report

November 2015

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

Submitted to:
Alliance Group Ltd

freshsolutions water
environmental consultants

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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 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.

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 just 39% of the 7DMALF.

The Alliance water take is located approximately 1 km downstream of the Riverton-Wallacetown Highway Bridge (Figure 1). 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 (Figure 2 and Figure 3).

2.0 Assessment Methodology

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.

The small size of the take relative to the large flow in the river, the short section of non-tidally influenced river (approximately 400 m) potentially affected by the take, the insensitivity of the lower Oreti River that results from the rivers morphology and tidal influence and the very minor effect of the abstraction on key environmental flow characteristics such as the duration of minimum flow, accrual period length and small and medium flood frequency all support the desktop approach to the current assessment of effects. Following a review and comment by Ryder Consulting Ltd Alliance opted to undertake an assessment of the ecological values of the lower Oreti River focusing on the section of river upstream of the tidally influenced section potentially most affected by the abstraction.

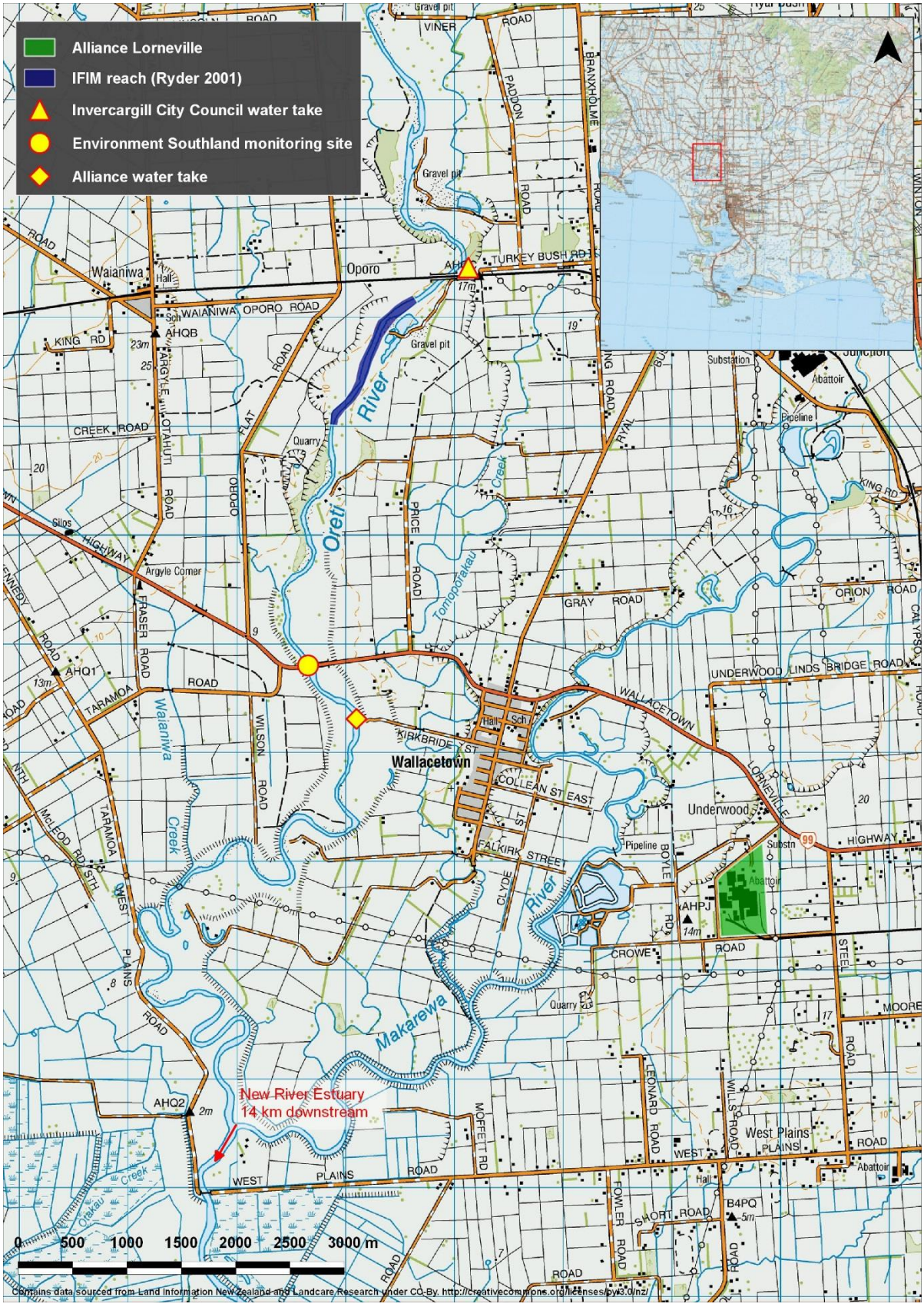

Figure 1: Location of water take.

Figure 2: View of the Alliance water take from the Oreti River.

Figure 3: View of the Alliance water take and Wallacetown Highway Bridge.

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 above/below the abstraction in summer 2016 will be included in the final assessment of effects of the abstraction.

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

3.1 Physical Description

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 4). Figure 4 shows the catchment area to the Wallacetown flow gauging site in black and the remaining catchment area to the estuary before it discharges into Foveaux Strait in red.

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 25.7km up the Oreti River from the New River Estuary to approximately 1km downstream of the Wallacetown Bridge (Chris Jenkins, pers. com). 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 1). 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 1: 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

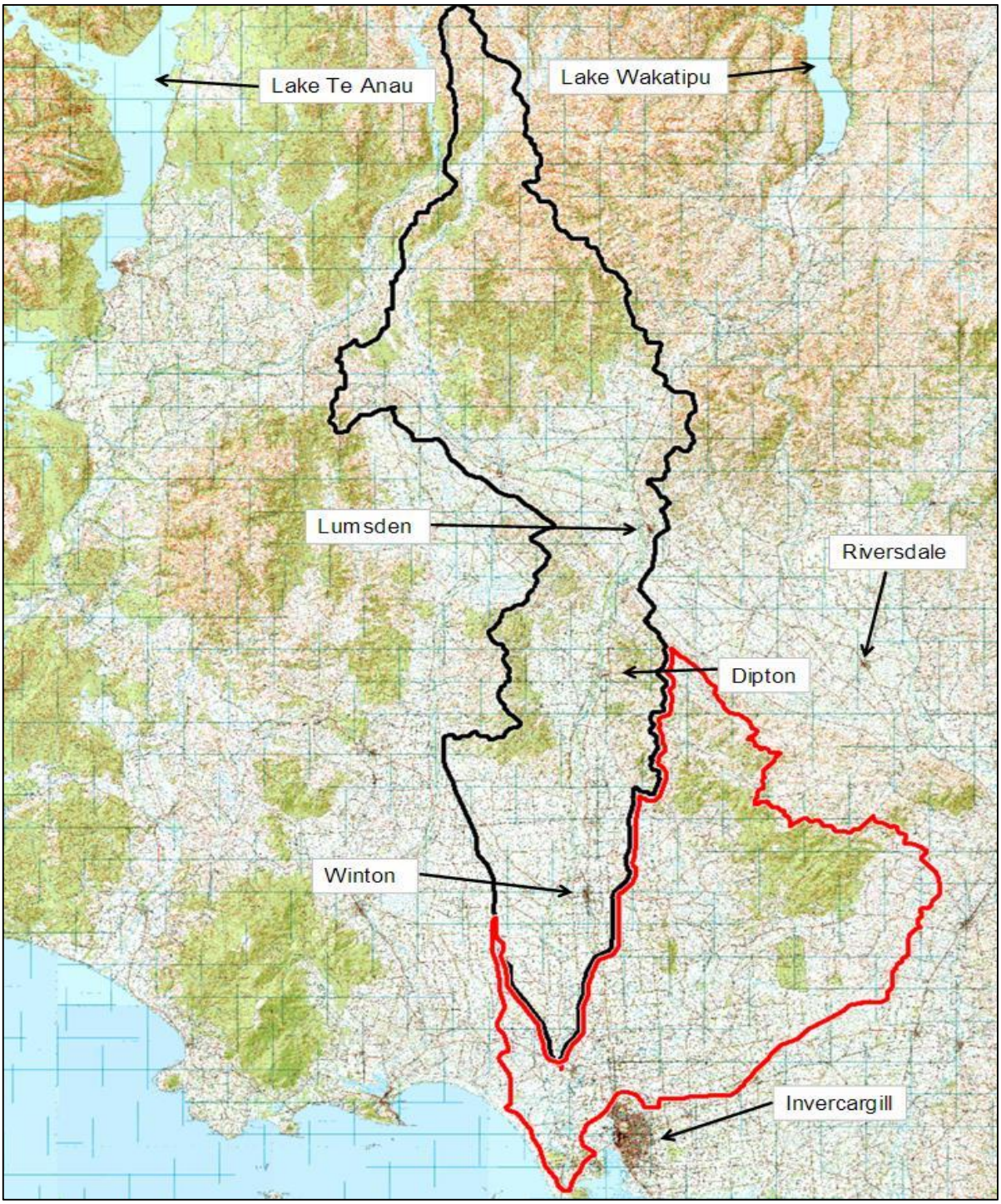

Figure 4: Oreti River Catchment.

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 5)

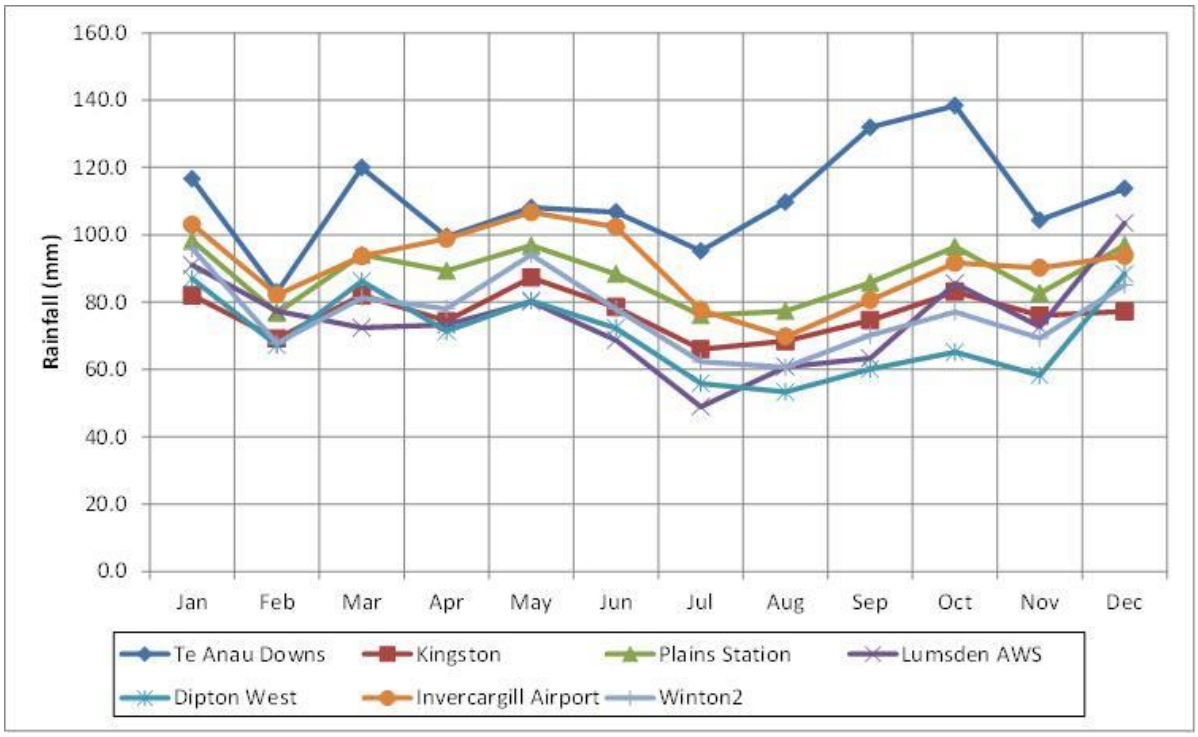

Figure 5: Monthly Average Rainfalls for Various Sites.

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. com.) 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 2.

Table 2: 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 litres per second 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 3 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 3: Measured and Naturalised Flow Statistics for the Oreti River at Wallacetown.

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
Wallacetown Naturalised	40,410	28,160	1,408,180	2,970	7,700	18.4	10.8	10.4	8.4

Table 3 shows that naturalising the Oreti at Wallacetown flows 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.

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 6).

The monthly average rainfall totals from Figure 5 along with the average monthly flows from Figure 6 are presented in Figure 7.

Rainfall and flow maxima are generally not in phase with each other (Figure 7). 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.

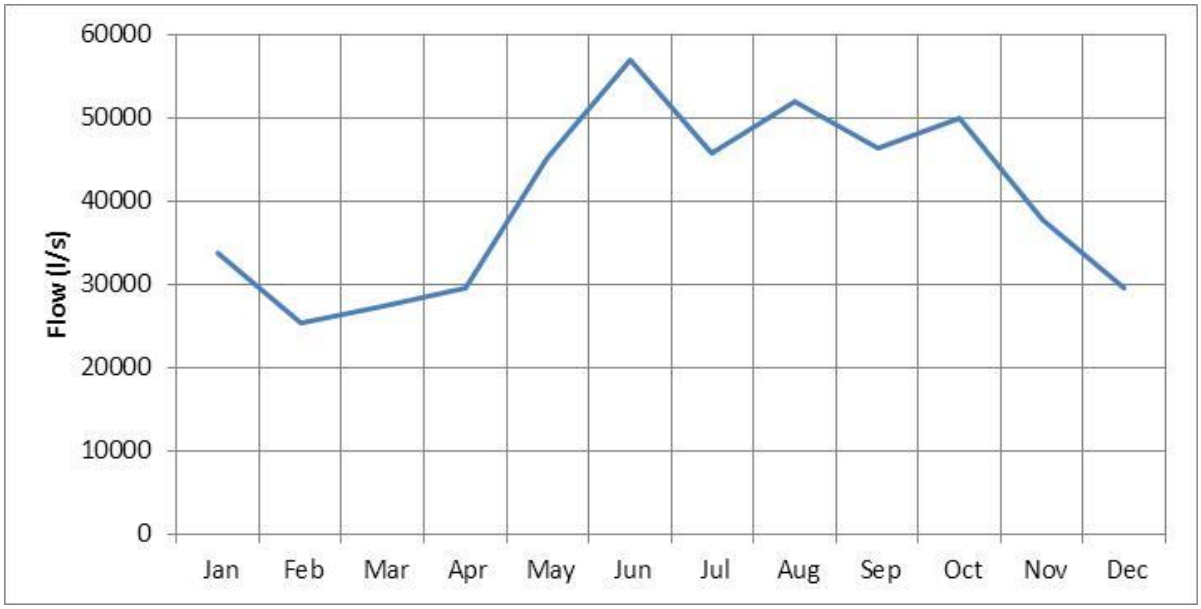

Figure 6: Monthly Flow Pattern for the Oreti at Wallacetown.

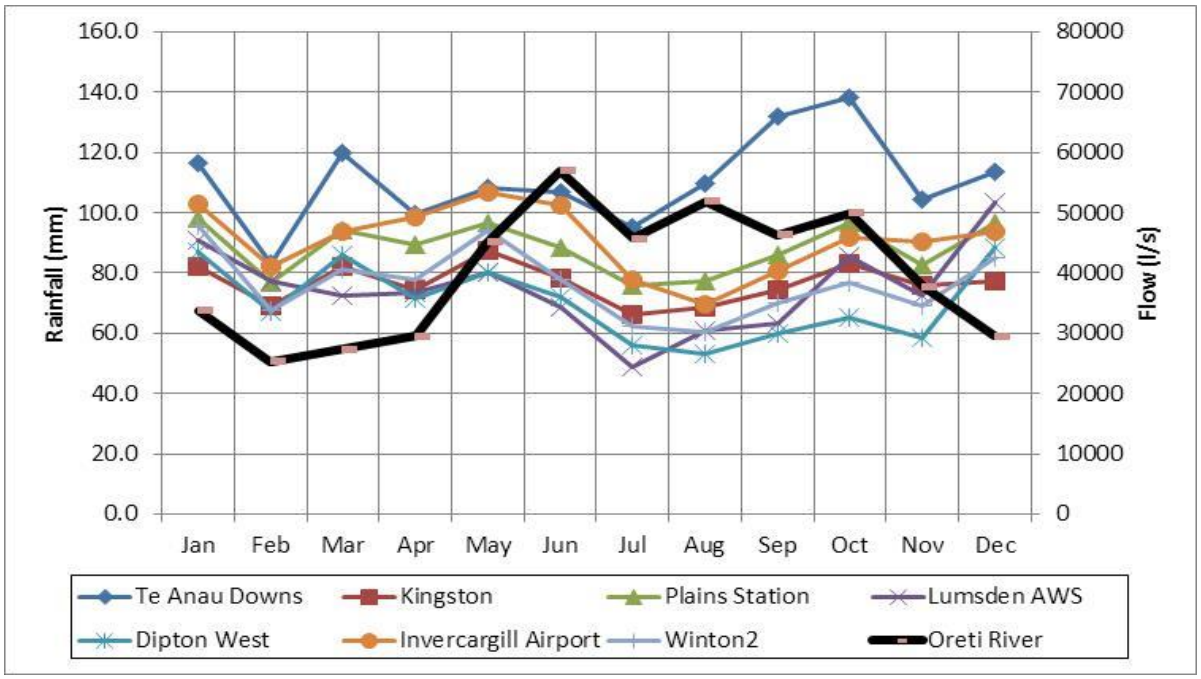

Figure 7: Average Flows at Wallacetown and Various Average Rainfalls.

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 3). 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 4).

Table 4: 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 - 20 March. Flows rose and fell in the intervening 13 day period. There was a 6 day consecutive period from 14–19 March when flows were below the 39% of 7DMALF flow.

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

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 19–28 March. There were no days below the 39% 7DMALF flow.

In 2013, there were consecutive days of flows below 50% of 7DMALF from 13 – 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.
- FRE_3 (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 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. The following key points summarise water quality data collected by Environment Southland at the Riverton-Wallacetown Highway Bridge site between 2005 and 2010 (Environment Southland 2012):

- 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 description of the current water quality of the lower Oreti River will be updated with more recent data including from SRC following the proposed summer 2015–2016 water quality and ecological survey of the river.

4.2 Aquatic Habitat

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 single moderately incised and meandering channel. The river is constrained between steep banks with few riffles (Figure 8 and Figure 9). River bed sediments are dominated by coarse and fine gravels near the Alliance water take and coarse and fine sands downstream.

Figure 8: View of Oreti River immediately downstream of the Alliance water take.

Figure 9: View of Oreti River approximately 5 km downstream from Alliance take.

4.3 Periphyton

Background Data

Water quality and aquatic habitat conditions in the Oreti River at and upstream 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 at the Riverton-Wallacetown Bridge between 2005 and 2010 (Environment Southland 2012):

- Chlorophyll-*a* concentrations at the Riverton-Wallacetown Bridge exceeded the MfE guideline in Biggs (2000) 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.

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 cobble substrates downstream of the abstraction point is likely to limit the diversity and abundance of periphyton and significantly reducing the likelihood to nuisance algal growths occurring downstream of the abstraction point.

Following a review and comment by Ryder Consulting Ltd Alliance opted to undertake an

assessment of the ecological values of the lower Oreti River in Summer 2015 – 2016 that will include the collection of in-stream habitat data.

4.4 Benthic Invertebrates

Background Data

Water quality and aquatic habitat conditions in the Oreti River at and 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 was 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 lower Oreti River in proximity to and downstream of Alliance's abstraction point is suited to supporting a range of water and habitat tolerant taxa that are tolerant of fine sediments and slow flowing water including cased caddis, snails, worms and chironomids. The lack of shallow riffle areas and tidal influence downstream of the abstraction point is likely to limit the diversity and abundance of mayflies and caddisflies significantly reducing the overall sensitivity of the benthic invertebrate community to water level changes.

Following a review and comment by Ryder Consulting Ltd Alliance opted to undertake an assessment of the ecological values of the lower Oreti River in Summer 2015 – 2016 that will include the collection of benthic invertebrate data.

4.5 Fish

Background Data

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 six species with an 'At Risk' classification (longfin eel, kōaro, giant kōkopu, īnanga, redfin bully and lamprey) 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 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 to 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 5. 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 - 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 5: 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	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 10).

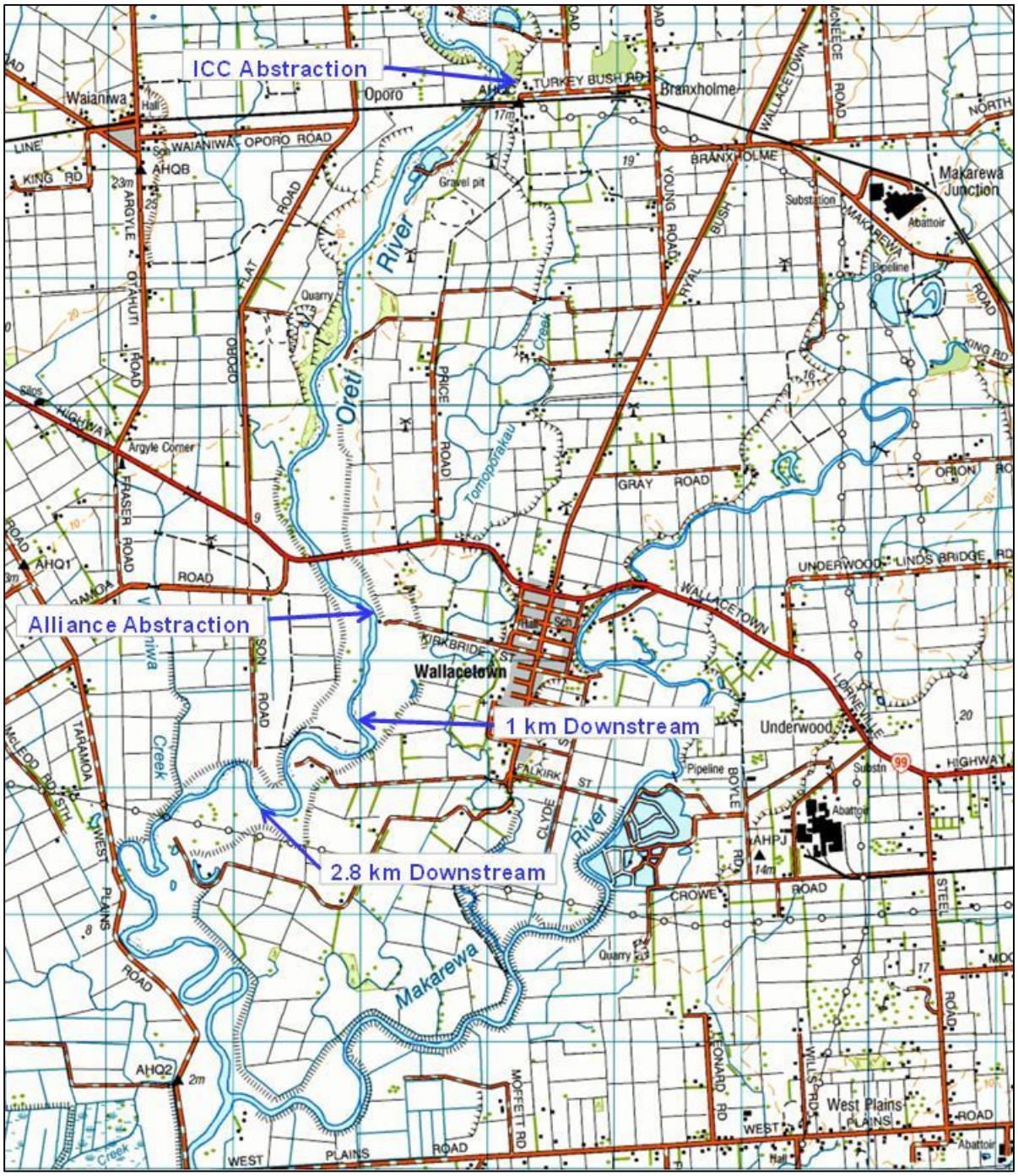

Figure 10: Downstream Section of the Oreti Catchment.

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 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.

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 flows are less than the 7DMALF under natural conditions, less than 7DMALF with the ICC abstraction included and 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 period 6 October 1977 to 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 6 shows the results of this analysis. Note that the table shows the total number of days less than 7DMALF over the entire record.

Table 6: 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 6, 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 5 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 11).

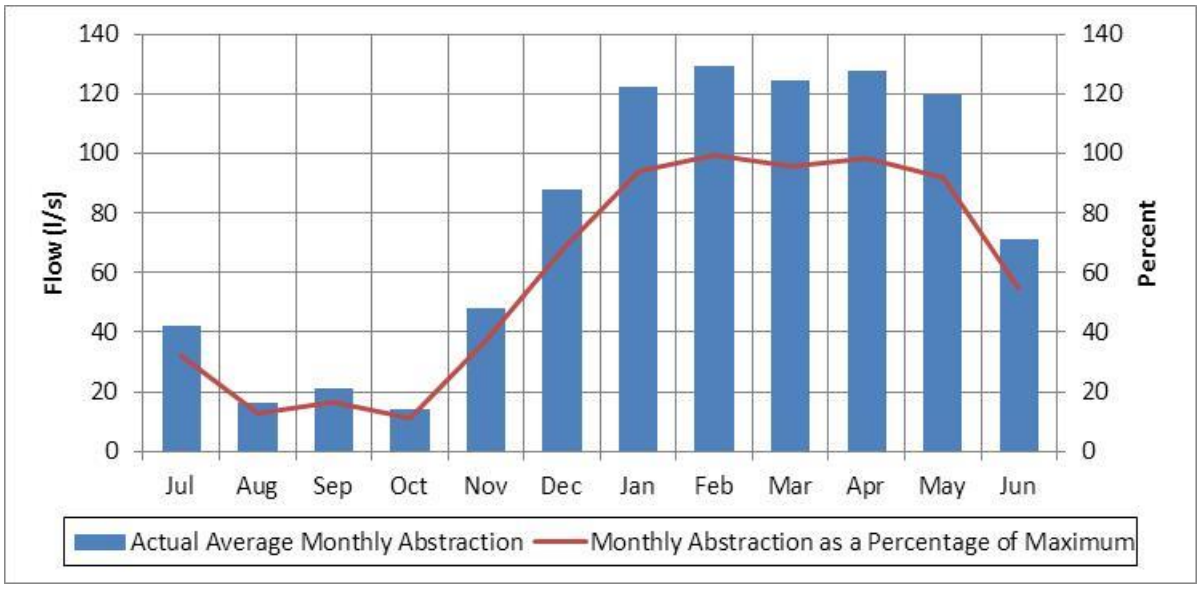

Figure 11: Alliance Monthly Water Abstraction

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 6 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 7 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 7: 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 7 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 8.

Table 8: 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 or extent of the current exceedances of water quality guidelines observed at the Riverton-Wallacetown Highway Bridge.

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–FRE 3 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 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 on a diverse and abundant riffle dwelling benthic invertebrate community. The periphyton and benthic invertebrate communities are therefore likely to be insensitive to the small reduction in water level associated with the take and any effects on periphyton growth and cover or benthic invertebrate community habitat and health are therefore assessed as less than minor.

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 2 and Figure 3; Section 2). 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 12). It is possible that a small number of 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 infrequent observation of a small number of eels indicates that the potential for entrainment or impingement at the water intake structure is low. Despite this Alliance is currently investigation options for reducing the risk of fish becoming impinged on the screen or entrained in the water take.

Figure 12: 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 key migration and spawning periods 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 lack of shallow riffle areas and tidal influence downstream of the abstraction point is likely to limit the diversity and abundance of mayflies and caddisflies and suitable habitat for supporting periphyton growths significantly reducing the overall sensitivity of the benthic invertebrate and periphyton communities to water level changes in most of the reach downstream of the take.

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 the receiving environment to water level changes and short length (400 m reach between the abstraction point and the upper extent of the tidal influence) any effects on biological communities including 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 a small number of small fish including smelt, īnanga, elvers and trout fry.

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.

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Report Signature Page

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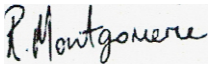


Richard Montgomerie

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.

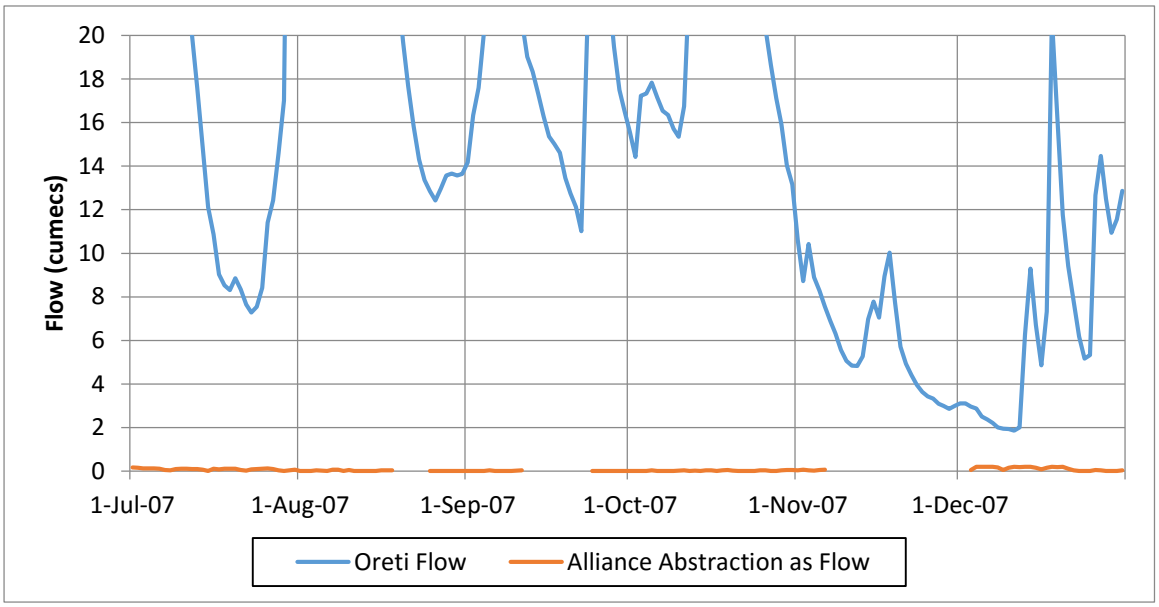
5.1.2 The Model

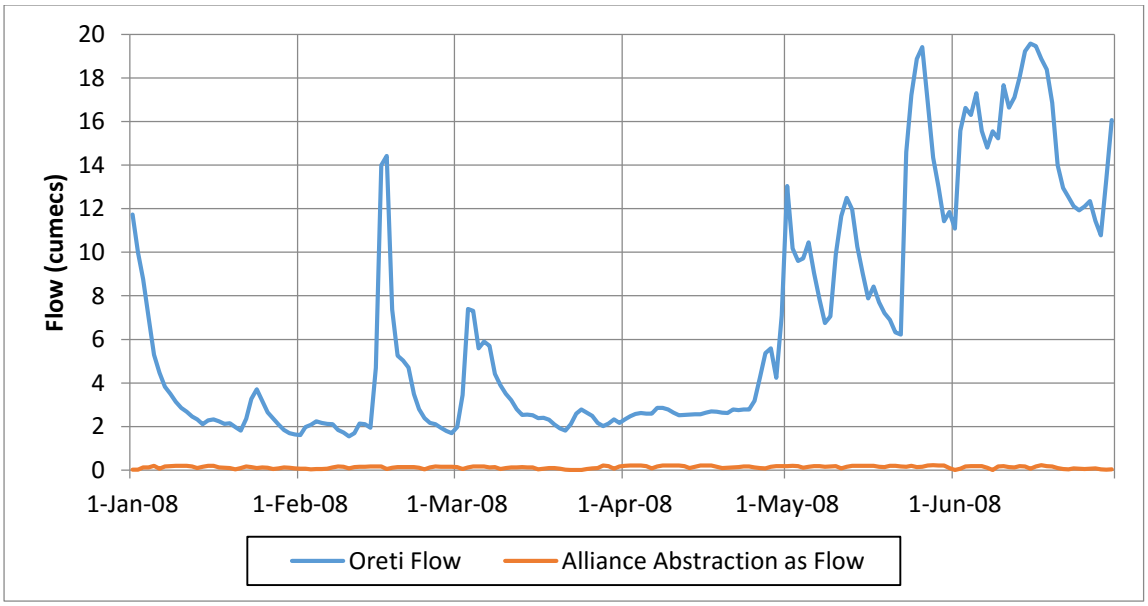
There were a series of assumptions that needed to be made for this model. They included:

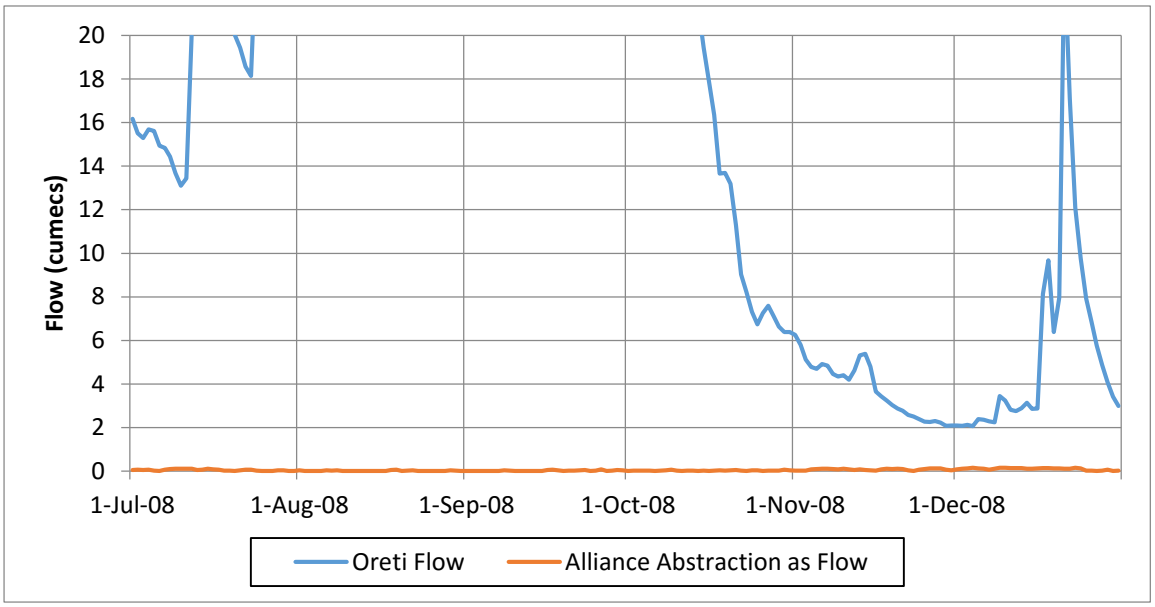
- Irrigation is assumed to occur continuously from 1 November to 31 March the following year. It is recognised that this is unlikely but making this assumption should result in a worst case situation. While it is possible to use derived rainfall, evapotranspiration and likely available soil moisture 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.

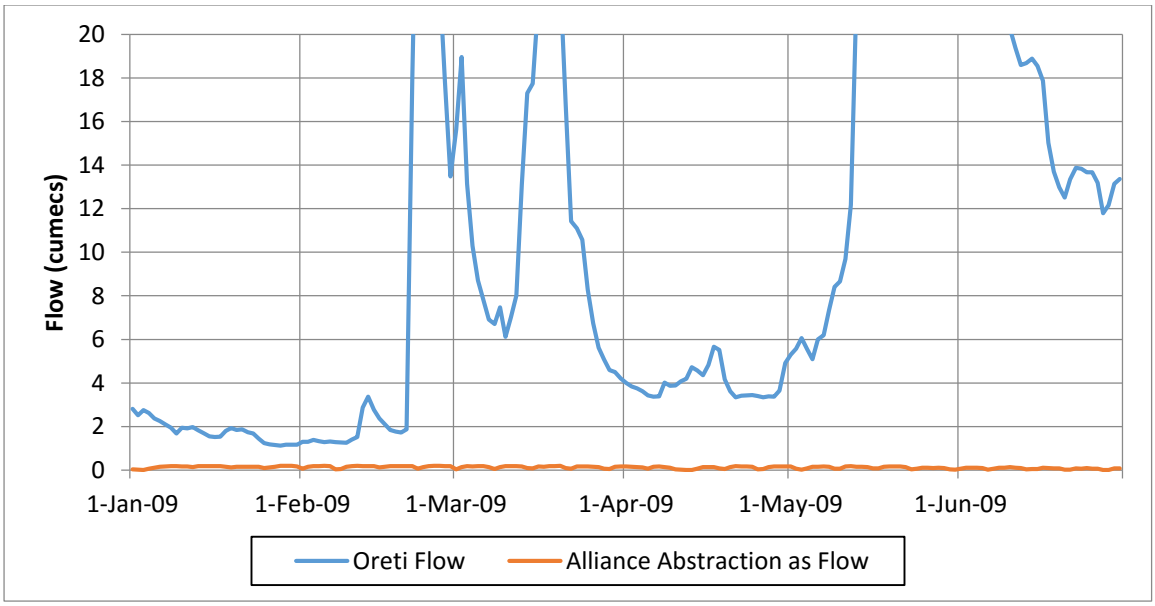
APPENDIX 3

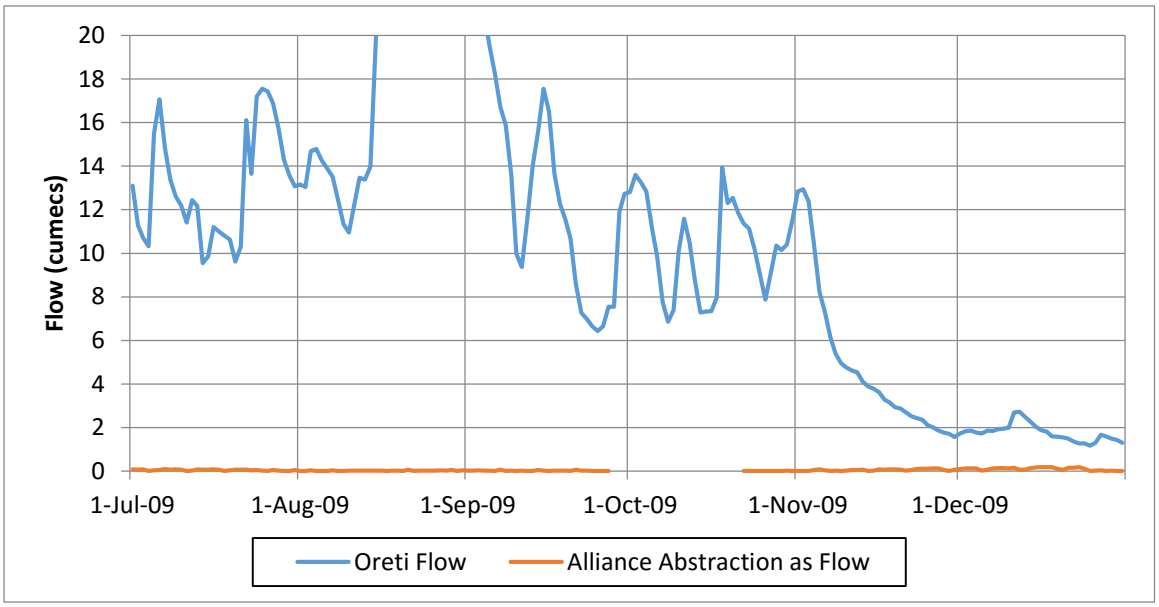
River Flow vs Alliance Abstraction (as flow)

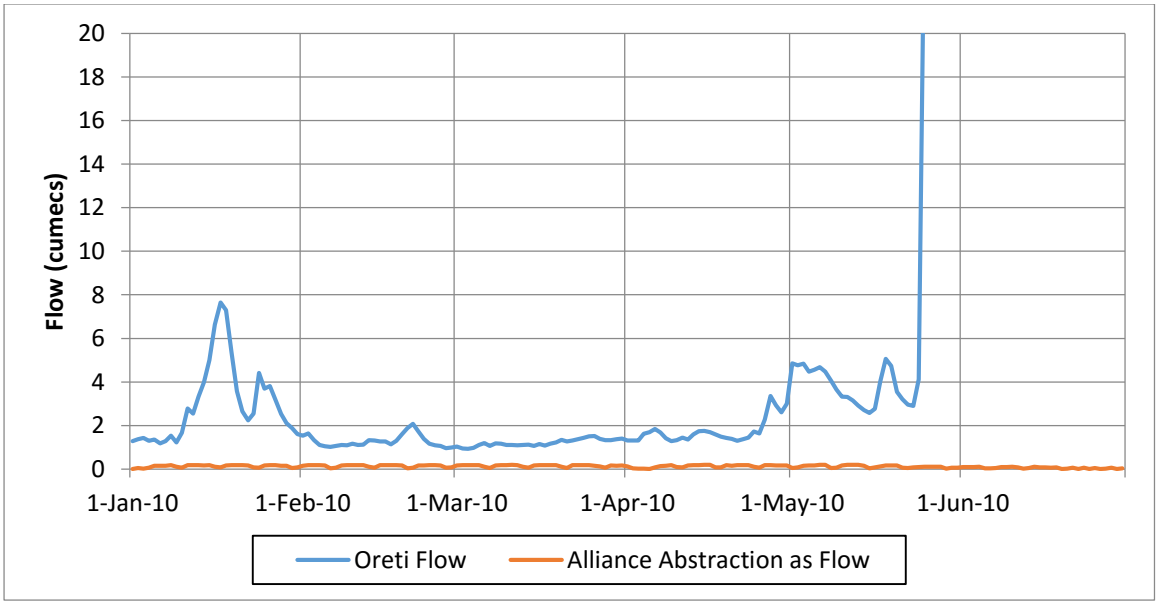

Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jul-07
1-Aug-07
1-Sep-07
1-Oct-07
1-Nov-07
1-Dec-07
Oreti Flow
Alliance Abstraction as Flow

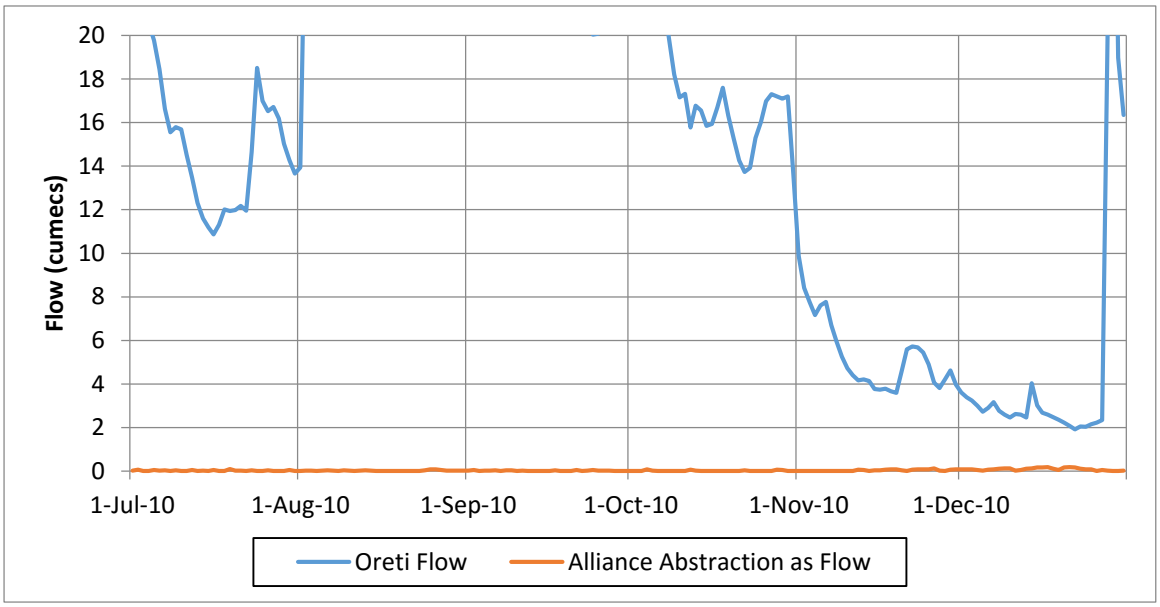

Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jan-08
1-Feb-08
1-Mar-08
1-Apr-08
1-May-08
1-Jun-08
Oreti Flow
Alliance Abstraction as Flow

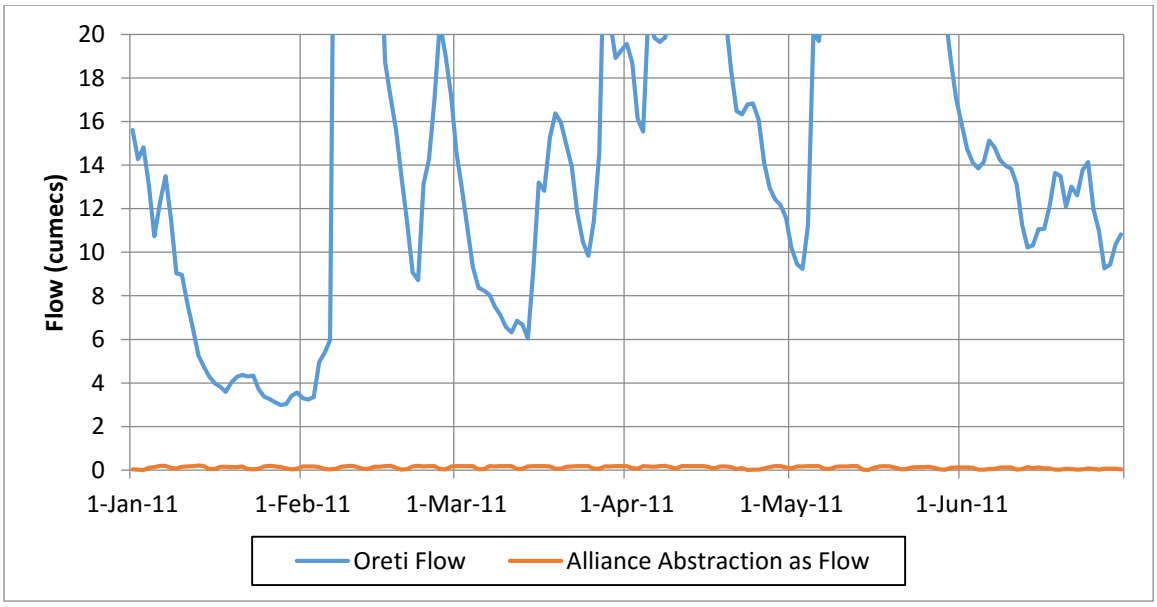

Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jul-08
1-Aug-08
1-Sep-08
1-Oct-08
1-Nov-08
1-Dec-08
Oreti Flow
Alliance Abstraction as Flow

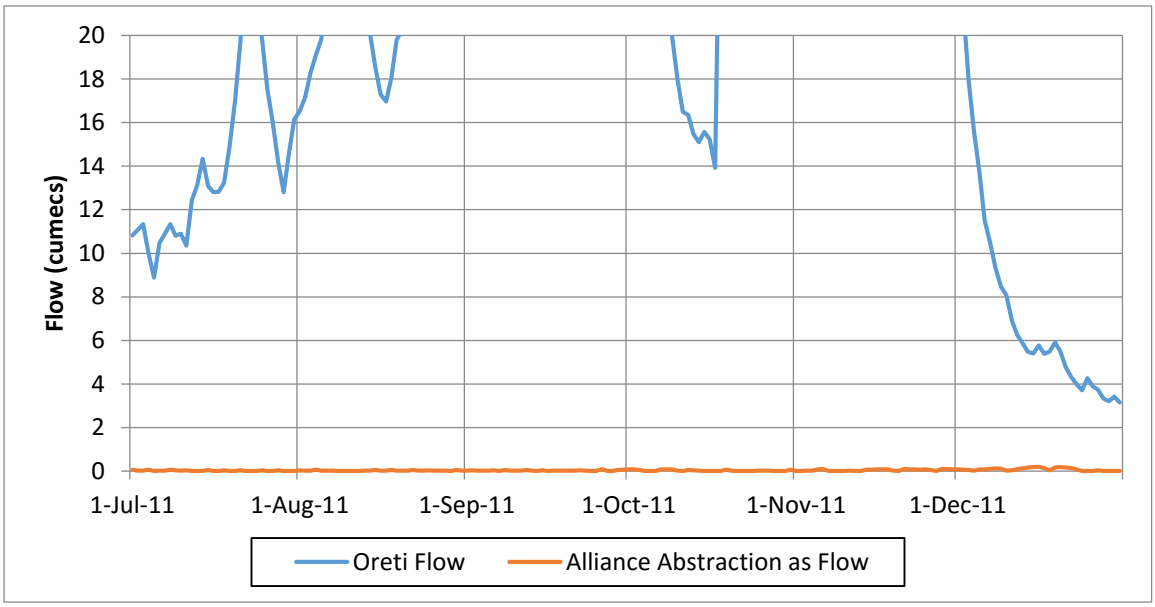

Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jan-09
1-Feb-09
1-Mar-09
1-Apr-09
1-May-09
1-Jun-09
Oreti Flow
Alliance Abstraction as Flow

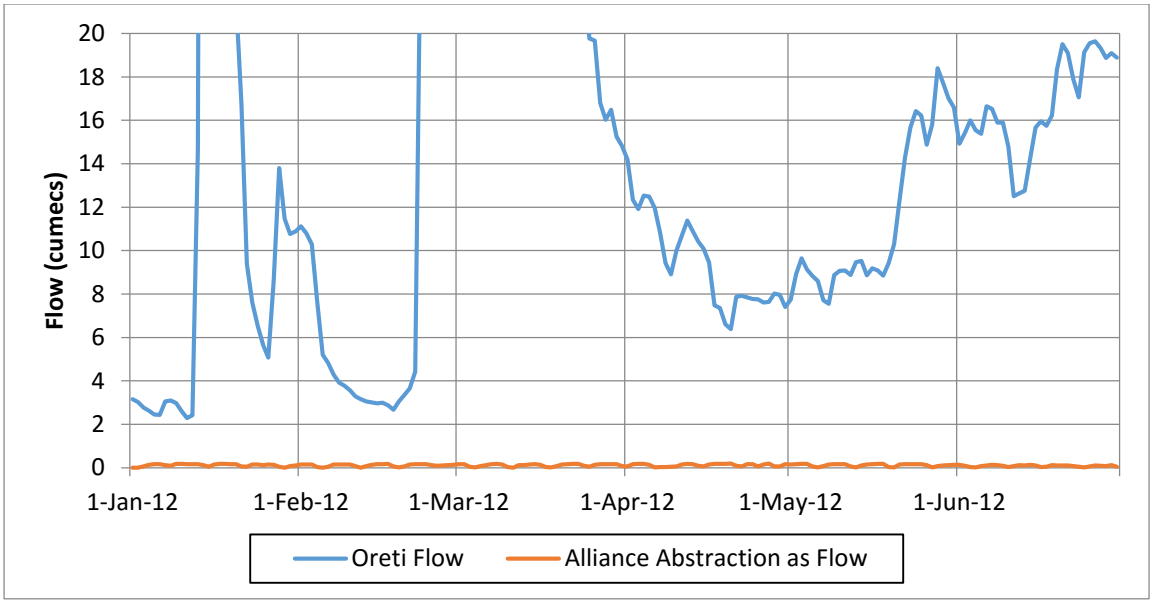

Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jul-09
1-Aug-09
1-Sep-09
1-Oct-09
1-Nov-09
1-Dec-09
Oreti Flow
Alliance Abstraction as Flow

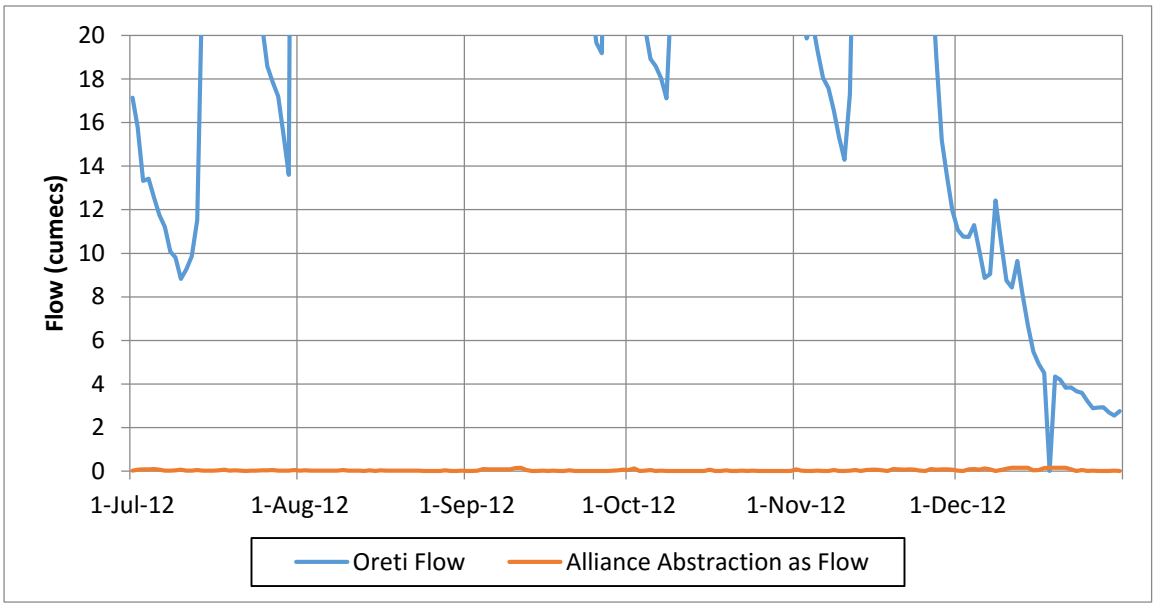

Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jan-10
1-Feb-10
1-Mar-10
1-Apr-10
1-May-10
1-Jun-10
Oreti Flow
Alliance Abstraction as Flow

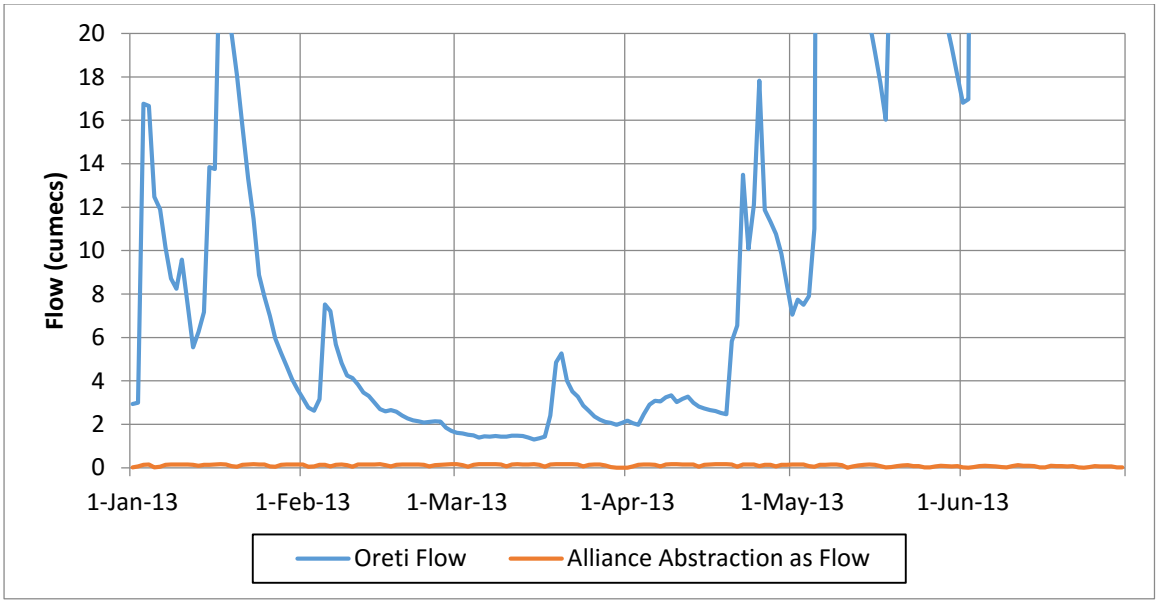

Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jul-10
1-Aug-10
1-Sep-10
1-Oct-10
1-Nov-10
1-Dec-10
Oreti Flow
Alliance Abstraction as Flow

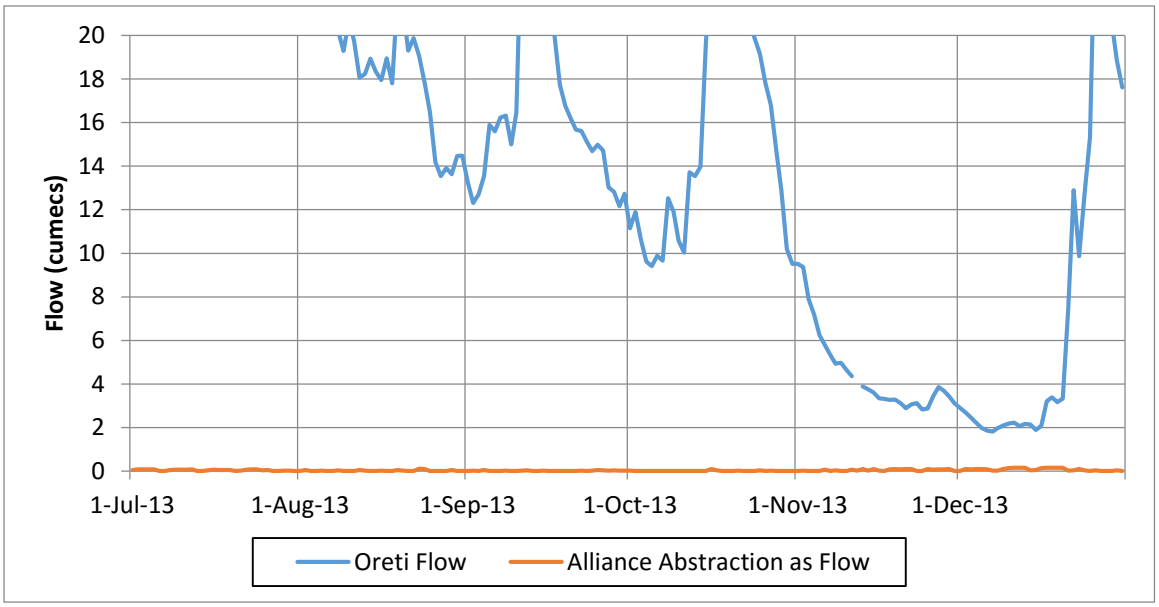

Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jan-11
1-Feb-11
1-Mar-11
1-Apr-11
1-May-11
1-Jun-11
Oreti Flow
Alliance Abstraction as Flow

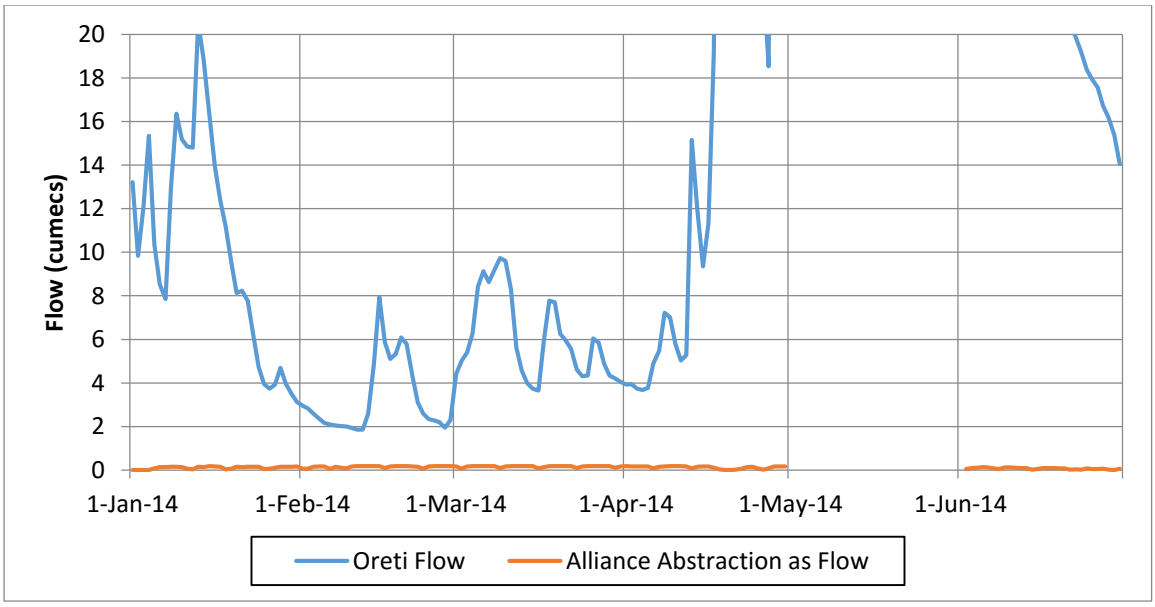

Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jul-11
1-Aug-11
1-Sep-11
1-Oct-11
1-Nov-11
1-Dec-11
Oreti Flow
Alliance Abstraction as Flow

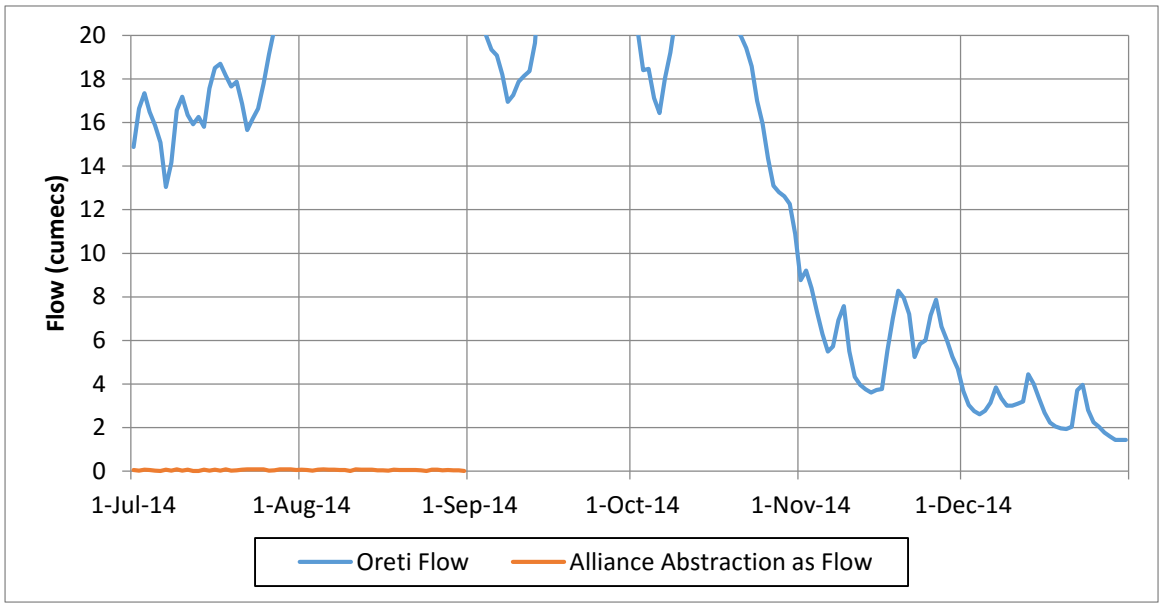

Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jan-12
1-Feb-12
1-Mar-12
1-Apr-12
1-May-12
1-Jun-12
Oreti Flow
Alliance Abstraction as Flow


Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jul-12
1-Aug-12
1-Sep-12
1-Oct-12
1-Nov-12
1-Dec-12
Oreti Flow
Alliance Abstraction as Flow


Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jan-13
1-Feb-13
1-Mar-13
1-Apr-13
1-May-13
1-Jun-13
Oreti Flow
Alliance Abstraction as Flow


Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jul-13
1-Aug-13
1-Sep-13
1-Oct-13
1-Nov-13
1-Dec-13
Oreti Flow
Alliance Abstraction as Flow


Flow (cumecs)
20
18
16
14
12
10
8
6
4
2
0
1-Jan-14
1-Feb-14
1-Mar-14
1-Apr-14
1-May-14
1-Jun-14
Oreti Flow
Alliance Abstraction as Flow


20
18
16
14
12
10
8
6
4
2
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