream and downstream locations, mean QMCI scores were higher upstream (mean = 6.3) than downstream (mean = 5.5).

The lower mean QMCI score for the downstream location reflected an increase in the relative abundance of Oligochaeta (MCI indicator score = 1) at downstream sites (representing 32–35%) compared with upstream sites (representing 15–22%) and the corresponding downstream decrease in the relative abundance of water and habitat sensitive *Deleatidium* mayfly. The increase in Oligochaete abundance at downstream sites is most likely to be related to minor reach and site scale differences in fine sediment supply from river bank erosion and deposition amongst the cobble dominated substrate sampled.

All other taxa except Elmidae (Coleoptera) and *Potamopyrgus* (Mollusca) represented less than 1% of community abundance and did not influence QMCI scores. Elmidae (MCI indicator score = 6) represented between 0.2–1.4% and *Potamopyrgus* (MCI indicator score = 4) between 4–12% of community abundance across sites and would also not have significantly influenced QMCI scores for sites.

Mean QMCI scores for Sites D1 and D2 placed these sites in the 'good' water quality class whilst mean QMCI scores for Sites U1 and U2 placed these sites in the 'excellent' water quality class (Figure 22).

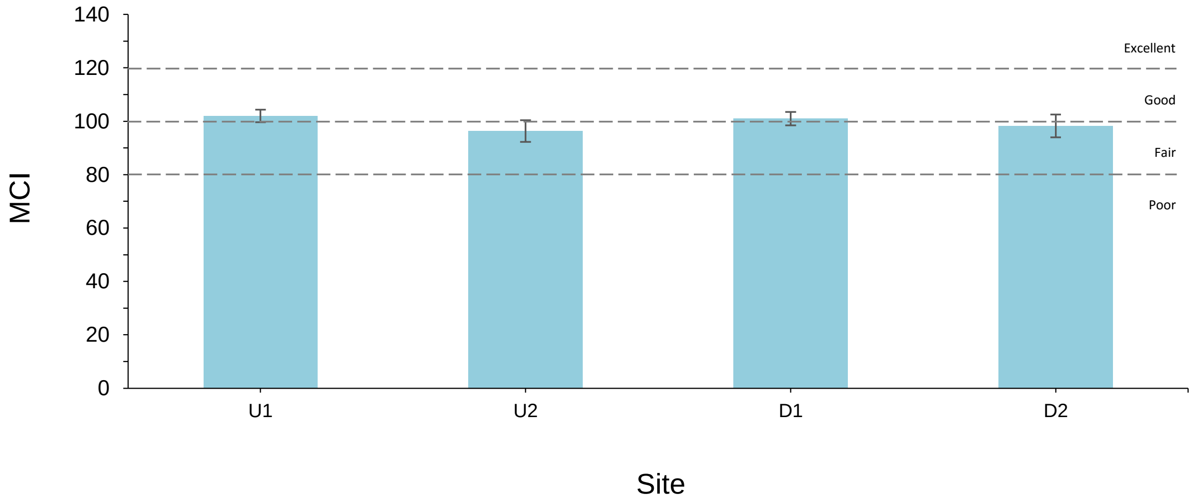


Figure 21: Mean MCI scores recorded in December 2015.

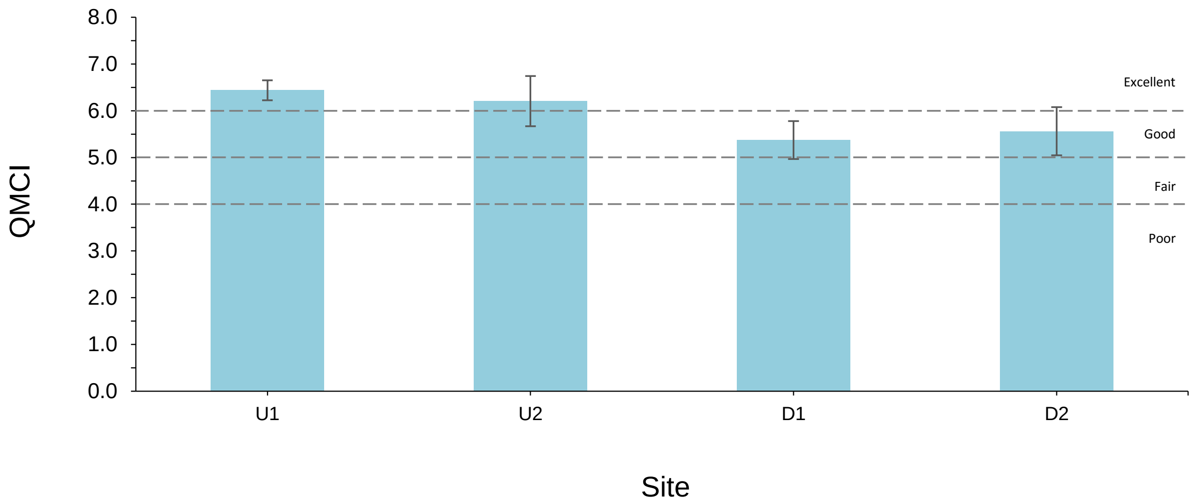


Figure 22: Mean QMCI scores recorded in December 2015.

4.5 Fish

The Oreti River supports a healthy native fish fauna classed as being ‘good quality’ based on the Index of Biotic Integrity (IBI) score (Wairesearch 2010). Twelve fish species had been recorded in the Oreti River catchment up until 2005 (Kingett Mitchell 2005) including:

- Longfin eel.
- Shortfin eel.
- Kōaro.
- Īnanga.
- Alpine galaxias.
- Lamprey.

- Upland bully.
- Common bully.
- Redfin bully.
- Common smelt.
- Black flounder.
- Perch.
- Brown trout.

In addition to the species recorded prior to 2005, Freshwater Solutions confirmed the presence of two new native fish species - *Galaxias fasciatus* (banded kōkopu) and *Galaxias argenteus* (giant kōkopu) in the Makarewa River. Fish surveys and the New Zealand Freshwater Fish Database (NZFFD) show that the Oreti River supports moderate to high native fish diversity including five species with an 'At Risk' classification (longfin eel, kōaro, giant kōkopu, īnanga and redfin bully) and one species with a Threatened 'Nationally Vulnerable' classification (lamprey) (Goodman et al. 2014).

The lower Oreti River supports a range of significant native fish values including recreational and commercial eel fishing, trout fishing and white baiting. The tidal interface supports whitebait spawning while the lower river itself is an important rearing and adult habitat for a range of species including eels, īnanga and trout. The lower Oreti is also an important migratory pathway for a range of fish species including eels, whitebait and bullies.

4.6 Recreational Values

Kingett Mitchell (2005) reported that the only detailed recreational survey carried out in the Oreti River catchment was undertaken in 1974–1975. The key finding from the survey was that a large number of recreational users downstream of Wallacetown were classified as 'onlookers' (66%) followed by boating (12%), picnicking (9%), swimming (8%) and angling (5%). Whitebaiting is popular along the tidal reach of the Oreti River as is duck shooting (Kingett Mitchell 2005).

The Oreti River supports a nationally significant brown trout fishery that receives moderate-high use (21,850 angler days in the 2007–2008 fishing season) with approximately 75% of use occurring downstream of Lumsden. By comparison, the Mataura River had 48,490 angler days in the 2007–2008 season and the Mararoa River having 1,520 angler days. The Oreti River was the seventh most heavily fished river out of the 33 rivers surveyed during the 2007–2008 national angler survey (NIWA 2009).

No information about recreational use of the section of river where the intake is located was identified and the extent and nature of the recreational use is therefore unknown.

Summary

The Oreti River water quality close to the Alliance water take is characterised by moderate nutrient concentrations, moderate-low visual clarity, low unionised ammonia concentrations, and water temperatures that are suitable for healthy river ecosystems.

The section of the Oreti River at the Alliance water take and downstream flows as a single moderately incised and meandering channel dominated by coarse and fine gravels near the Alliance water take and coarse and fine sands downstream.

Nuisance algal growths such as cyanobacteria mats occur in the Oreti River during stable summer low flows. Didymo is present in the Oreti River but is not understood to form extensive mats in the lower river.

Water quality and aquatic habitat conditions in the Oreti River are suited to supporting a moderately healthy benthic macroinvertebrate community. The median MCI score at Wallacetown Bridge between 2005 and 2010 was 95 and was above Environment Southland's hard-bottomed lowland stream threshold of 90 on all sampling occasions.

The periphyton community in December 2015 was characterised by the dominance of thin diatoms while the benthic invertebrate community at sites upstream and downstream of Alliance's take was dominated by mayflies, had low diversity and QMCI scores that range from 'good' downstream to 'excellent' upstream.

The Oreti River supports a healthy native fish fauna classed as being 'good quality' based on the Index of Biotic Integrity score.

A survey in the 1970s revealed that a large number of recreational users downstream of Wallacetown were classified as 'onlookers' followed by boating, picnicking, swimming and angling. Whitebaiting is popular along the tidal reach of the Oreti River as is duck shooting. The Oreti River supports a nationally significant brown trout fishery that receives moderate-high use.

5.0 Water Take Effects

5.1 Introduction

The abstraction of water has the potential to affect river flow, water quality, the quantity and quality of aquatic habitat, and can directly affect fish through the entrainment and impingement of fish on screens.

The minimum flow exerts a strong influence on the quantity of aquatic habitat while flow variability exerts a strong influence on habitat quality. The effect of the abstraction on flow variability was assessed by calculating the number of FRE1.5, FRE2 and FRE3 events, accrual period lengths (days between FRE3 events) and the duration at low flows. The following assessment of effects is based on the maximum allowable take (22,500 m^3/day at the current maximum rate (260 L/s).

5.2 Water Abstraction by Alliance

Monthly water usage by Alliance for the 2007/08 to 2012/13 seasons is presented in Table 9. Water usage in August to October is very low, increases in November and December, and peaks between January and May. June and July show decreasing usage compared to earlier months. Daily abstractions range from 0 to 18,743 m^3 (217 L/s). River flow and Alliance's abstraction (as flow) for the period between 2007 and 2014 are presented in graphs in Appendix 3 and show that the abstraction represents a very small proportion of river flow throughout the period.

Table 9: Monthly abstraction volume (m^3), average abstraction and average flow.

Season	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
2007/08	226,879	-	-	38,875	-	273,674	323,654	287,311	214,389	417,353	452,085	269,552
2008/09	130,725	29,550	46,201	59,192	186,901	260,437	376,334	378,655	368,478	287,961	289,967	181,580
2009/10	125,185	51,560	42,106	1,415	125,356	255,936	342,118	343,41	400,169	331,075	307,210	140,245
2010/11	53,482	45,912	38,826	29,029	89,876	223,073	301,259	300,319	385,003	330,331	317,300	170,666
2011/12	50,539	51,282	56,271	66,424	116,896	211,194	310,919	278,313	306,425	306,070	318,325	211,622
2012/13	89,054	40,688	90,912	34,678	105,929	191,166	310,471	293,377	330,198	316,910	235,693	135,195
2013/14	110,071	42,443	31,948	21,191	110,193	190,456	286,921	350,496	423,619	316,052	-	180,845
2014/15	125,224	123,245	-	-	-	-	-	-	-	-	-	-
Average abstraction (m^3)	113,895	54,954	51,044	35,829	122,525	229,419	321668	318845	346897	329393	320097	184244
Average flow (L/s)	43	21	20	13	47	86	120	132	130	127	120	71

5.3 River Reach Downstream

Alliance’s existing consent does not have a minimum flow so abstraction does not cease when flows fall below the minimum flow. Therefore the reach downstream of the Alliance abstraction site is the reach that will be most affected (Figure 23).

Approximately 400 m downstream of the Alliance abstraction site, flows and water levels in the Oreti River begin to be affected by tidal fluctuations. After discussions with Chris Jenkins from Environment Southland on 24 February 2014, it appears that by about 2.8 km downstream of the Alliance abstraction, spring tidal fluctuations in the river could be as much as approximately 1.2 m and during neap tides about 0.4 m.

It is apparent then that by 2.8 km downstream of the Alliance abstraction, the tidal influence is significant. Therefore there is likely to be a decreasing gradient of effects between the abstraction point and a point 2.8 km downstream of the intake where the tidal effect is expected to negate the effect of the ICC and Alliances takes. The greatest potential (albeit small) effect of Alliance’s abstraction on river water level and habitat availability is therefore in the non-tidal section of river immediately downstream and in the tidal section of the river during low tide.

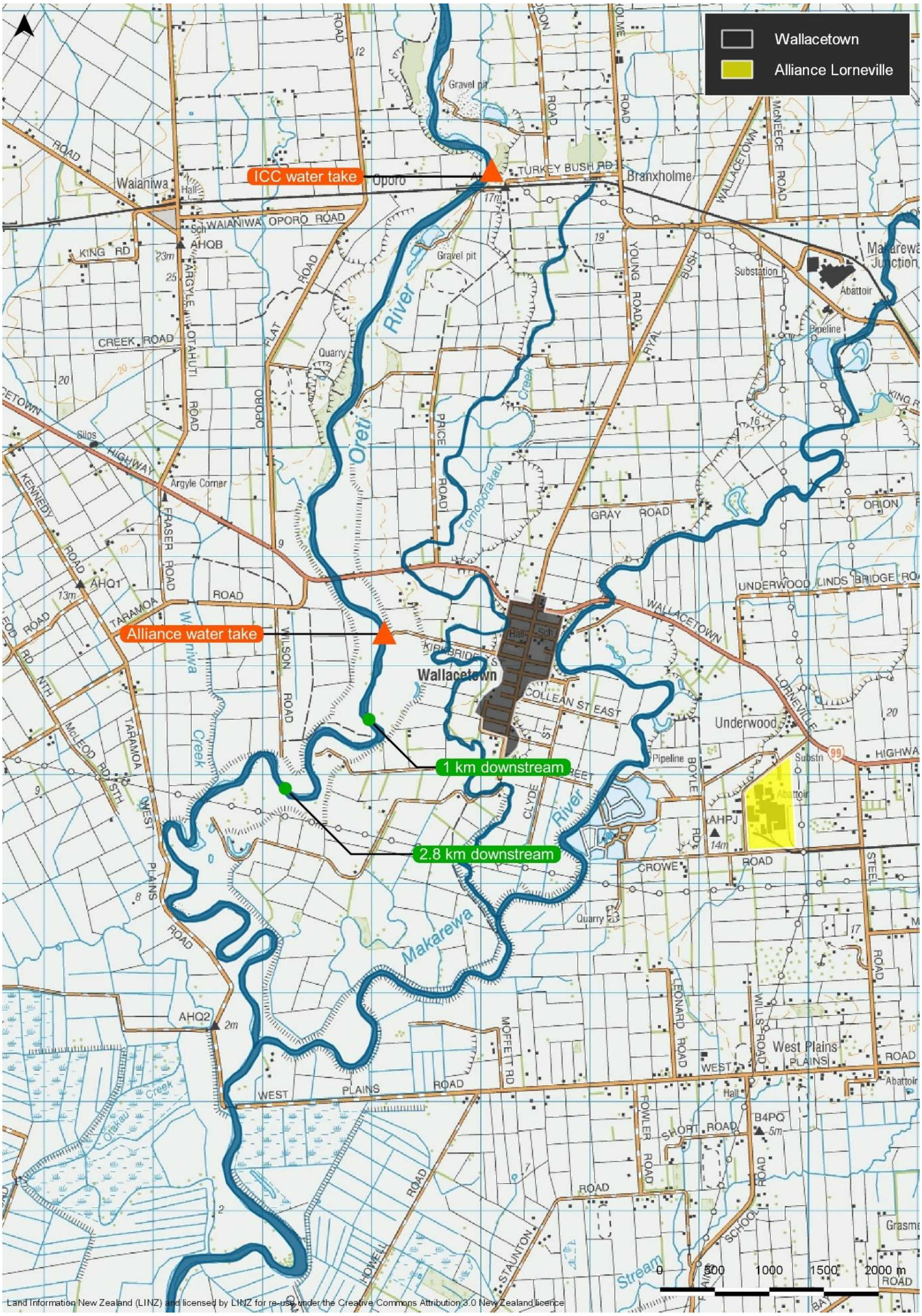


Figure 23: Downstream section of the Oreti River Catchment.

5.4 River Flow

Effect of Other Abstractors

Surface water abstractions for irrigation upstream of Wallacetown have minimum flows set at Wallacetown that they must meet and all are set up so that the impact on the river is minimised and there are no long periods of flow flat-lining at the minimum flow.

The minimum flow that these permits must meet is 7,500 L/s which is currently the Environment Southland official 7DMALF at Wallacetown for abstraction consents. When flows reach this minimum, all abstractions except the Invercargill City Council and the Alliance abstractions must cease.

The ICC abstraction can take it below the 7DMALF and this abstraction along with the current abstraction for Alliance if it was fully exercised, could abstract about 560 L/s from the river in this lower reach to the sea.

Likely impacts that are analysed here include impacts on the 7DMALF, flat lining of river flows, other abstractors, environmental flows (FRE1.5, FRE2 and FRE3), and potential increase in accrual periods between the FRE3 flows.

Irrigation will have no effect on the reach downstream of Wallacetown when flows fall to 7,500 L/s because they are shut down when flows fall to this level at Wallacetown. However, the ICC abstraction will continue regardless of the flow at Wallacetown as it must. The effect of this abstraction will be to take the natural flow as derived in this report down to the actual flows measured at Wallacetown.

Therefore when flows are at the flow of 7,500 L/s upstream of the ICC intake and irrigation abstraction has ceased, the ICC will take the natural flows as much as 300 L/s below the flow measured at the Wallacetown Bridge before the Alliance abstraction is added to it.

This analysis assesses the impact of the ICC abstraction first and then assesses the extra impacts the Alliance abstraction will have on flows in excess of those caused by the ICC abstraction.

Effects on 7DMALF

In this section, the number of days when flow is less than the 7DMALF under natural conditions, the number of days when flow is less than 7DMALF with the ICC abstraction included and the number of days when flow is less than 7DMALF with the ICC and Alliance abstraction are calculated and assessed.

For the purposes of this analysis, the natural 7DMALF at Wallacetown is 7,700 L/s and the measured 7DMALF is 7,380 L/s. These were calculated from the record for the period between 6 October 1977 and 31 August 2015.

A similar data analysis to that undertaken by Raineffects (2012) has been used in this analysis. In that analysis, a series of likely daily mean flows at Wallacetown were calculated using natural flows, ICC abstractions and estimates of irrigation abstractions. This derived series will be used to review days below 7DMALF under natural conditions, natural flows with only ICC abstractions, irrigation and ICC abstractions and then with the Alliance abstraction added. In this analysis, the 7DMALF will be the calculated natural 7DMALF of 7,700 L/s, not the 7,500 L/s that the irrigation consents are linked to. This means that irrigation will have an effect on days below 7DMALF in this exercise whereas if the irrigation minimum of 7,500 L/s was used, there would be little or no effect. Table 10 shows the results of this analysis. Note that the table shows the total number of days less than 7DMALF over the entire record.

Table 10: Number of days flows below natural 7DMALF.

	Calculated natural flow	Natural flow less ICC	Natural flow less irrigation Less ICC	Natural flow less irrigation less ICC less Alliance
Days	697	775	876	957
Average days per year (range)	19 (0–71)	21 (0–75)	24 (0–79)	26 (0–81)

For the final column in Table 10 the Alliance abstractions were added to the model from the previous Raineffects (2012) report and were based on actual water usage on a monthly basis. The monthly water usage data in Table 9 was assessed as a percentage of the maximum month. For example, the maximum monthly abstraction as a flow was February with an abstraction of 130 L/s. The August abstraction of 16 L/s is 13% of 130 L/s. Similarly, the December abstraction of 88 L/s is 68% of 130 L/s (Figure 24).

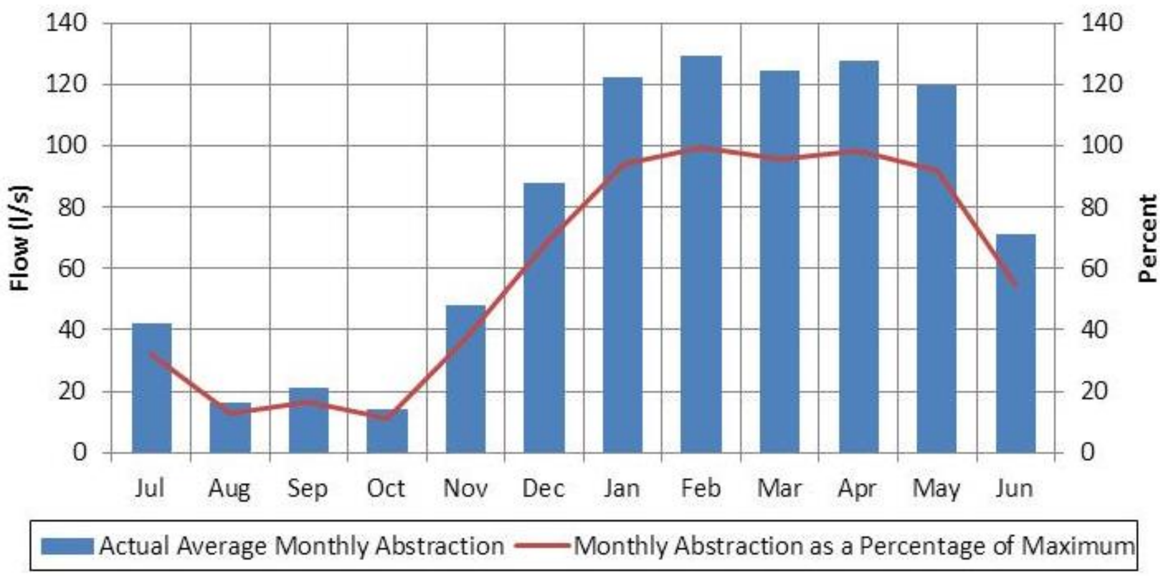


Figure 24: Alliance monthly water abstraction

In order to calculate a worst case scenario, these percentages were used to estimate monthly usage by Alliance assuming a 260 L/s maximum abstraction. These abstractions were then subtracted from the calculated flow record 'natural flows less irrigation abstraction less ICC abstractions'.

Table 10 shows that naturally flows fell below the 7DMALF for about 19 days per year. It also shows that increasing abstractions result in more days of flows less than the natural 7DMALF. There is an increase in the average number of days below 7DMALF to 21 days with the ICC abstraction added, a further rise to 24 days when future irrigation is combined with the ICC abstraction, and a further 2 days rise to 26 days when the Alliance abstraction is added. The increase due to Alliance is from a total of 876 days for the Oreti River with combined irrigation and ICC abstractions to 957 days in total with the Alliance abstraction added. This is an overall increase of 9% in days less than 7DMALF compared to naturalised flows due to the Alliance abstraction. Note that irrigation is also restricted by a minimum flow at the upstream recorder site on the Oreti River at Lumsden.

Effects on Environmental Flow Variability

Abstractions from rivers can be large enough to cause flows to be held at or close to the imposed minimum flow for longer periods of time than they would be naturally.

In this river, no flat-lining of flows due to irrigation abstraction at the imposed minimum of 7,500 L/s is likely to occur because of the structured step down in irrigation abstractions implemented by Environment Southland.

On top of the irrigation the Alliance and ICC abstractions are additional to irrigation but they are not constrained by minimum or residual flows so they will continue to take water at basically the same rate. This means that they will continue to draw the flow down with no flat-lining at any particular low flows.

The key flows are those equivalent to 1.5 times median flow, two times median flow and three times median flow (FRE1.5, FRE2 and FRE3). Three times median flow is usually a flow sufficient to move gravel and small stones in a riverbed. In most rivers and streams, the greater the flow, the less the frequency of each of the flows with FRE3 flows occurring the least often.

Table 11 shows the flow frequency for environmental flows using naturalised medians for naturalised flows with no abstraction, for actual measured flows (ICC abstraction only), for naturalised flows with both ICC and irrigation abstractions and for flows with all abstractions including Alliance.

Table 11: Environmental flow frequency.

Flow	FRE1.5	FRE2	FRE3
Naturalised	10.7	10.3	8.4
Actual measured flows	10.8	10.3	8.2
Naturalised less ICC and irrigation abstractions	10.8	10.2	8.1
Naturalised less all abstractions including Alliance	10.8	10.2	8.0

Table 11 shows that if the averages for each category are rounded to one decimal point there is no change to the frequency of environmental flows for FRE1.5 and FRE2 irrespective of the degree of abstraction. If the averages are taken to three decimal places, then there is a very small difference between the derived natural and derived natural with all abstractions added. There is a marginal change in frequency between the existing FRE3 frequency between the situation as it exists at the Wallacetown bridge flows and those downstream of the Alliance intake. The changes to environmental flow frequencies are therefore no more than minor downstream of the Alliance intake.

Effects on Accrual Period Length

Accrual period is an important determinant of the potential for nuisance algal growths to occur particularly as nuisance cyanobacteria growths have been recorded upstream. An analysis of accrual days between FRE3 events was undertaken. The analysis was for the number of 20+, 30+, 40+, 50+, 75+ and 100+ days between FRE3 events and was undertaken on the naturalised flows with no abstractions, the naturalised flows at the Wallacetown site with irrigation and ICC abstraction and naturalised flows less all abstractions including Alliance. It should be noted that this analysis does not include all FRE3 events. If the days between events were between 7 and 19 days they were not included in this analysis. The results of the analysis are included in Table 12.

Table 12: Accrual periods between FRE3 flows for various abstractions.

Flow	Accrual Days					
	20+	30+	40+	50+	75+	100+
Naturalised flows	54	41	24	49	24	25
Naturalised less Irrigation and ICC abstraction	54	39	25	48	23	25
Naturalised less all abstractions including Alliance	53	39	25	49	23	24

The analysis shows that the introduction of full abstraction will have virtually no effect on accrual periods between FRE3 environmental flows downstream of the Alliance intake.

Summary

The key findings arising from the assessment of the effect of Alliance's abstraction on low flow and flow variability are:

- Any potential effects of the Alliance abstraction are likely to occur only in the approximately 2.8 km reach downstream of the abstraction site before tidal influence becomes much more dominant.
- There is unlikely to be any changes to existing flow flat-lining, environmental flow frequency and accrual periods between FRE3 flows.
- The only identified effect on the river due to this abstraction was a likely small increase in the number of days flows were below the natural 7DMALF. There is an overall increase of 9% in days less than 7DMALF compared to naturalised flows due to the Alliance abstraction. These small effects of the abstraction on 7DMALF are not expected to result in water quality and ecological effects as outlined below.

5.5 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 the water quality sampling on 8 December 2015 that showed very similar water quality upstream and downstream of the take support this conclusion.

5.6 Aquatic Habitat

Abstracting water from rivers can alter the quantity and quality of habitat for biological communities including periphyton, benthic invertebrates, native fish and trout. The effect of the Invercargill City Council (ICC) water take on aquatic habitat was undertaken in 2001 using River Hydraulics and Habitat Simulation (RYHABSIM) (Ryder Consulting 2001). The RYHABSIM study by Ryder Consulting (2001) was undertaken upstream of the Riverton-Wallacetown Highway in a wider and shallower section compared to the reach from which Alliance abstracts water. The reach from which Alliance abstracts water is therefore less sensitive to the effects of abstraction (e.g., reduced water level reducing the wetted area and habitat availability and quality for benthic invertebrates) altering compared to the reach from ICC abstracts water. The Ryder Consulting (2001) study therefore provides an indicative and conservative estimate of possible changes to aquatic habitat at and downstream of the Alliance abstraction.

The key finding from Ryder Consulting (2001) was that abstraction of between 0.30 and 0.42 m^3/s by ICC would have a negligible effect on aquatic habitat. Based on modelling undertaken by Ryder Consulting (2001), the effects of Alliance's abstraction of 0.26 m^3/s on the amount and quality of aquatic habitat within a less sensitive river reach with deeper water habitat and the influence of the tide are therefore expected to be less than minor. The cumulative effects of the ICC and Alliance take are also assessed as less than minor.

The hydrology assessment undertaken and presented in this report demonstrates that Alliances abstraction has a less than minor effect on the duration of low flows (as indicated by the number of days when the river flow is at MALF increasing from 23 to 25 days on average per year) and also on environmentally relevant flow statistics such accrual period length and FRE 1.5 to FRE3 frequency. The results of the RYHABSIM modelling in a nearby more sensitive reach of the Oreti River which showed little, if any, effect from the ICC abstraction coupled with the results of the hydrology assessment indicate that Alliance's abstraction is very likely to have no more than minor 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.

The reach immediately downstream of the Alliance water take is dominated by deep run and pool habitat with fine gravels and sand and is not suited to periphyton growths or a diverse and abundant riffle dwelling benthic invertebrate community. Further downstream where the influence of the tide increases and the proportion of run and pool habitat and depositional areas increases the influence of Alliances take is likely to be much reduced. The period of greatest effect of Alliances abstraction on in-stream habitat in the tidal reach is likely to occur during low tide although these effects are still assessed as minor based on the analysis of the effects of the take on river flow and water level.

The periphyton and benthic invertebrate communities in the deeper run and pool habitat is likely to be insensitive to any small reduction in water level associated with the take and any effects on periphyton growth and cover or benthic invertebrate habitat and community health along most of the downstream reach is therefore assessed as less than minor.

There are several gravel beaches and shallow riffle areas between the abstraction point and the Makarewa River confluence where algal proliferations are more likely to occur during extended periods of low flow in summer and where the effects of Alliance's water take on water levels could increase slightly.

The periphyton survey results from the December 2015 survey indicated that the take was not having a detectable effect on the periphyton community at the time of the survey and support the conclusion that the effect of the abstraction on the periphyton community is very minor.

The benthic invertebrate survey results from the December 2015 survey indicated that Oligochaete abundance did increase causing a slight decrease in QMCI scores at Site D1 and D2. The slight decrease in QMCI score is therefore most likely to be related to reach and site scale differences in fine sediment supply and deposition associated with river bank erosion, a decrease in river bed gradient and an increase in depositional areas. Given the very small influence of the abstraction of key river flow statistics the minor differences in benthic invertebrate community observed at Sites D1 and D2 in December 2015 are considered unlikely to be related to the effect of the abstraction.

Īnanga spawn on the tidal interface during spring tides. The water level in this section of the river is strongly influenced by the river flow and tidal cycle at the time and is likely to be very insensitive to the small reduction in water level associated with the take and are therefore not expected to influence īnanga spawning habitat. Some native fish such as elvers and juvenile trout prefer riffle habitat for rearing. As outlined previously there are very few riffles between the Alliance take and the tidal zone. The extent of any potential effect of the take on riffle dwelling juvenile native fish or trout is therefore likely to be very small and the effect less than minor.

The lower Oreti River is an important migratory pathway for a range of native fish and also trout. Most upstream migration occurs in spring during incoming tides (e.g., īnanga and sea run trout) or during small freshes (e.g., elvers) and outside of the summer low flow period when the Alliance takes has the greatest potential to influence water levels. The nature of the habitat downstream (i.e., deep U shaped channel, limited riffle areas and small effect on water levels) means that effects on fish migration has been assessed as less than minor.

The lower Oreti River provides important adult fish habitat and is a highly productive area with a range of species including adult eels, flounder, īnanga, smelt and trout. Most adult fish are expected to utilise the deeper tidally influenced section of the lower Oreti River and away from the short section of the river influenced by the Alliance take. As a consequence of this the take is not expected to have any effect on adult fish habitat or production.

As previously outlined the lower Oreti River is tidally influenced from approximately 400 m downstream of the Alliance take. The effects discussed in this section relate mostly to periods of low or outgoing tide. The effects during high or during incoming tides would be less than we have described here as the effect of the tide is expected to be significantly greater than any water level effect associated with the take.

5.7 Entrainment of Fish

The water take is located at the end of a 45 m long artificial intake channel located on the true-left bank of the river (shown in Figure 3 to Figure 6; Section 3.0). The embayment area is characterised by a silt bed and extensive macrophyte growth. The intake structure is fitted with a coarse screen (metal bars) with bars spaced approximately 50 mm apart. A second screen with 16 mm diameter mesh is positioned 2 m behind the coarse screen (Kingett Mitchell 2005) (Figure 25).

The artificial intake channel is a still water environment during periods of normal river flow, has no flow to attract migratory fish and no shallow gravel riffle habitat preferred by a number of native fish found in the Oreti River. As a result of these features the artificial intake channel is unlikely to be regularly used by juvenile migratory fish or most of the riffle dwelling fish species present in the river. It is possible that that small fish such as smelt, īnanga, elvers and trout fry could pass through the screen and into the water treatment plant.

Water is pumped to the water supply reservoir at the Lorneville Site where it passes through the water treatment plant before being used in the processing plant. The water take and treatment system allows checks for fish that have been entrained at four points; the intake screen, pump house, water supply reservoir (during annual cleaning operations) and the water treatment plant.

Between 2000 and 2005 there had been no fish observed on intake screens, the pump had been affected on two occasions (due to longfin eel), no fish observed during cleaning of the reservoir, and a single eel observed at the water treatment plant. No fish have been seen by water treatment operators or maintenance staff since 2005 (Frances Wise pers. comm.).

The lack of suitable habitat for most juvenile fish species found in the artificial abstraction channel coupled with the infrequent observation of a small number of eels indicates that the potential for entrainment or impingement of small fish at the water intake structure is likely to be low. Despite this Alliance has investigated options for reducing the risk of fish becoming impinged on the screen or entrained in the water take and is proposing to replace the existing inner screen (12 mm and 18 mm centres), with a 2 mm bar and an approach velocity not exceeding 0.12 m/s.

Figure 25: View of intake structure.

5.8 Cultural Values

The effects of the water take on cultural values were not the subject of this assessment and will be discussed separately with iwi. This discussion will include the implications of the water take under the statutory acknowledgement for the Oreti River.

6.0 Intake Channel Maintenance

The water take is located at the head of a 45 m long, 8 m wide artificial intake channel. The intake channel is not subject to the scouring effects of floods and is likely to be a depositional zone for sediment and debris during flood events. As a result of the flow and sediment conditions the intake channel supports abundant macrophyte growths. These macrophytes are likely to provide cover for eels and the channel itself may provide a refuge for trout and native fish during flood events.

The artificial intake channel requires cleaning approximately annually and has typically been undertaken in September. The removal of macrophytes and sediment during intake channel maintenance works has the potential to disturb the bed of the intake channel causing benthic invertebrate mortality and removing or causing mortality to sediment dwelling fish and in particular to eels. The mortality of benthic invertebrates from the approximately 360 m^2 area of river bed is minor given the very large areas of similar undisturbed habitat upstream and downstream of the intake channel. The effect of removing a small number of eels and possibly other native fish during channel maintenance activities is also assessed minor based on the small area and artificial nature of the habitat.

However it is recommended that the effect on eels and other native fish be minimised by ensuring that the contractor is prepared to capture and return any eels, removed during maintenance activities, to the river and that the key migration period between 1 December and 30 June be avoided.

7.0 Conclusion

This assessment of effects is based on the maximum allowable take (22,500 m^3/day at the current maximum rate (260 L/s). The proposed water take will result in a less than minor effect on the duration of MALF, the number of FRE1.5, FRE2 and FRE3 events and accrual period length. As a consequence any effects of the abstraction on water quality (e.g., reduced assimilative capacity) are expected to be less than minor.

The periphyton and benthic invertebrate survey results from the December 2015 survey indicated that the take was not having an adverse effect on these communities at the time of the survey and support the conclusion that the effect of the abstraction on periphyton and benthic invertebrate communities is very minor.

As a consequence of the less than minor effect of the take on low flow duration, flow variability and water quality, the lack of sensitivity of most of the receiving environment to water level changes any effects on biological communities including periphyton, benthic invertebrates, fishing spawning and rearing habitat, food production, adult habitat and cover, access to spawning and rearing areas and fish passage are expected to be less than minor.

The current intake design and screen has the potential to entrain fish including smelt, īnanga, elvers and trout fry. Alliance has investigated options for installing a fish screen to minimise/avoid fish being entrained into the intake and is proposing to install a finer mesh screen to prevent fish being entrained into the intake structure.

The effects of the maintenance activities in the intake channel are also assessed as minor as a result of the small amount and nature of the habitat (artificial channel) affected and the infrequent (annually) nature of the activity.

8.0 References

Goodman, J., Dunn, N., Boubee, J., David, B., Griffths, M., Allibone, R., David, B., Hitchmough, R., Ling, N., Ravenscroft, P., Rolfe J. 2014: Conservation status of New Zealand freshwater fish, 2013. Department of Conservation New Zealand Threat Conservation Series 7.

Biggs 2000: New Zealand Periphyton Guidelines – Detecting, Monitoring and Managing Enrichment in Streams. Report prepared for Ministry for the Environment. June 2000.

Cawthron 2010: Benthic Cyanobacteria and Anatoxin-a and Homanatoxin-a Concentrations in Five Southland Rivers. Report prepared by Cawthron Institute for Southland Regional Council.

Environment Southland 2012: Draft Water Quality Methodology for Southland Water 2010 Report. June 2012.

Kingett Mitchell 2005: Alliance Lorneville Assessment of Environmental Effects 2005. Report prepared for Alliance Group Ltd. July 2005.

MfE 2008: Draft Guidelines for the Selection of Methods to Determine Ecological Flows and Water Levels. Report prepared by BECA Infrastructure Ltd for Ministry for the Environment. March 2008.

NIWA 2009: Angler usage of lake and river fisheries managed by Fish and Game New Zealand: results from the 2007/08 National Angler Survey. April 2009.

Raineffects Limited 2012: Assessment of Impacts on Oreti River Due to Irrigation Abstraction. November 2012.

Raineffects Limited 2012: Assessment of Impacts on Oreti River Due to Water Abstraction by Alliance Group Ltd. November 2014.

Ryder, G. 1995: Oreti catchment aquatic biota/chemistry assessment. Report prepared by Robertson Ryder Ltd for Southland Regional Council. December 1995.

Ryder Consulting Ltd 2001: Effects of the Branxholme abstraction on trout habitat of the lower Oreti River. Report prepared for Invercargill City Council. December 2001.

Stark, J. D., Boothroyd, I. K. G., Harding, J. S., Maxted, J. R., Scarsbrook, M. R. 2001: Protocols for sampling macroinvertebrates in wadeable streams. Prepared for the Ministry for the Environment. November 2001.

Stark, J., Maxted, J. 2007: A user guide for the Macroinvertebrate Community Index. Cawthron Report No 1166. April 2007.

Wairesearch 2010: Freshwater fish in the Southland Region: Spatial distribution in relation to land cover and temporal trends. Report prepared by Wairesearch Ltd for Southland Regional Council.

Report Signature Page

Freshwater Solutions Ltd

R. Montgomerie

Richard Montgomerie

Director

APPENDIX 1

Natural Flow Discussion

4. Hydrology

4.1 General

There are two key water level recording sites in the Oreti catchment, the Oreti River at Lumsden and the Oreti River at Wallacetown. The continuous Lumsden record began on 1 July 1976 and the continuous Wallacetown record began on 1 July 1977. Records for both sites for this report are available up to 2 September 2012. Both records are generally of good quality. They both have some gaps but none of the gaps are large enough to prevent the use of any of the data in any one year and the records from their dates of commencement are assumed to be usable. No other flow records are used in this report.

4.2 Hydrology Statistics

Table 1 shows the basic hydrology statistics for the Lumsden and Wallacetown sites.

Table 1: Flow Statistics For Oreti River Sites.

Site	Flows (cumecs)						No of Events/yr		
	Mean	Median	Max	Min	7DMALF	Spec Disch (L/s/km^2)	FRE 1.5	FRE 2.0	FRE 3.0
Lumsden	28.40	18.61	1,146	2.19	5.28	26	13.0	12.9	11.0
Wallacetown Actual	39.94	27.55	1,404	2.60	7.38	18	11.5	11.0	8.9
Wallacetown Naturalised	40.33	27.84	1,404	3.00	7.73	18	11.5	11.0	8.9

The specific discharges in Table 1 relate to the mean flows for each site.

4.3 Natural Flows

Since the two consents to abstract water upstream of the Lumsden site are unlikely to have been exercised before 2 September 2012 which is the end of the flow record used for this site, then it can be assumed that the Lumsden flow record is natural.

It was noted earlier that the ICC consent that was renewed on 10 June 2003, has been in place since before the continuous water level record began at Wallacetown. Since the abstraction point is just upstream of this recorder, the abstraction will have an immediate effect on the measured flows at Wallacetown. There are some records available for this abstraction and they include a period during the 1980's and more recently since the year 2000. Inspection of these records show that in the 1980's, the average abstraction was around 400 L/s while those since 2000 show that the average daily take is around 300 L/s. Note that since the abstraction point for this consent is just upstream of the Wallacetown recorder, the impact of this abstraction is limited to that short section upstream and the reach downstream of the recorder to the sea.

Other abstractions that could impact on the natural flows at Wallacetown prior to 2 September 2012 include Huisman (14 L/s), Lumsden Golf Club (0.1 L/s), Lockhead Holdings (6 L/s), and Smalley (15.4 L/s). The other abstractions in Table 2 are either groundwater abstractions with no connection to the river or have been issued in 2012 and are unlikely to have been operating before 2 September 12012. For both cases, neither should impact on the flows at

Wallacetown. Of the 4 mentioned which could impact, all are groundwater abstractions and one has possibly only impacted in the 2010/11 and 2011/12 irrigation seasons assuming it was set up as soon as it was granted.

The total abstraction up to the 2010/11 season that could impact on the Wallacetown flows excluding the ICC abstraction totalled 20.1 L/s of groundwater abstraction and with Smalley's groundwater abstraction included in the last 2 seasons, a total of 35.5 L/s.

Groundwater abstractions, unless they are directly beside the river, generally take weeks or possibly even months to have any impact on the river they are hydraulically connected to. Usually the further away the abstraction is from the river, the less impact is has. For these hydraulically connected groundwater abstractions totalling 20.1 L/s pre 2010 and 35.6 L/s from 2010/11 onwards, such flows even if they were 100% connected to the river, would have no measureable impact on the record at Wallacetown. The degree of accuracy of flow measurement is generally assumed to be plus or minus 8% although at low flows in smaller streams, they can probably be measured to about plus or minus 4%. The lowest flow measured at Wallacetown is 2614 L/s and its general margin of error is plus or minus 209 L/s (8%). Therefore it can be assumed for this report that with the exception of the ICC abstraction, the record at Wallacetown is natural.

The ICC abstraction has a maximum rate of take for water supply of 520 L/s but it can, 6 times per day for 15 minutes at a time, take 720 L/s for flushing filters. However it appears that the usual daily take over the period of record is between 300 L/s and 370 L/s.

There is a question as to the value of adding an estimate of the ICC abstraction back into the record since it could be assumed that because the ICC abstraction has been operating throughout the entire period of record and is a continuous abstraction, the statistics included in Table 3 are the real flows at this site.

However from discussion with Lawrence Kees of Environment Southland, it appears that the Regional Water Plan for Southland, March 2010 generally requires naturalised flows to be used for hydrology statistics when applying for abstraction permits (pers. comm. Lawrence Keys).

Measurements of water use by ICC are not easily accessed but some flow data are required to naturalise the Wallacetown flows. In the Background section of a report by Ryder Consulting (December 2001), titled "Effects of the Branxholme Abstraction on Trout Habitat of the Lower Oreti River", it states "…currently maximum abstraction rates typically go as high as 0.37 m^3/sec although an extra ordinarily high rate of 0.42 m^3/s has been recorded, which means the full quota allowed by the existing water right has not been utilized." In a recent discussion between Anita Dawe of Btw South Ltd and Environment Southland, the indications from the data held by Environment Southland were that during the 1980s, abstraction was generally around 400 L/s and in the 2011 year, average abstraction was around 290 L/s. For the purposes of this exercise, it will be assumed that the average daily abstraction up until the new permits were granted in June 2003 was 370 L/s and this would apply from the start of the record until the end of 2003. After that, the assumption is that the average daily abstraction for the remainder of the record is 300 l/s. These flows were added back into the record and the resultant flow statistics are included in Table 1. As expected, the mean, median, lowest flow and 7-day MALF all show a small increase but there are no changes to the environmental flow frequency since the flow changes are small and have little impact on higher flows.

APPENDIX 2

Model Calculation Discussion

5. Impacts of Abstractions on Flows at Wallacetown

5.1.1 General

Since this new proposed abstraction is downstream of Lumsden, it will have no impact on flows at Lumsden so no analysis of these flows is necessary. All the following analyses will be undertaken on the Wallacetown record.

Likely impacts that are analysed here include impacts on the 7 day MALF, flat lining of river flows, other abstractors, environmental flows (FRE1.5, 2, and 3), and potential increase in accrual periods between the FRE3 flows. For some of these analyses, a simple excel spreadsheet model was developed to analyse any possible impacts.

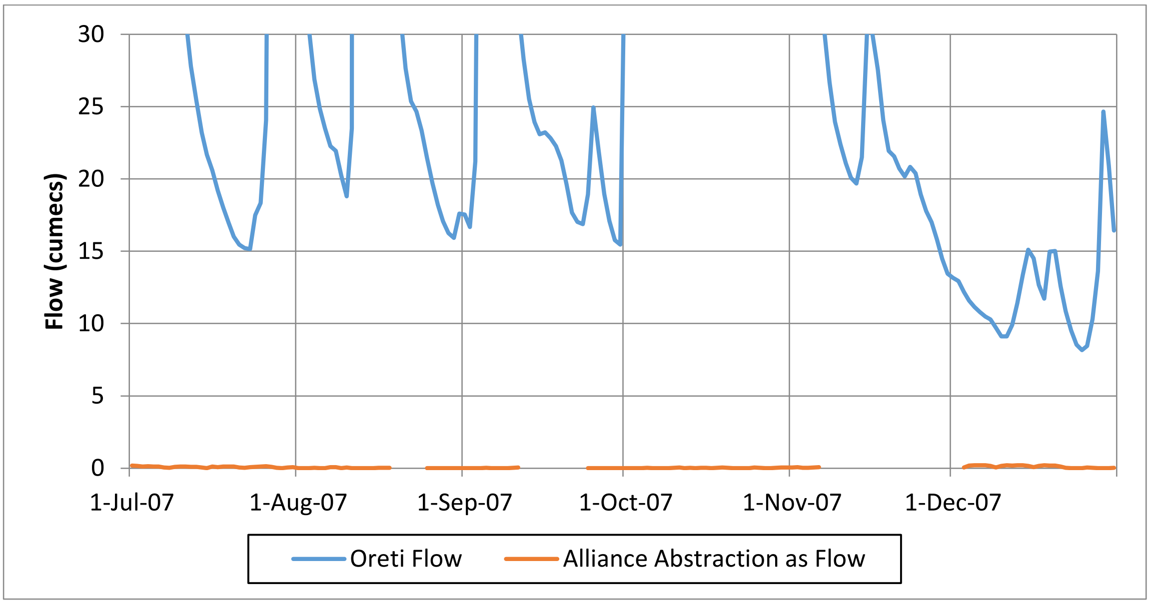
5.1.2 The Model

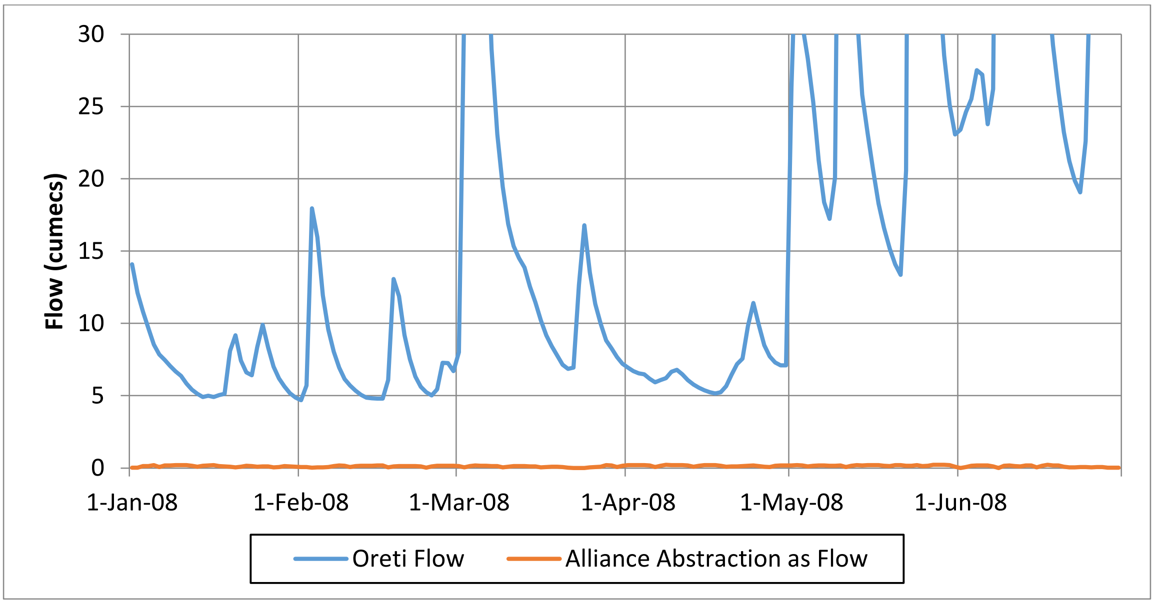
There were a series of assumptions that needed to be made for this model. They included:

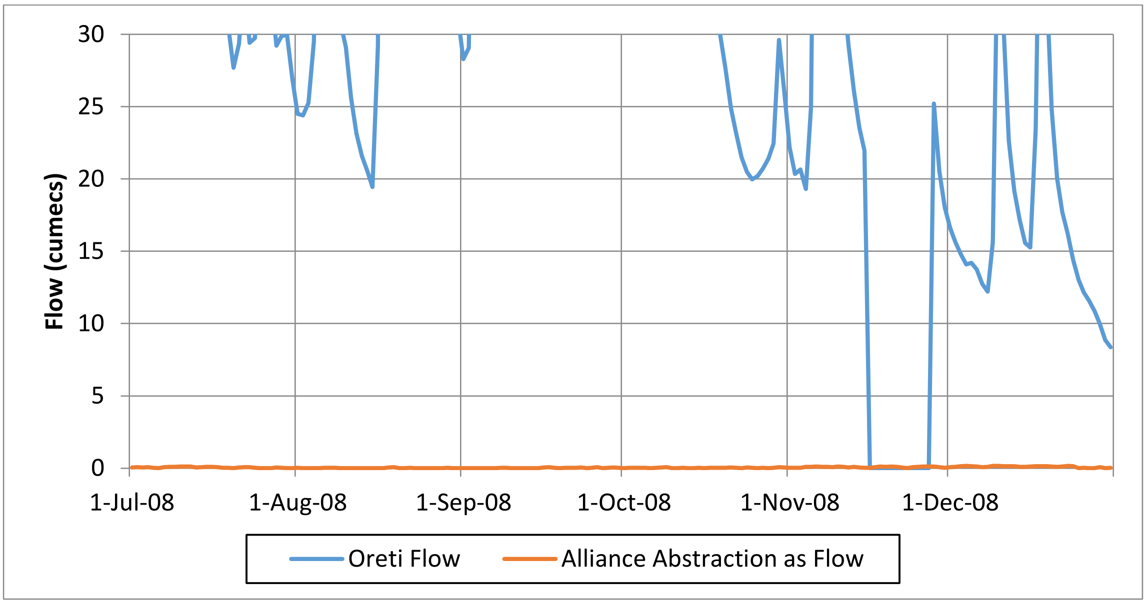
- Irrigation is assumed to occur continuously from 1 November to 31 March the following year. It is recognised that this is unlikely but making this assumption should result in a worst case situation. While it is possible to use derived rainfall, evapotranspiration and likely available soil moisture to calculate irrigation demands during the period of flow record, such a model is expensive to derive and operate and for the purposes of this exercise, is not warranted.
- The maximum rate of take allowable according to the consents will occur at all times during the above time period until the flow in the Oreti at Wallacetown reaches the previously mentioned trigger flow of 9,031 L/s. From this flow, there is a series of steps where each irrigation permit has to reduce to half its abstraction rate then to quarter of their rate and then to zero. In all this reduction, a continuous abstraction of 350 L/s will continue. This abstraction will cover for the ICC abstraction (300 L/s) and any groundwater abstractions that do not have cut offs but which may impact on the Wallacetown flows. It is likely a worst case scenario.
- After reviewing all the information available on likely abstractions upstream of Wallacetown, the total abstraction that is likely to occur including the new consent being applied for is 869 L/s. This is made up of Castlerock Dairies current abstraction 162 L/s, Highland Dairy Farms 47 L/s, McPherson 30 L/s, Terraces Dairy 60 L/s, Hamilton 182 L/s, Castlerock Dairies 38 L/s and 350 L/s to cover for ICC and any other groundwater abstractions that may have an effect on the record at Wallacetown. In 15 steps, the abstraction reduces from 869 L/s to 350 L/s when flows are at 7,500 L/s at Wallacetown. The 350 L/s continues irrespective of the flow at Wallacetown.
- The minimum flow at Lumsden of 5,200 L/s will be recognised and if abstraction is occurring and flows fall below 5,200 L/s at the Lumsden site, the total irrigation abstraction will cease but the ICC abstraction will continue.

APPENDIX 3

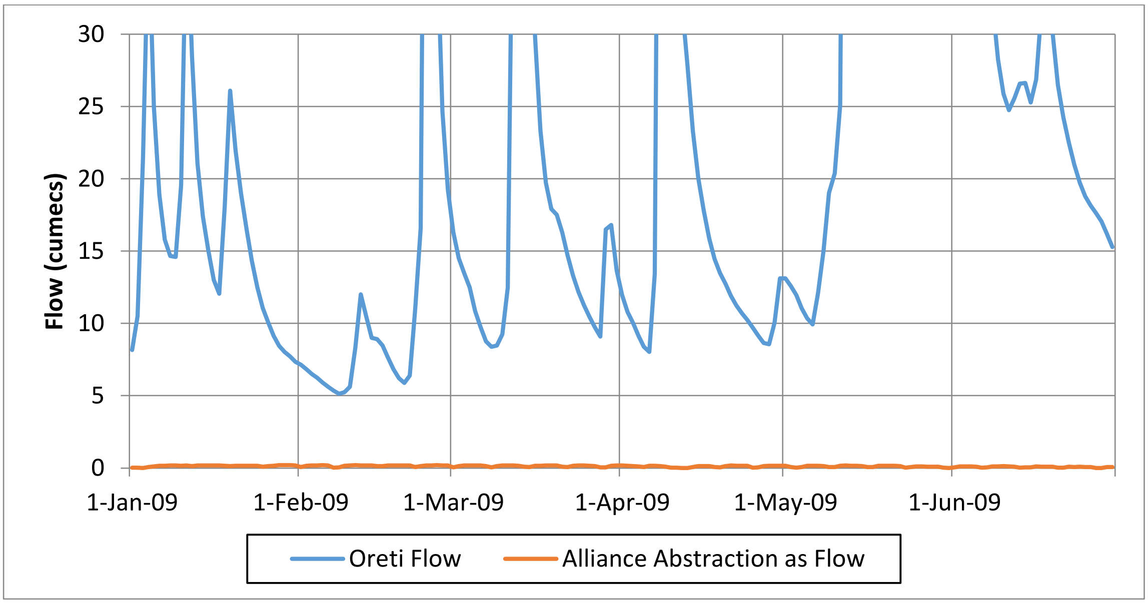
River Flow vs Alliance Abstraction (as flow)


30
25
20
15
10
5
0
Flow (cumecs)
1-Jul-07
1-Aug-07
1-Sep-07
1-Oct-07
1-Nov-07
1-Dec-07
Oreti Flow
Alliance Abstraction as Flow

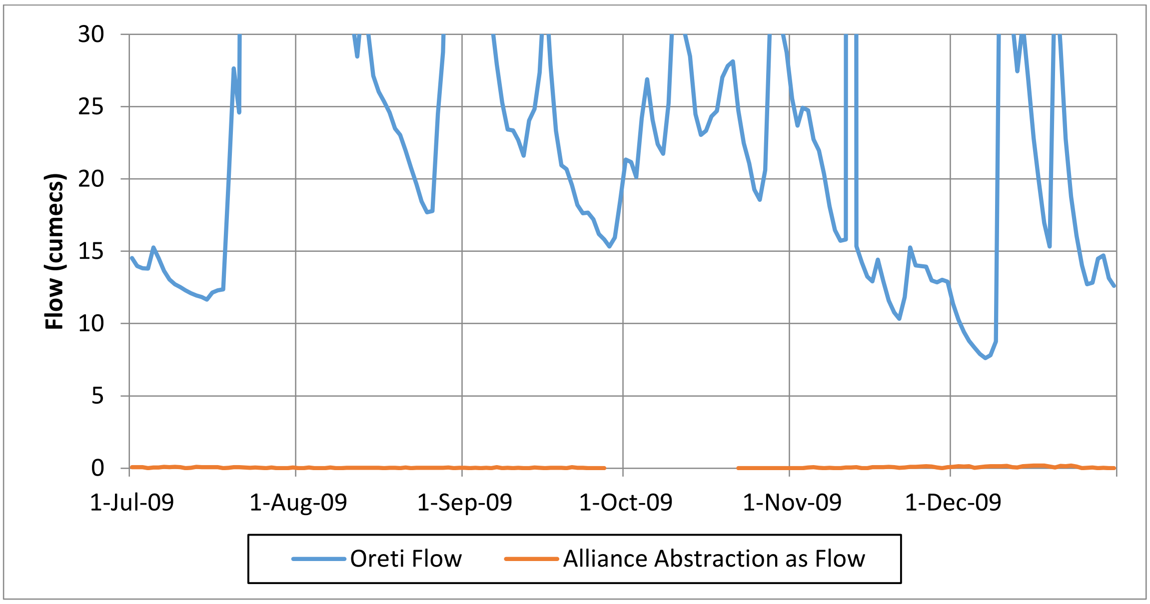

30
25
20
15
10
5
0
Flow (cumecs)
1-Jan-08
1-Feb-08
1-Mar-08
1-Apr-08
1-May-08
1-Jun-08
Oreti Flow
Alliance Abstraction as Flow

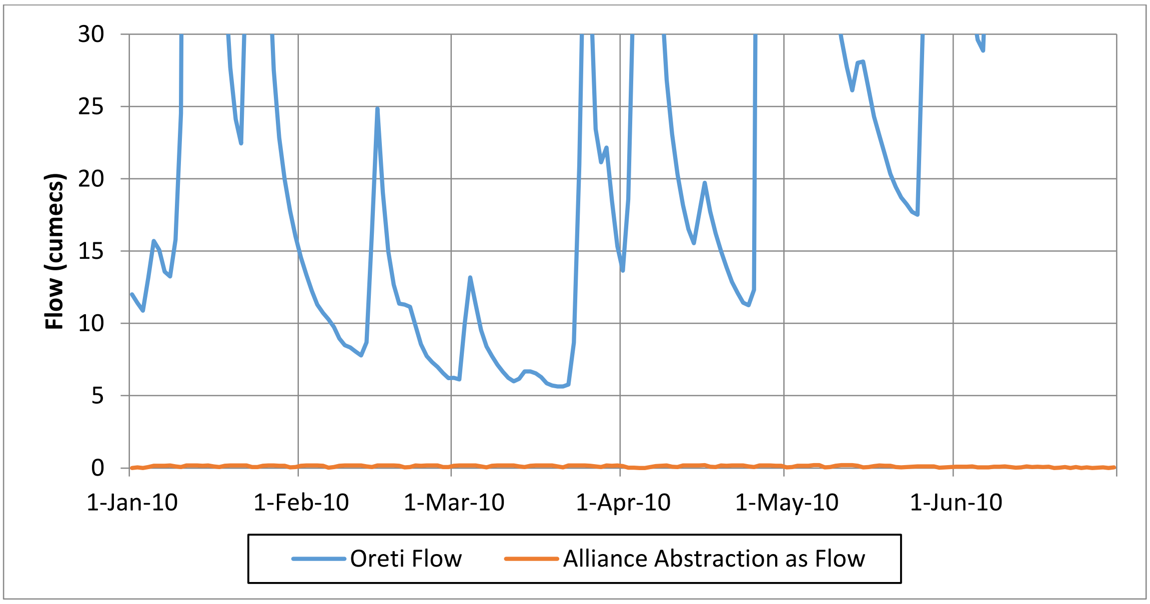


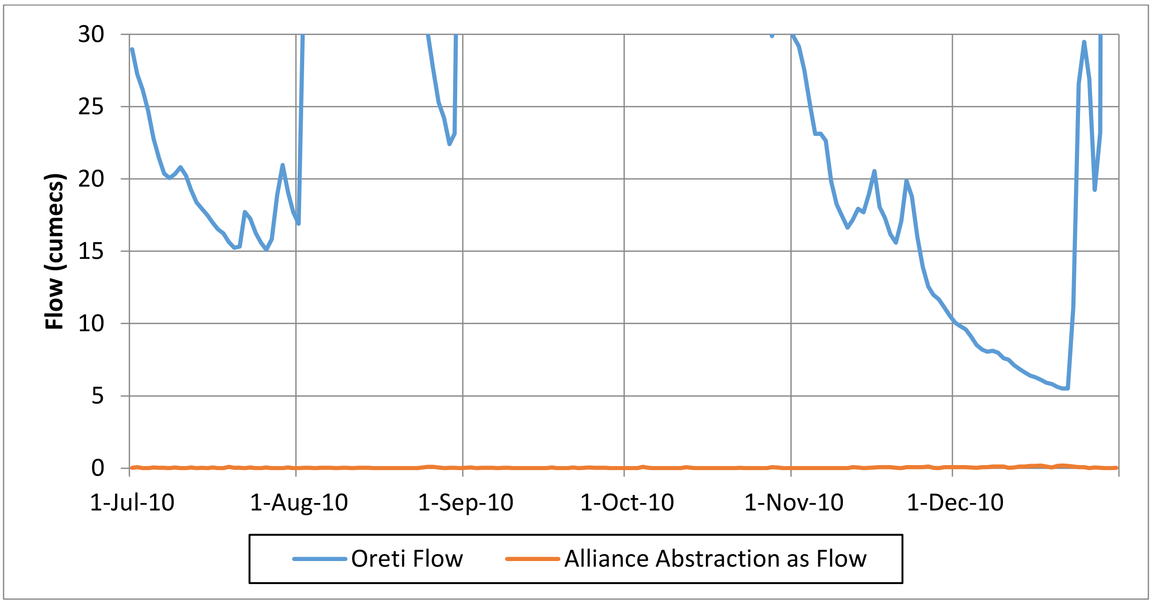
Flow (cumecs)
30
25
20
15
10
5
0
1-Jul-08
1-Aug-08
1-Sep-08
1-Oct-08
1-Nov-08
1-Dec-08
Oreti Flow
Alliance Abstraction as Flow



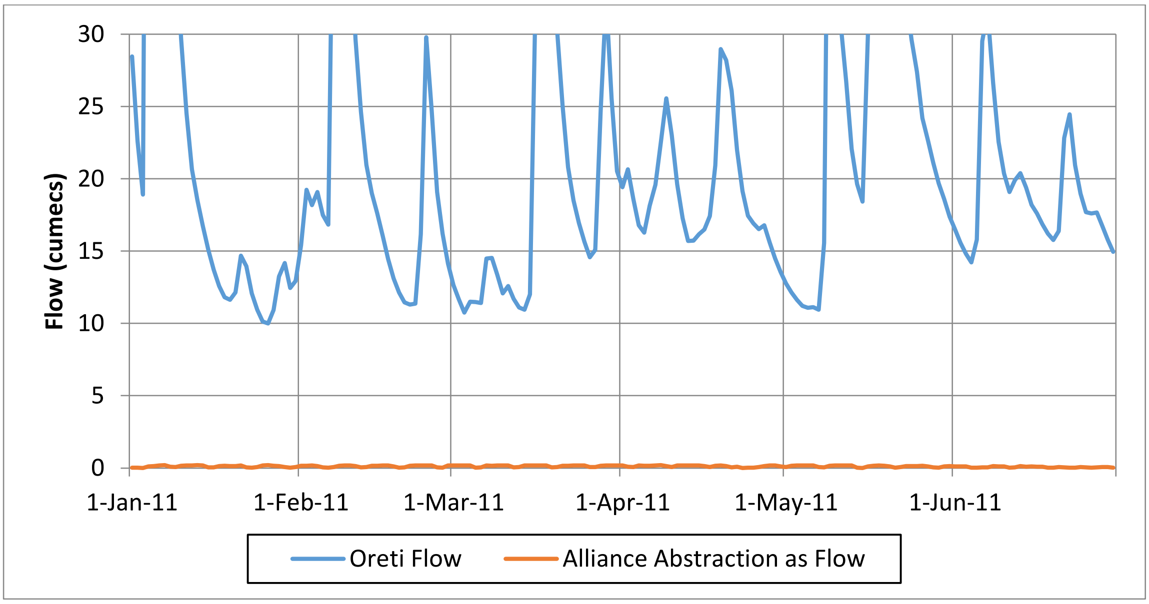
Flow (cumecs)
30
25
20
15
10
5
0
1-Jan-09
1-Feb-09
1-Mar-09
1-Apr-09
1-May-09
1-Jun-09
Oreti Flow
Alliance Abstraction as Flow


30
25
20
15
10
5
0
Flow (cumecs)
1-Jul-09
1-Aug-09
1-Sep-09
1-Oct-09
1-Nov-09
1-Dec-09
Oreti Flow
Alliance Abstraction as Flow

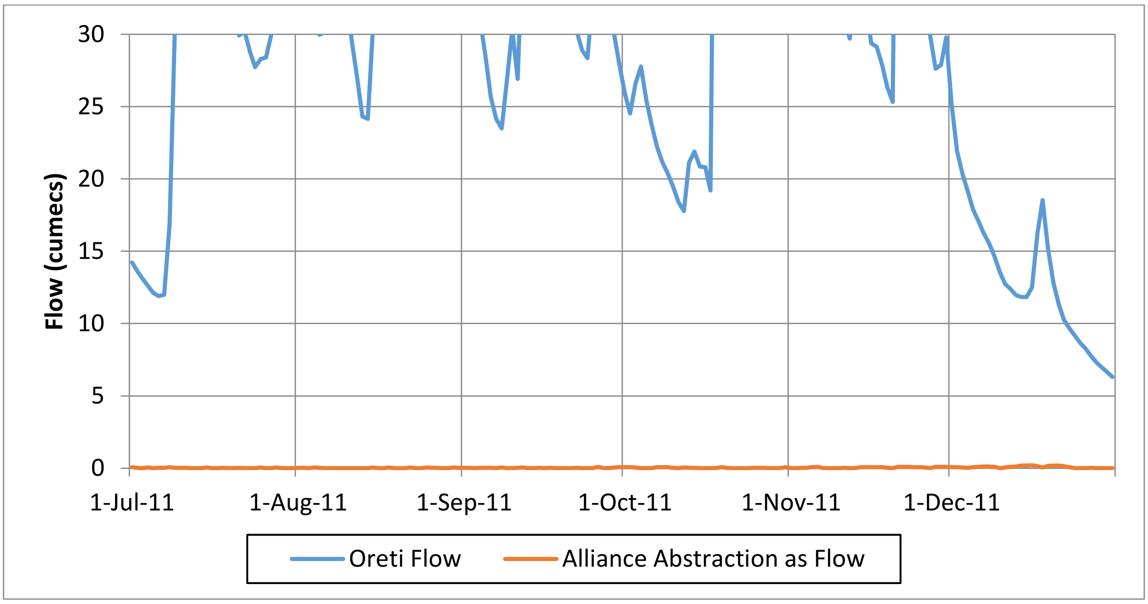

30
25
20
15
10
5
0
Flow (cumecs)
1-Jan-10
1-Feb-10
1-Mar-10
1-Apr-10
1-May-10
1-Jun-10
Oreti Flow
Alliance Abstraction as Flow

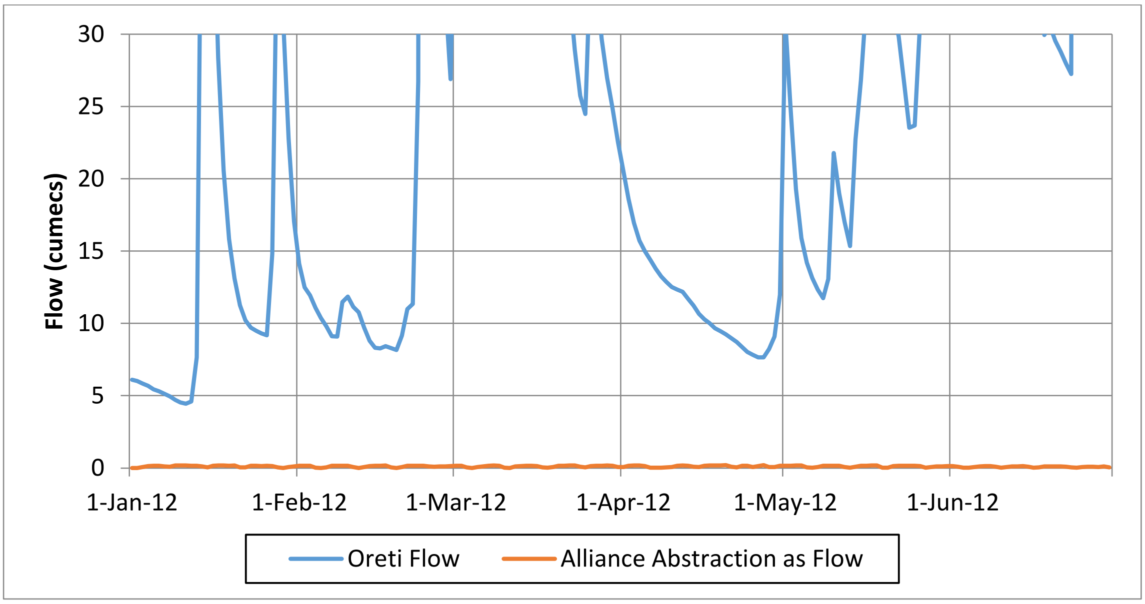


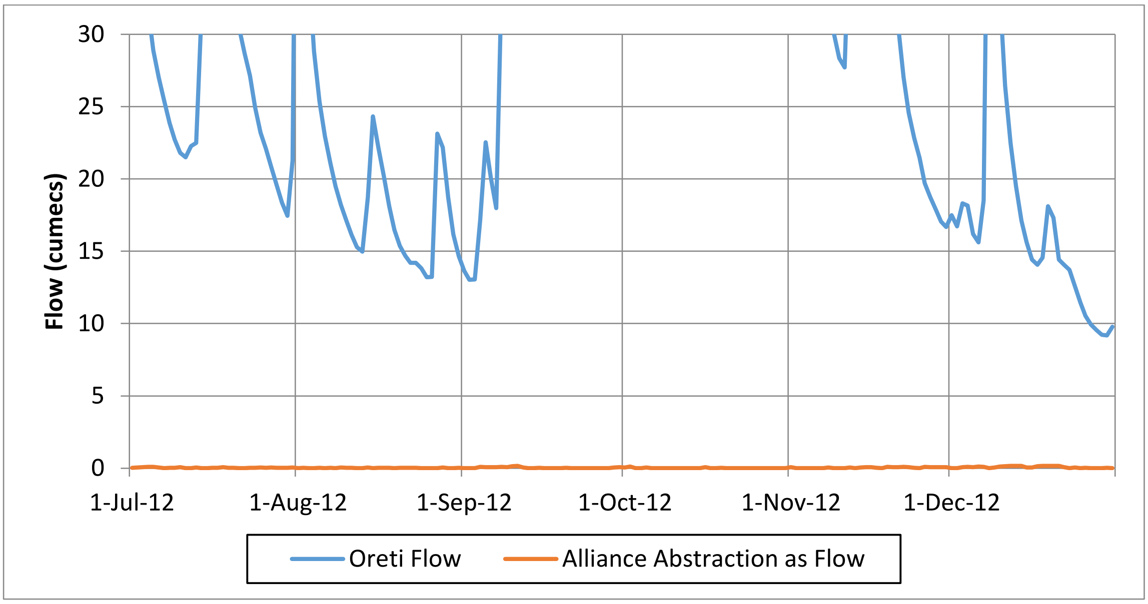
Flow (cumecs)
30
25
20
15
10
5
0
1-Jul-10
1-Aug-10
1-Sep-10
1-Oct-10
1-Nov-10
1-Dec-10
Oreti Flow
Alliance Abstraction as Flow



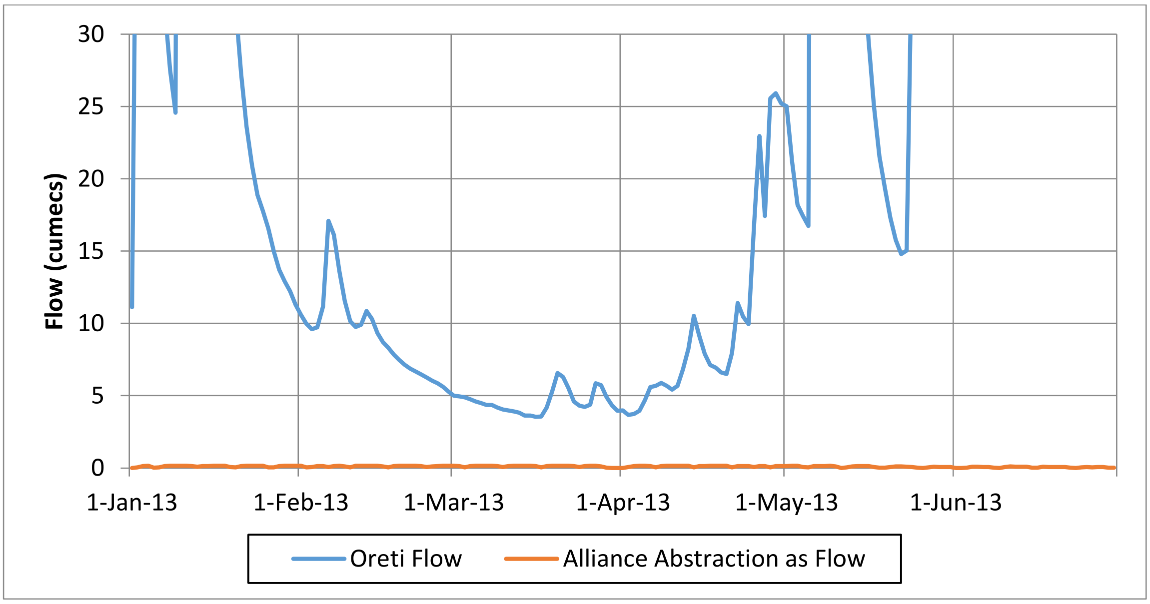
Flow (cumecs)
30
25
20
15
10
5
0
1-Jan-11
1-Feb-11
1-Mar-11
1-Apr-11
1-May-11
1-Jun-11
Oreti Flow
Alliance Abstraction as Flow


30
25
20
15
10
5
0
Flow (cumecs)
1-Jul-11
1-Aug-11
1-Sep-11
1-Oct-11
1-Nov-11
1-Dec-11
Oreti Flow
Alliance Abstraction as Flow

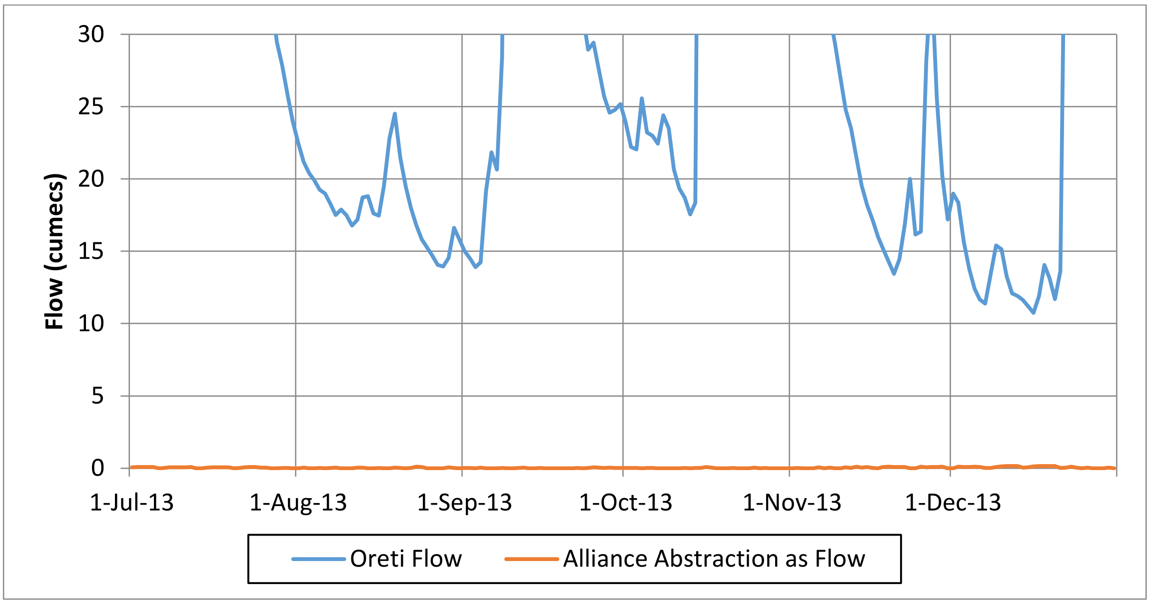

30
25
20
15
10
5
0
Flow (cumecs)
1-Jan-12
1-Feb-12
1-Mar-12
1-Apr-12
1-May-12
1-Jun-12
Oreti Flow
Alliance Abstraction as Flow

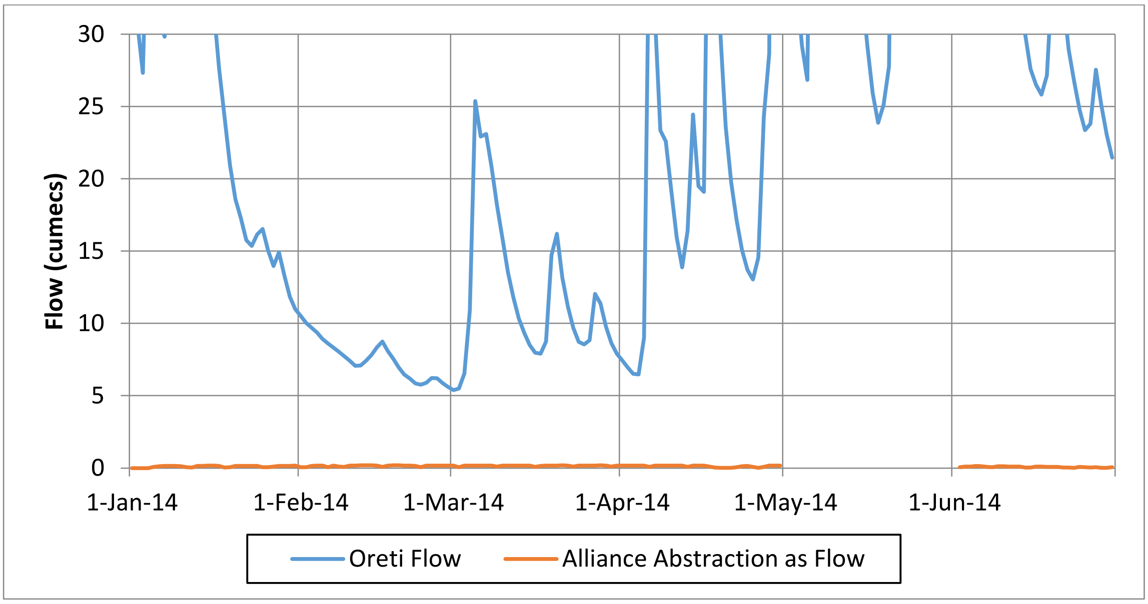


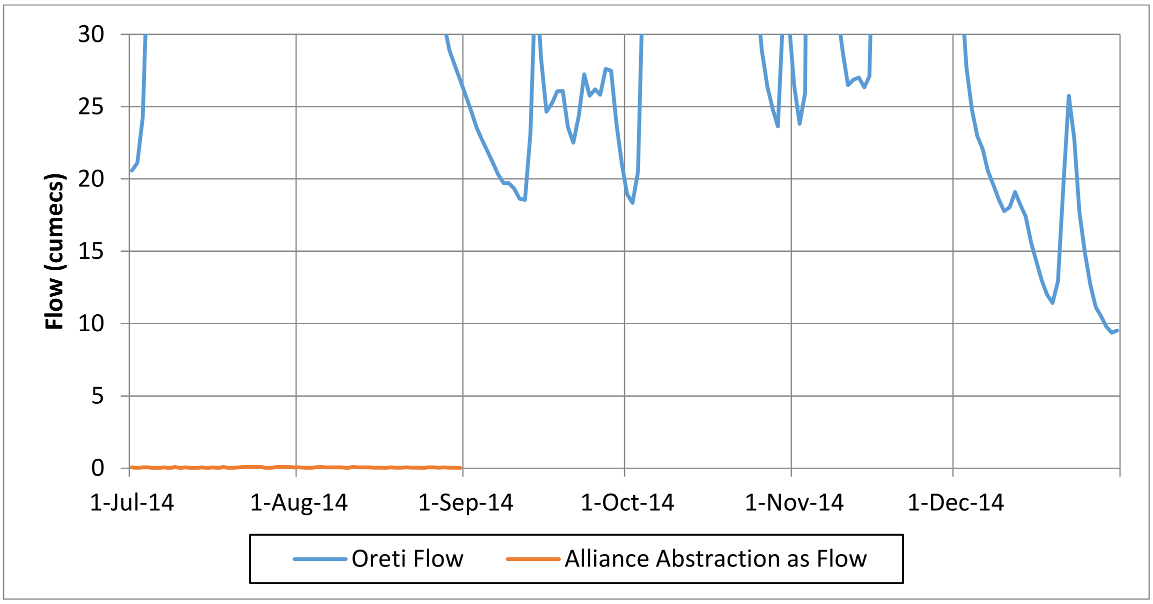
30
25
20
15
10
5
0
Flow (cumecs)
1-Jul-12
1-Aug-12
1-Sep-12
1-Oct-12
1-Nov-12
1-Dec-12
Oreti Flow
Alliance Abstraction as Flow



30
25
20
15
10
5
0
Flow (cumecs)
1-Jan-13
1-Feb-13
1-Mar-13
1-Apr-13
1-May-13
1-Jun-13
Oreti Flow
Alliance Abstraction as Flow


30
25
20
15
10
5
0
Flow (cumecs)
1-Jul-13
1-Aug-13
1-Sep-13
1-Oct-13
1-Nov-13
1-Dec-13
Oreti Flow
Alliance Abstraction as Flow


30
25
20
15
10
5
0
Flow (cumecs)
1-Jan-14
1-Feb-14
1-Mar-14
1-Apr-14
1-May-14
1-Jun-14
Oreti Flow
Alliance Abstraction as Flow


30
25
20
15
10
5
0
Flow (cumecs)
1-Jul-14
1-Aug-14
1-Sep-14
1-Oct-14
1-Nov-14
1-Dec-14
Oreti Flow
Alliance Abstraction as Flow

APPENDIX 4

Raw Benthic Invertebrate Data

	MCI	U1a	U1b	U1c	U1d	U1e	U2a	U2b	U2c	U2d	U2e	D1a	D1b	D1c	D1d	D1e	D2a	D2b	D2c	D2d	D2e
Ephemeroptera																					
Deleatidium	8	400	204	236	212	356	404	416	284	508	316	228	248	352	400	260	356	212	248	656	236
Trichoptera																					
Aoteapsyche	4	7	-	-	-	5	1	1	2	2	1	1	3	2	14	1	1	2	1	1	5
Costachorema	7	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Ecnomina	8	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hudsonema	6	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	-
Hydrobiosis	5	2	1	-	3	2	-	-	-	1	-	-	-	1	-	-	2	1	1	1	2
Olinga	9	-	-	-	1	-	2	-	-	1	1	-	1	2	9	1	-	-	2	-	2
Oxyethira	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	1	-
Plectrocnemia	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Polyplectropus	8	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Psilochorema	8	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	1	-	-	-
Pycnocentria	7	-	-	1	1	-	1	-	-	-	-	-	1	-	9	-	-	-	-	1	-
Pycnocentrodes	5	5	3	5	3	3	7	-	3	1	7	1	3	6	6	-	7	3	4	5	3
Megaloptera																					
Archichauliodes	7	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coleoptera																					
Elmidae	6	15	1	2	7	4	3	1	11	11	10	-	1	2	1	2	2	2	-	1	3
Diptera																					
Aphrophila	5	-	-	1	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Eriopterini	9	1	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Orthocladiinae	2	-	-	-	-	-	-	1	1	-	-	-	-	-	2	-	1	-	-	-	-
Tanytarsini	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1	-
Crustacea																					
Ostracoda	3	-	-	1	-	-	-	1	1	-	1	-	-	-	2	-	1	-	-	2	-
Paracalliope	5	-	1	-	-	1	-	-	-	-	-	-	2	1	-	-	1	1	-	-	-
Paraleptamphopus	5	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Acarina																					
Acarina	5	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Mollusca																					
Potamopyrgus	4	112	60	13	44	27	40	40	5	48	12	1	4	6	72	8	19	48	10	6	17
Sphaeriidae	3	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
OLIGOHAETA	1	128	56	40	11	76	112	16	252	21	200	96	264	288	52	192	84	348	168	212	72
PLATYHELMINTHES	3	1	-	-	1	-	-	-	-	1	-	-	-	1	-	2	-	-	-	-	-
NEMERTEA	3	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

ATTACHMENT B

Soil Work Ltd – Memo re Lysimeters

SOILWORK LTD
Professional Soil Consultants PO Box 5908 Dunedin NZ Ph 03 467 9560

ALLIANCE GROUP LTD, LORNEVILLE PLANT:

WASTEWATER IRRIGATION:
METHODOLOGY USED TO ESTIMATE NITRATE-NITROGEN LEACHING

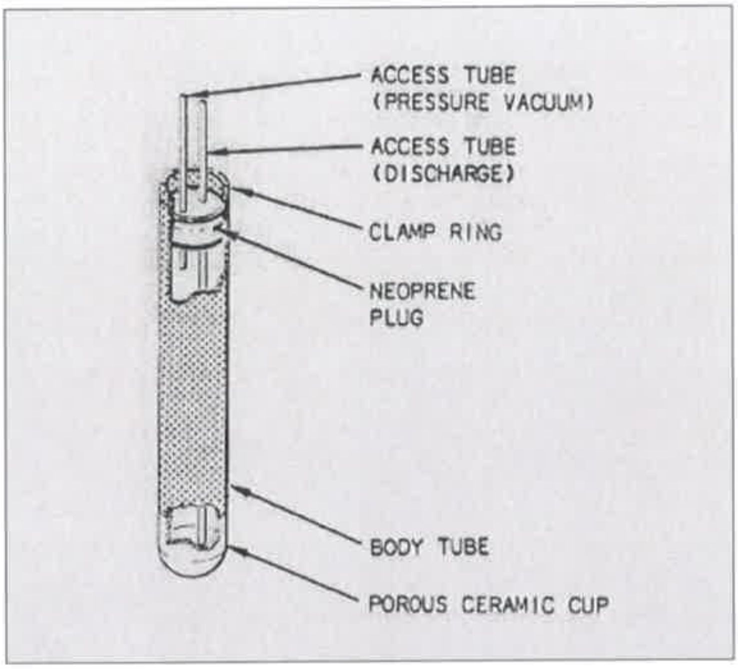
Prepared for

Alliance Group Ltd, Lorneville Plant
Invercargill
New Zealand

By Dr P. B. Greenwood

February 2016

The lysimeters used on the Lorneville farm are pressure/vacuum soil water samplers, similar to that illustrated below, which consist of ceramic cups (approximately 5 cm diameter and 6 cm long) attached to lengths of plastic pipe. They contain pressure and vacuum tubes for extracting samples of leachate.



Leachate samples are collected monthly by creating a small suction within each lysimeter. Leachate travelling through the profile in soil macropores (pores larger than approximately 30 μm) is thus collected and withdrawn for analysis. Each sample is analysed for nitrate-N concentration. An estimate of nitrate leaching is then assessed using the nitrate concentrations in leachate samples together with estimates of drainage for the periods between sampling dates.

Drainage is calculated using a SoilWork daily soil water model. This has been used regularly since 1996 to assess wastewater and irrigation options in Southland, Otago, and Canterbury, and to monitor the effects of wastewater irrigation at many sites. The results of its use in Southland have been peer-reviewed favourably on two occasions since 2001 (by Lincoln Environmental and Pattle Delamore Partners).

The model balances water inputs (rainfall and wastewater applications) with storage within the soil and water losses (evapotranspiration, drainage, runoff). With input of rainfall and potential evapotranspiration data, it estimates actual evapotranspiration using the current soil water content as a basis for adjustments to the potential rate. Actual evapotranspiration, rainfall, and internal soil drainage characteristics are used to estimate daily soil water content and drainage.

Meteorological data from from Invercargill, the nearest fully equipped meteorological station for which suitable data is available, has been used for rainfall, and for potential evapotranspiration using the 'Penman' equation. Records of wastewater irrigations were supplied by Alliance Group staff. Soil data used in the model was from measurements made earlier for the various soils.

Lysimeters were installed in six monitoring sites in October 2002. Three of those sites comprise Waikiwi soils and three comprise Dacre soils and for each of those soils two sites are located within wastewater irrigation areas whilst the remaining site does not receive any wastewater.

At each monitoring site there are three individual lysimeter installations, thus for each of the two soil types there are six individual lysimeter installations within wastewater irrigation areas and three such installations in non-irrigated control areas. In total, there are eighteen individual lysimeters.

Although wastewater irrigation occurs on both soil types during dry conditions, most occurs on the Waikiwi soils. Nonetheless, some lateral movement of nutrients from animal returns and wastewater will invariably occur into the slightly lower Dacre soils from time to time. This transfers nutrients from the gently sloping minor sideslopes between Waikiwi soils and Dacre soils, to the slightly lower relict stream channels that comprise Dacre soils. Thus, while Dacre soils occupy a comparatively small proportion of the area that is irrigable, equal numbers of lysimeters are installed in both the Waikiwi and Dacre soil types.

Estimates of nitrate leaching clearly improve in accuracy as the number of small-cup lysimeters that are used increases. While the number used until now is considered to be the minimum required for a general estimate of leaching on this farm, it was considered appropriate for this site because:

- the wastewater irrigation scheme on Lorneville farm is of a minor scale with wastewater applications occurring for only a short period during dry conditions each season in summer to early autumn (in 2013-2014, for instance, an average of only 1.5 irrigations, with an associated 103 kg N/ha, was conducted on each irrigable area and these occurred between 28 January and 13 March using a long average irrigation return time of 28 days);
- wastewater applications occur in a moderately uniform manner with a fixed application amount per irrigation event.

If earlier monitoring of groundwater nitrate-N concentrations had shown increased values in response to wastewater irrigation, additional lysimeter installations would have been recommended to Alliance to increase the accuracy of nitrate leaching estimates and to assist in determining appropriate measures to reduce leaching losses. Groundwater nitrate-N concentrations, however, have remained low. For the 2013-2014 season, for instance, the average value in an upstream bore was 4.3 g/m^3, whereas for the irrigation bore and a downstream bore the corresponding average value was 2.9 g/m^3.

Nonetheless, Alliance have accepted a recent recommendation that the number of leachate monitoring sites be increased to four per soil type instead of the current three. As a result, it is intended that there will be eighteen individual lysimeters located within wastewater irrigation areas and six in non-irrigated areas.

ATTACHMENT C

Golder Associates – s92 Responses Air Discharges

5 February 2016 Reference No. 1378104044_019_LR_Rev0_090

Frances Wise
Alliance Group Limited
P.O. Box 1410
Invercargill

RESPONSE TO ENVIRONMENT SOUTHLAND SECTION 92 REQUEST – APPLICATION FOR ALLIANCE LORNEVILLE

Dear Frances

This letter[1] provides responses from Golder Associates (NZ) Limited (Golder) to further information requested by Environment Southland (ES) regarding Alliance Group Limited (Alliance) application to discharge contaminants to air (APP-20158595). The information was requested in a letter from Joanna Gilroy (Senior Consents Officer, ES) to Mitchell Partnerships Ltd, dated 26 January 2016.

The ES information requests regarding air discharges are restated below followed by Golder's response.

ES Question 1

A description of the sensitivity of the receiving environment, primarily the rural land immediately east of the discharge that is affected by the highest PM_{10} and SO_2 concentrations (exceeding guidelines). What is the potential for the use of this land to change?

Golder Response

A consideration of the potential for the future use of rural land immediately east of the coal-fired boilers (CFBs) to change is a matter that is best addressed by Alliance's expert planning advisors. Section 4.2 of the CFB air discharge assessment report (Golder 2015a) provides our own view, which is that the current land use for the area in question is unlikely to change.

ES Question 2

A description of any anticipated plant expansion and whether or not the supplied modelling reflects the actual and likely effects of the proposed activity over the term of the consent. Or is it likely that the emissions from the site will remain at the status quo (as modelled) for the requested 35 years?

Golder Response

Alliance has indicated to Golder that future stock processing rates are not expected to increase above current levels. The CFB steam output profiles used to define the air emission profiles were based on the

[1] Subject to the limitations in Attachment A.

2013/2014 processing season when the new rendering plant was fully commissioned. The proposed ambient PM_{10} percentile concentration limits are therefore based on the current processing rates, plant design and associated CFB operating profiles. If, for any reason, the CFB energy demand and the average discharge rate of contaminants increases over the next 35 years, then the proposed ambient monitoring of PM_{10} would effectively detect increased levels and any non-compliance with the proposed percentile concentration limits. If this situation occurred in the future, then this would need to be addressed by Alliance through increased controls on CFB particulate emissions to achieve compliance or else a variation of consent would be required.

ES Question 3

Inclusion of an annual check on the hydrolyser exhaust gas extraction to the boiler, or an explanation as to why the applicant considers this unnecessary.

Golder Response

Section 5.3 of the odour mitigation report (Golder 2015b) recommends annual checking of the blood dryer's exhaust air extraction system that discharges this odorous stream through the CFB primary combustion air system. Golder considers that it is reasonable for Alliance to include the hydrolyser exhaust extraction as part of this annual check, especially as it is part the same extraction and combustion system that targets the blood dryer.

ES Question 4

Clarification of whether or not the meal room and load-out areas are the only direct discharges of odour on the site.

Golder Response

The meal room is the only rendering building that has its air directly vented to the atmosphere. However, there a number of reasons why rendering odours have been noticed beyond the site boundary, described here. Section 2 of the baseline odour survey (Golder 2015c) confirms that rendering odours were uncontrolled during the commissioning phase of the new rendering plant, which occurred in the 2012/2013 processing season. These emissions are now effectively contained. Raw material odours associated with unloading operations at the new raw material reception building were also suspected of causing some rendering offal type odours beyond the site boundary; new extraction system installed in 2015 has controlled these to a minor level. Finally, as discussed by Golder (2015c), it is suspected that sulphide odours associated with the fellmongery wastewater are likely to have been noticed on some occasions during the last few years and some of these are likely to have been attributed by the community to the rendering plant operation.

Closure

Please contact the undersigned to discuss the above responses as necessary.

Yours sincerely

GOLDER ASSOCIATES (NZ) LIMITED

Roger Cudmore
Principal Environmental Consultant

RSC/NG/RLC/als
Attachments: Attachment A – Report Limitations

References

Golder 2015a. Assessment of Coal-Fired Boiler Air Emissions. Report Number 1378104044_017_R_Rev2_060 prepared by Golder Associates (NZ) Limited for Alliance Group Limited, Lorneville. October 2015.

Golder 2015b. Process Odour Mitigation. Report Number 1378104044-013-R-Rev4-090 prepared by Golder Associates (NZ) Limited for Alliance Group Limited, Lorneville. October 2015.

Golder 2015c. Baseline Odour Survey. Report Number 1378104044-014-R-Rev1-030 prepared by Golder Associates (NZ) Limited for Alliance Group Limited, Lorneville. October 2015.

Attachment A - Report Limitations

This Report / Document has been provided by Golder Associates (NZ) Limited ("Golder") subject to the following limitations:

i) This Report / Document has been prepared for the particular purpose outlined in Golder's proposal and no responsibility is accepted for the use of this Report / Document, in whole or in part, in other contexts or for any other purpose.

ii) The scope and the period of Golder's Services are as described in Golder's proposal, and are subject to restrictions and limitations. Golder did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Report / Document. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Golder in regards to it.

iii) Conditions may exist which were undetectable given the limited nature of the enquiry Golder was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Report / Document. Accordingly, if information in addition to that contained in this report is sought, additional studies and actions may be required.

iv) The passage of time affects the information and assessment provided in this Report / Document. Golder's opinions are based upon information that existed at the time of the production of the Report / Document. The Services provided allowed Golder to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

v) Any assessments, designs and advice made in this Report / Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Report / Document.

vi) Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Golder for incomplete or inaccurate data supplied by others.

vii) The Client acknowledges that Golder may have retained subconsultants affiliated with Golder to provide Services for the benefit of Golder. Golder will be fully responsible to the Client for the Services and work done by all of its subconsultants and subcontractors. The Client agrees that it will only assert claims against and seek to recover losses, damages or other liabilities from Golder and not Golder's affiliated companies. To the maximum extent allowed by law, the Client acknowledges and agrees it will not have any legal recourse, and waives any expense, loss, claim, demand, or cause of action, against Golder's affiliated companies, and their employees, officers and directors.

viii) This Report / Document is provided for sole use by the Client and is confidential to it. No responsibility whatsoever for the contents of this Report / Document will be accepted to any person other than the Client. Any use which a third party makes of this Report / Document, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this Report / Document.