BEFORE ENVIRONMENT SOUTHLAND

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of Lorneville Processing Plant Resource Consent Applications (APP-20158595)

STATEMENT OF EVIDENCE OF RICHARD MONTGOMERIE
ON BEHALF OF ALLIANCE GROUP LIMITED

4 July 2016

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QUALIFICATIONS AND EXPERIENCE

1 My full name is Richard Neilsen Montgomerie.

2 I am a freshwater scientist and a director of Freshwater Solutions Limited, a specialist freshwater environmental consultancy. I have held senior roles at Kingett Mitchell Ltd, the Water Research Centre (UK) and Golder Associates. I have worked as a freshwater scientist and environmental consultant throughout New Zealand and in Europe since 1998. I specialise in monitoring and assessing the ecological effects associated with a wide range of activities including land development, discharges to water, land use change, water takes, damming and diverting water.

3 I hold the qualification of Master of Science in Freshwater Ecology from Otago University.

4 I have been involved in monitoring the effects of Alliance's treated wastewater discharge to the Makarewa River and abstraction of water from the Oreti River since 1998. I have been involved in work associated with the assessment of the current and possible future treated wastewater discharge and water abstraction effects on the Makarewa River, Oreti River and New River since 2012 including the following:

(a) Environmental data review and monitoring plan preparation;

(b) Site specific receiving water ammonia criteria evaluation;

(c) New River Estuary nutrient and sediment load estimates;

(d) Water quality, aquatic plant, benthic invertebrate and fish surveys in 2013 – 2014;

(e) Mixing zone assessment in summer 2014; and

(f) Assessment of the effects within the Makarewa River, Oreti River and the New River Estuary.

5 I have visited the Alliance Lorneville processing plant and undertaken monitoring or other water quality and ecology related assessments on numerous occasions since 1998 but particularly between 2012 and 2015.

6 In preparing this evidence I have reviewed:

(a) The reports and statements of evidence of other experts giving evidence relevant to my area of expertise, including:

(i) Dr Mike Fitzpatrick;

(ii) Mr Azam Khan; and

(iii) Dr Mark James.

(b) The Section 42 Officers' Report and the evidence of Dr Greg Ryder.

7 I have read and agree to comply with the Code of Conduct for Expert Witnesses (Environment Court Practice Note 2014). This evidence is within my area of expertise except where I state that I am relying on facts or information provided by another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

SCOPE OF EVIDENCE

8 My evidence is divided into two parts and addresses the following matters:

PART A:

(a) A description of the existing aquatic receiving environment including hydrology, water quality and ecology of the Makarewa River, lower Oreti River and New River Estuary; and

(b) A review of the relevant sediment, water quality and ecology data collected under the existing treated wastewater discharge consent.

PART B:

(c) A discussion of the effects of the water abstraction on the Oreti River.

EXECUTIVE SUMMARY

Treated Wastewater Discharge to the Makarewa River

9 The Plant discharges treated wastewater to the Makarewa River about 5 km upstream of the confluence with the Oreti River. The Makarewa/Oreti River confluence is approximately 14 km upstream of the New River Estuary. The lower Makarewa River is heavily influenced by the tide and the point of discharge is located near the upper end of the tidally influenced section of the River. The tide affects river level and water velocity but not salinity.

10 The tidal cycle and river profile and flow conditions mean that the area within which mixing takes place, at low river flow and low tide, extends

approximately 200 m downstream of the discharge. While around the time of high tide the mixing zone extends from approximately 200 m downstream to a location at least 200 m upstream of the discharge.

11 Lower Makarewa River water quality is characterised by elevated nutrient concentrations, high faecal indicator bacteria counts (>1,000 cfu/100 ml), low visual clarity (<1.6 m), moderate-high Amm-N concentrations (typically 2.5–7.5 g/m^3), generally moderate but occasionally low summer time dissolved oxygen concentrations (typically 5–9 g/m^3) and river water temperatures and pH that are suitable for supporting healthy biological communities.

12 Sediment quality upstream and downstream of the discharge shows elevated nutrient concentrations in the immediate vicinity of the discharge and 1.5 km downstream.

13 The benthic invertebrate and aquatic plant communities in the lower Makarewa River change in response to the substrate, channel gradient, water velocity, tidal influence and water quality changes that occur upstream and downstream of the Wallacetown-Lorneville Highway Bridge.

14 The native fish community in the lower Makarewa River is dominated by common bully and shortfin eels with a seasonal migration of īnanga, smelt, koaro, banded kokopu, giant kokopu, and lamprey.

15 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. Further downstream, the Oreti River naturally meanders within a single channel characterised by a series of long runs, shallow pools and occasional riffles. The river is constrained between steep banks with few riffles.

16 Oreti River at the Riverton - Wallacetown Highway Bridge is classified by SRC as ‘lowland hard bed’. The water quality approximately 10 km upstream of the Makarewa River confluence is characterised by moderate nutrient concentrations, moderate-low visual clarity, low unionised ammonia concentrations and river water temperatures that are suitable for protecting river ecosystem health.

17 The lower Oreti River is characterised by moderate benthic invertebrate community health and organic enrichment and are reflective of the elevated nutrients concentrations, and the increasingly developed nature of the catchment.

18 The Oreti River supports a healthy native fish fauna classed as being 'good quality' including six species with a 'declining' threat classification and one species with a 'nationally endangered' threat classification.

19 The New River Estuary supports high ecological values including a diverse bird fauna and freshwater and marine fish populations. Fish include five species of flatfish, eels, brown trout, smelt, whitebait and giant kokopu. The estuary provides important spawning and rearing habitat for marine and freshwater fish including whitebait species and has the highest usage of trans-equatorial shorebirds of all Southland estuaries.

20 Downstream of the Alliance discharge the median contribution of total nitrogen to the Makarewa River between 2001 and 2014 was approximately 53% of the total river load. Based on data from selected seasons Robertson and Stevens (2013), estimated that the mean annual load of total nitrogen to the New River Estuary is approximately 4,531 tonnes/year (Robertson and Stevens 2013). Accordingly, this would mean the contribution of the Plant to the load in the New River Estuary is approximately 4%.

21 The estimated median seasonal total phosphorus load is 18.4 tonnes/season. Hence, downstream of the discharge the median contribution of total phosphorus to the Makarewa River between 2001 and 2014 was approximately 68.1% of the total river total phosphorus load. According to Robertson and Stevens (2013) the mean annual load of total phosphorus to the New River Estuary is approximately 370 tonnes/year. Hence, the total phosphorus contribution from the Plant to the New River Estuary is approximately 5.0%.

22 The MfE/MOH Category D *E. coli* limit of < 550 cfu/100 ml was exceeded at the Bridge Site (upstream of the influence of the discharge) on 22 out of 47 sampling occasions while at the 350 m Site (downstream of the discharge) it was exceeded on 24 out of 47 sampling occasions.

23 The assessment of the receiving environment demonstrates that the lower Makarewa River is a typical lowland river draining a catchment that has been almost fully developed for agriculture. The lower Makarewa River is a silty slow flowing macrophyte dominated river with a benthic invertebrate community that is dominated by water and habitat tolerant taxa that prefer slow flowing macrophyte dominated habitat. The lower Makarewa River is an important migratory pathway for a range of native fish and also

supports a diverse native fish assemblage including species with a threat classification. The fish community is dominated by common bully and shortfin eel with brown trout also present.

Oreti River Water Take

24 Water quality and aquatic habitat conditions in the Oreti River are suited to supporting a moderately healthy benthic macroinvertebrate community. The median Macroinvertebrate Community Index 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 at sites upstream and downstream of Alliance's take in December 2015 was dominated by mayflies, had low diversity and Quantitative Macroinvertebrate Community scores that ranged from 'good' downstream to 'excellent' upstream.

25 The Oreti River supports a healthy native fish fauna classed as being 'good quality' based on the Index of Biotic Integrity score. Whitebaiting is popular along the tidal reach of the Oreti River. The Oreti River supports a nationally significant brown trout fishery that receives moderate-high use.

26 The Oreti River in vicinity of Alliance's intake channel supports a healthy aquatic plant and benthic invertebrate community. At times of extended low flow nuisance algal growths do occur that reduce the diversity of water and habitat sensitive benthic invertebrate taxa. The only identified effect on the river due to Alliance's abstraction was a likely small (9%) increase in the number of days flows were below the natural 7DMALF. In my opinion this is very unlikely to result in water quality and ecological effects.

27 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 within five years

28 I do not agree with Dr Ryder the need to upgrade to the screen within two years. I base my opinion on the assessment of effects that I undertook that indicated that the risk of entrainment of small fish or impingement of larger fish is low. In my opinion undertaking the upgrade within 5 years of the commencement of the consent is appropriate.

PART A:

ASSESSMENT OF RECEIVING ENVIRONMENT

29 The Plant is located on the west Southland Plains within the Makarewa River catchment. The Plant discharges treated wastewater to the Makarewa River about 5 km upstream of the confluence with the Oreti River. The Makarewa/Oreti River confluence is approximately 14 km upstream of the New River Estuary. As I discuss further in my evidence, the lower Makarewa River is heavily influenced by the tide and the point of discharge is located near the upper end of the tidally influenced section of the River.

30 A data review in 2012 identified some gaps and resulted in an expansion of the compliance discharge and river water quality monitoring programme. Additions to the programme included increasing the range of parameters, sampling sites and sampling frequency to ensure that all relevant effects could be assessed using comprehensive datasets and to allow comparisons against relevant Southland Regional Council (**SRC**) guidelines and limits.

31 The monitoring plan was presented to stakeholders and the SRC. Stakeholders and SRC provided useful feedback and endorsed the proposed plan with no additional survey work added.

32 Alliance undertakes regular compliance water quality monitoring at three sites: Bridge Site (upstream of the discharge), 350 m downstream of the discharge and at the Boundary Site (1,200 m downstream of the discharge). A very large volume of data collected from these sites between December 2001 and May 2014 was summarised and presented as part of our assessment.

33 Four biological monitoring sites (Sites U1, U2, D1 and D2) were selected on the Makarewa River (Figure 1) and sampled in early March 2013, November 2013, February 2014 and March 2014 (Table 1). In addition, samples of whitebait caught from the Makarewa River in the vicinity of the

discharge between 17 August and 4 November 2013 were collected from fishermen and identified.

34 The Plant's discharge point is located near the upper end of the tidally influenced section of the river. There is a decreasing gradient of tidal influence from Site D1 to Site U2. The tide affects river level and water velocity but not salinity. Site U1 near the Wallacetown-Lorneville Highway Bridge is unaffected by the tidal cycle. The changes that occur in an upstream direction between Sites D1 and U2 include an increase in coarse substrate, an increase in riffle habitat, decreased macrophyte cover and decreased river water level variation. The tidal cycle and river profile and flow conditions means that the area within which mixing takes place, at low river flow and low tide, extends approximately 200 m downstream of the discharge. While around the time of high tide the mixing zone extends from approximately 200 m downstream to a location at least 200 m upstream of the discharge.

35 The New River Estuary is regularly and comprehensively monitored by Invercargill City Council (**ICC**) and SRC. The Catchment Land Use for Environmental Sustainability (**CLUES**) model was used to determine the proportion of nutrients in the estuary that are discharged by the Plant compared to other point and diffuse nutrient sources. The assessment of the water quality, ecological values and assessment of the effects of the discharge on the New River Estuary was undertaken by Dr Shane Kelly of Coast and Catchments Ltd using published reports, and a copy of this was attached to my report (Assessment of the Receiving Environment for Alliance Lorneville's Treated Wastewater Discharge).

UPPER MAKAREWA RIVER

36 The Makarewa River drains a 991 km^2 catchment that, apart from a small portion of the headwaters on the south western flanks of the Hokonui Hills, has been fully developed for agriculture.

37 The Makarewa River flow is gauged by the SRC at Counsell Road approximately 15 km upstream of the Plant. The key flow statistics calculated for the gauging site were:

(a) Mean: 15.67 m^3/s;

(b) Median: 7.65 m^3/s;

(c) Minimum: 0.80 m^3/s;

(d) 7 day Mean Annual Low Flow: 1.75 m^3/s;

(e) FRE3 (number of flow events / year exceeding three times the annual median flow); and

(f) Like many other lowland Southland rivers the Makarewa River regularly experiences accrual periods of lower flows that allow proliferation of algal growths.

38 SRC has monitored water quality at Lora Gorge Road and at Wallacetown since 2000. Both monitoring sites are classified by SRC as 'lowland soft bed'. The upper Makarewa River is characterised by elevated nutrient and in particular dissolved reactive phosphorus concentrations (>0.01 g/m^3), low visual clarity (<1.6 m), low unionised ammonia (Amm-N) concentrations (<0.034 g/m^3) and river water temperatures that are suitable for protecting river ecosystem health.

39 SRC has monitored periphyton and benthic invertebrates at King Road, Wallacetown and at the Winton-Hedgehope Road since 2000. The upper Makarewa River is characterised by low – moderate benthic invertebrate community health and organic enrichment (median Macroinvertebrate Community Index - MCI scores ranging from 81–103), regular exceedance of periphyton chlorophyll-*a* and occasional exceedance of the periphyton Ash Free Dry Weight guidelines and is reflective of the elevated nutrients concentrations, the modified nature of the river and highly developed nature of the catchment.

40 The upper Makarewa River catchment provides a range of recreational values but the most significant is likely to be brown trout angling. The national angling survey results recorded that 3,610 ± 670, 1,910 ± 610, 1,940 ± 670 angler days were spent fishing the Makarewa River in the 1994/1995, 2001/2002 and 2007/2008 season respectively. The angler usage in the 2007/2008 season ranked the river below the Mataura River (40,260 ± 3,600), Oreti River (21,850 ± 2,040), Aparima River (7,730 ± 1,120), Waiau River (18,540 ± 2,290) and ahead of the Waihopai River (370 ± 210).

41 The Southland Fish and Game Council information on angler access points indicates that there are 12 angler access points in the upper Makarewa River including one on the Otapiri Stream, one on the Dunsdale Stream and four on the Hedgehope Stream.

LOWER MAKAREWA RIVER

42 The lower river has been modified through river drainage and flood protection works as well as the cumulative effects of land use within the catchment. The lower Makarewa River is actively managed to reduce the impacts of large floods.

43 The river flow of the lower Makarewa River is very similar to the gauged section at Counsell Road. The key feature of the hydrology of the lower Makarewa River is the influence of the tide which alters river water level, depth and velocity but does not alter salinity.

44 The lower Makarewa River is a low gradient river and the flow is held up and the flow direction reversed by the incoming tide. There is a decreasing gradient in the influence from the incoming tide between the Oreti River confluence and approximately 2.2 km upstream of the Plant's discharge. In the approximately 1.2 km reach downstream of the Plant's discharge the river level increases by over 1–1.5 m compared to an increase in water level of approximately 0.1 m at a point 2.2 km upstream of the discharge. At times of low river flow, water flows upstream during incoming tides from a point approximately 300 m upstream of the discharge down to and including the Oreti River.

45 Water quality monitoring data collected upstream and downstream of the discharge from the Plant indicates the lower Makarewa River water quality is characterised by elevated nutrient concentrations that can result in nuisance algal growths, high faecal indicator bacteria counts (>1,000 cfu/100 ml), low visual clarity (<1.6 m), moderate-high Amm-N concentrations (typically 2.5–7.5 g/m^3), generally moderate but occasionally low summer time dissolved oxygen concentrations (typically 5–9 g/m^3) and river water temperatures and pH that are suitable for supporting healthy biological communities.

46 Sediment quality in 2002 and 2014 at sites upstream and downstream of the discharge showed elevated nutrient concentrations in the immediate vicinity of the discharge and 1.5 km downstream.

47 The benthic invertebrate and aquatic plant communities in the lower Makarewa River change in response to the substrate, channel gradient, water velocity, tidal influence and water quality changes that occur upstream and downstream of the Wallacetown-Lorneville Highway Bridge. The lower Makarewa River is characterised by low (< 80 - < 90)

Macroinvertebrate Community Index scores, regular exceedance of periphyton chlorophyll-*a* and occasional exceedance of the periphyton Ash Free Dry Weight guidelines, occurrence of nuisance algal growths such as cyanobacteria mats and macrophyte dominated plant community in the tidally influenced section.

48 The native fish community in the lower Makarewa River is dominated by common bully and shortfin eels with a seasonal migration of īnanga, smelt, koaro, banded kokopu, giant kokopu, and lamprey.

49 The lower Makarewa River provides a range of recreational values but the most significant are likely to be white baiting and game bird hunting. The lower Makarewa River supports a brown trout fishery but the extent of the use by trout anglers is unknown. The Southland Fish and Game Council information on angler access points indicates that there are three angler accesses in the lower Makarewa River, one at the Wallacetown-Lorneville Highway Bridge and two at Wallacetown at the ends of Collean Road and Clyde Streets. Given the poor access to the lower Makarewa River downstream of the Plant discharges and the abundance of popular and productive fisheries nearby in the Mataura, Aparima and Oreti Rivers, the angler use of the lower Makarewa is expected to be limited to occasional use by local anglers. The lower Makarewa River does attract whitebaiters who fish using handheld nets and nets erected on temporary stands.

LOWER ORETI RIVER

50 The lower Oreti River, downstream of Wallacetown, 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. Further downstream, the Oreti River naturally meanders within a single channel characterised by a series of long runs, shallow pools and occasional riffles. The river is constrained between steep banks with few riffles.

51 The hydrology statistics for the lower Oreti River based on flow data from the Wallacetown recorder are:

(a) Mean flow = 39.9 m^3/s;

(b) Median flow = 27.6 m^3/s;

(c) Minimum flow = 2.6 m^3/s;

(d) 7 Day Mean Annual Low Flow = 7.4 m^3/s;

(e) FRE3 (number of flow events/year exceeding three times annual median flow) = 8.9; and

(f) The lowest river flows occur in December, February, March and April and the highest flows in winter and spring.

52 SRC has monitored water quality on the Oreti River at the Riverton - Wallacetown Highway Bridge since 2000. The site is classified by SRC as 'lowland hard bed'. The SRC water quality results show that the Oreti River approximately 10 km upstream of the Makarewa River confluence is characterised by moderate nutrient concentrations (>0.01 g/m^3 dissolved reactive phosphorus and nitrate-nitrogen concentrations <2.9 g/m^3) moderate-low visual clarity (median <1.6 m), low unionised ammonia concentrations (<0.034 g/m^3) and river water temperatures that are suitable for protecting river ecosystem health.

53 The lower Oreti River is characterised by moderate benthic invertebrate community health and organic enrichment (median Macroinvertebrate Community Index score = 95), regular exceedance (40%) of periphyton chlorophyll-*a* but no exceedance of the periphyton Ash Free Dry Weight guidelines. The biological results from the lower Oreti River are reflective of the elevated nutrients concentrations, and the increasingly developed nature of the catchment.

54 The Oreti River supports a healthy native fish fauna classed as being 'good quality' based on the Fish IBI score. A total of 12 fish species had been recorded in the Oreti River catchment up until 2005. Freshwater Solutions confirmed the presence of two new native fish species including banded kokopu and giant kokopu in the Makarewa River.

55 Fish surveys and the New Zealand Freshwater Fish Database show that the Oreti River supports moderate to high native fish diversity including six species with a 'declining' threat classification (longfin eel, koaro, giant kokopu, banded kokopu, redfin bully and lamprey) and one species with a 'nationally endangered' threat classification (alpine galaxias).

56 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%). White baiting is

popular along the tidal reach of the Oreti River as is duck shooting (Kingett Mitchell 2005).

57 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. The Oreti River was the seventh most heavily fished river out of the 33 rivers surveyed during the 2007/2008 national angler survey.

NEW RIVER ESTUARY

58 New River Estuary is a large (4,600 ha), shallow (mean depth of around 2 m) 'tidal lagoon' estuary, situated at the confluence of the Oreti and Waihopai Rivers. Its catchment largely consists of agricultural land, but it is also subject to stormwater and wastewater discharges from Invercargill City.

59 Large areas of the Waihopai Arm have been affected by drainage and reclamation, but the broader estuary still contains a range of habitats including extensive mudflats, seagrass and relatively large saltmarsh areas. Most of the estuary has a sandy substrate but soft and very soft mud substrates also cover a relatively large proportion of the inlet, particularly: in or near natural settlement areas in the Waihopai arm and Daffodil Bay; along the banks of the upper Oreti and Waihopai Rivers; and among rushland in the east of the estuary.

60 SRC began to sample the New River Estuary water quality in 2012. Invercargill City Council has monitored water quality twice monthly in the New River Estuary since 1991. The results of the Invercargill City Council monitoring show that the New River Estuary at Sandy Bay and Dunns Road is characterised by high nutrient concentrations and moderate chlorophyll-*a* concentrations.

61 The New River Estuary supports high ecological values including a diverse bird fauna (74 water bird species) and freshwater and marine fish populations. Fish include five species of flatfish, eels, brown trout, smelt, whitebait and giant kokopu. The estuary provides important spawning and rearing habitat for marine and freshwater fish including whitebait species and has the highest usage of trans-equatorial shorebirds of all Southland estuaries.

62 The majority of the estuary is well flushed and largely remains free of nuisance macroalgae. Around 10.6% of the estuary is covered with high to very high percentages of nuisance macroalgae with the most extensive growths occurring in the Waihopai Arm, at Bushy Point and in Daffodil Bay, where significant and worsening problems are being caused by rotting macroalgae and poorly oxygenated, sulfide rich sediments. In the Waihopai Arm, Stevens and Robertson (2012) reported that sediment conditions are so degraded that even the nuisance macroalgae are now dying off due to over-enrichment.

63 In 2012, around 8% of the estuary was classified as having gross eutrophic conditions, due to the combination of high sediment mud content, shallow redox potential discontinuity depths, elevated nutrient and organic concentrations, the displacement of invertebrates sensitive to organic enrichment, and high macroalgal growth (>50% cover). A trend of worsening conditions since 2001 was also noted. Seagrass cover has also decreased by around 41% since 2001, with greatest losses occurring in the Waihopai Arm.

64 The New River Estuary is located on the edge of Invercargill City and provides a wide range of recreational values and opportunities including:

(a) Game bird hunting;

(b) Fishing;

(c) Bird watching;

(d) Power boating;

(e) Sea Scouts;

(f) Water skiing;

(g) Rowing;

(h) Bathing;

(i) Walking;

(j) Photography;

(k) Horse riding;

(l) Mountain biking; and

(m) Picnicking.

65 Public access to the estuary is good particularly around the Sandy Point Domain where several walking, horse riding and mountain bike tracks provide access to the lower Oreti River, the Oreti Arm of the New River Estuary and Daffodil and Whalers Bays on the southern edge of the estuary.

DISCHARGE VOLUME AND QUALITY

Discharge Volume

66 The discharge typically starts about two weeks after commencement of the processing season and after the wastewater treatment pond levels have increased. The discharge is not continuous during the processing season and is closed at times during the season. The discharge typically ceases about four weeks after the processing season finishes. The start and end dates of the discharge for the last 13 seasons are shown in Table 2.

67 Alliance manages the discharge to ensure it complies with its existing consent conditions and at times of low river flow during summer months Alliance is able to reduce or occasionally hold the discharge for periods of up to 15 processing days (assuming the wastewater treatment pond levels are low). During extended periods of very low river flow Alliance's consent allows it to discharge wastewater to land for temporary storage under emergency provisions.

68 Alliance's consent requires that the discharge does not exceed 22,730 m^3/day. The median discharge for the period between December 2001 and June 2014 was 12,195 m^3/day (5%-ile-95%-ile: 4,853–18,927 m^3/day) (Figure 2). On no occasion has the consent limit been exceeded.

Discharge Quality

69 The median pH and conductivity of the discharge was 8.2 (5%-ile-95%-ile: 7.7–8.8) and 1.9 mS/m respectively.

70 The seasonal median conductivity between 2001/2002 and 2005/2006 seasons was 2.9–3.0 mS/m. Following this the seasonal median conductivity ranged from 1.5 mS/m - 3.4 mS/m.

71 The median total suspended solids concentration in the discharge was 50 g/m^3 (5%-ile-95%-ile: 13–190 g/m^3). The total suspended solids

concentration in the discharge exceeded the 300 g/m^3 consent limit on four occasions between December 2001 and June 2014.

72 The median total suspended solids load in the discharge for the entire monitoring period was 580 kg/day (5%-ile-95%-ile: 150–2,000 kg/day); the maximum seasonal median total suspended solids load was 1,040 kg/day in 2001/2002 and the minimum was 262 kg/day in 2012/2013 and 2013/2014.

73 The median total nitrogen concentration in the discharge was 110 g/m^3 (5%-ile-95%-ile: 29–160 g/m^3). The dominant nitrogen species was ammoniacal nitrogen (median = 96 g/m^3; 5%-ile-95%-ile: 17–150 g/m^3), which typically comprised approximately 87% of total nitrogen (median value). The median total nitrogen load in the discharge for the entire monitoring period was 1,320 kg/day (5%-ile-95%-ile: 250–2,380 kg/day); the maximum seasonal median total nitrogen load was 1,820 kg/day in the current 2013/2014 season and the minimum was 930 kg/day in 2003/2004.

74 The median total phosphorus concentration in the discharge was 11 g/m^3 (5%-ile-95%-ile: 6.0–16 g/m^3) and the median dissolved reactive phosphorus concentration in the discharge was 9.0 g/m^3 (5%-ile-95%-ile: 3.0–14 g/m^3). Dissolved reactive phosphorus typically comprised 81% of TP (median). The median total phosphorus load in the discharge for the entire monitoring period was 140 kg/day (5%-ile-95%-ile: 43–250 kg/day); the maximum seasonal median total phosphorus load was 170 kg/day in the 2005/2006 and 2012/2013 seasons, and the minimum was 100 kg/day in 2003/2004.

75 The median biochemical oxygen demand (BOD) concentration in the discharge was 16 g/m^3 (5%-ile-95%-ile: 6.2–45 g/m^3). The median biochemical oxygen demand load in the discharge was 120 kg/day (5%-ile-95%-ile: 51–650 kg/day); the maximum seasonal median biochemical oxygen demand load was 410 kg/day in 2007/2008.

76 The median faecal coliform concentration in the discharge was 3,100 MPN/100mL (5%-ile-95%-ile: 93–67,100 MPN/100mL). The median faecal coliform load in the discharge for the entire monitoring period was 4.5×10^{11} MPN/day (5%-ile-95%-ile: 9.3×10^{9}–8.6×10^{12} MPN/day); the maximum seasonal median faecal coliform load was 1.0 x

10^{12} MPN/day in 2009/2010 and the minimum was 1.0 x 10^{11} MPN/day in 2011/2012.

77 The median *E. coli* concentration in the discharge was 2,400 cfu/100 mL (5%-ile-95%-ile: 100–27,600 cfu/100mL). The median *E. coli* load was 3.6 x 10^{11} cfu/day (5%-ile-95%-ile: 1.0 x 10^{10}–3.8 x 10^{12} cfu/day).

78 Analysis of a comprehensive suite of metals/metalloids in the discharge showed the presence of the alkali and alkaline earth metals calcium, magnesium, potassium and sodium, which are associated with meat processing wastes, and aluminium which is used in the wastewater treatment system.

Mixing of the Discharge

79 A reach survey to assess mixing during low tide and high tide conditions and low river flow was conducted on 14 March 2014. The key findings of the mixing assessment were:

(a) At low river flow and near low tide conditions the discharge appears to be well mixed transversely at the river surface 200 m downstream of the discharge;

(b) At low river flow and near high tide conditions the discharge appears to be well mixed at the river surface and at depth from 200 m downstream of the discharge; and

(c) At low river flow and near high tide conditions the discharge is not fully mixed either transversally at the river surface or vertically at 200 m upstream of the discharge.

80 The tidal cycle and river profile and flow conditions means that the mixing zone, at low river flow and low tide extends some 200 m downstream of the discharge while near the high tide the mixing zone extends from approximately 200 m downstream to more than 200 m upstream of the discharge.

RIVER WATER AND SEDIMENT QUALITY AND CHARACTERISTICS

81 Alliance's existing consent stipulates that Class D Standards apply for the Makarewa River, namely 'the natural water temperature shall not be changed by more than 3 degrees Celsius'. This requirement was met on all but two occasions; 8 January 2004 when the temperature at the Bridge Site was 16.4°C, but was 19.6°C at the 350 m Site, and 16 April 2014

when the temperature at the Bridge Site was 7.0°C, but was 11.2°C at the 350 m Site.

82 pH at the 350 m Site was slightly greater than that at the Bridge Site 65% of the time. The Class D Standards stipulate 'pH shall be within the range 6–9 except when due to natural causes'; on no occasion was the pH at the 350 m Site outside this range.

83 The discharge results in a slight increase in the Makarewa River conductivity at the 350 m Site and the increase is also evident at the Boundary Site. There is no consent requirement relating to conductivity. Comparison of river conductivities downstream of the discharge with mass loadings of parameters that are well defined due to regular analysis (e.g., ammoniacal nitrogen) indicates the downstream trends in conductivity are well correlated to discharge mass loads.

84 Direct comparison of dissolved oxygen at the Bridge Site and the 350 m Site indicates the dissolved oxygen at the 350 m Site was less than that at the Bridge Site 79% of the time. The consent states 'the dissolved oxygen concentration of the receiving waters beyond 200 m of the point of discharge shall be consistently maintained at not less than 6 g/m^3', where 'consistently maintained' means for 96% of samples taken in any year. This requirement was met for all years.

85 Class D Standards require dissolved oxygen not to be reduced below 5 g/m^3. This condition was not met on 6 out of 1,631 occasions monitored from December 2001–June 2014. These occasions were as follows:

(a) 24 January 2002: discharge = 12,115 m^3, mean daily river flow = 1.8 m^3/s;

(b) 18 February 2002: discharge = 11,704 m^3, mean daily river flow = 1.9 m^3/s;

(c) 21 February 2007: discharge = 9,260 m^3, mean daily river flow = 1.5 m^3/s;

(d) 22 February 2007: discharge = 5,665 m^3, mean daily river flow = 1.4 m^3/s;

(e) 3 March 2007: discharge = 7,109 m^3, mean daily river flow = 1.1 m^3/s; and

(f) 24 March 2013: discharge = 8,112 m^3, mean daily river flow = 2.5 m^3/s.

86 Dissolved oxygen data from a sonde that was deployed 350 m downstream of the discharge indicated a clear diurnal pattern. The median dissolved oxygen over the period of sonde deployment was 8.9 g/m^3 (range 7.3–12 g/m^3).

87 The consent requires river water clarity (measured as clarity tube distance) not be reduced below 20% at the 350 m Site compared with the Bridge Site. The 5%-ile-95%-ile black disc clarity was 16–240 cm (median 45 cm) at the Bridge Site, 15–190 cm (median 39 cm) at the 350 m Site and 16–59 cm (median 38 cm) at the Boundary Site. The clarity was reduced by more than 20% at the 350 m Site compared with the Bridge Site on 53 of the 321 occasions measured (17%).

88 Hue and brightness are the main attributes used to describe water colour which is well characterised by the Munsell system. Between 10 March 2014 and 23 April 2014 Alliance conducted a series of Munsell colour measurements at its three regular monitoring sites.

89 The water colour at all three sites was predominantly 10Y (30) 8/2 (pale greenish yellow) and only differed at sites downstream of the discharge compared with the Bridge Site on two occasions; on both occasions the colour difference was 2.5 points on the Munsell scale.

90 Alliance made 35 visual assessments of foams, scums and floatable material between 28 April 2013 and 18 December 2013. Freshwater Solutions made visual assessments of foams, scums and floatable material during biological surveys on 7 and 8 March 2013, 7 November 2013, 6 February 2014, 12 March 2014 and during the mixing zone assessment on 14 March 2014.

91 Overall the observations made during the 2012/2013 and 2013/2014 seasons indicates that foams and scums are visible in the river with and without the discharge but that generally foam and scum is limited to the mixing zone. Results indicated that there may be need for additional management measures applied to the discharge to avoid the generation of conspicuous foams or scums beyond the zone of reasonable mixing. I understand that these measures have been put in place and foam production has decreased. This is discussed in the evidence of Mark James and Frances Wise.

92 The median total nitrogen concentration at the Bridge Site was 1.3 g/m^3 and was predominately comprised of organic nitrogen. There was a significant increase in total nitrogen at the 350 m Site (median 5.3 g/m^3) and the Boundary Site (3.8 g/m^3). The composition of total nitrogen at the downstream sites was dominated by ammoniacal nitrogen.

93 The median total phosphorus concentration at the Bridge Site was 0.067 g/m^3 and increased to 0.49 g/m^3 and 0.32 g/m^3 at the 350 m Site and the Boundary Site, respectively. Total phosphorus upstream was more associated with particulates (60%) than the downstream sites (25–29%).

94 Following the first two years of the consent the ammoniacal nitrogen condition reverted to the 1984 USEPA acute criteria, which are pH and temperature dependant and summarised in a table in the consent. This is discussed in Dr Mike Fitzpatrick's evidence. This condition was not met on 12 out of 1,374 occasions between November 2003 and June 2014, most recently in April 2013.

95 Alliance has contributed a median ammoniacal nitrogen load of 153 tonnes/season to the Makarewa River. The highest seasonal ammoniacal nitrogen loads of approximately 180–190 tonnes/season occurred in 2001/2002, 2002/2003, 2005/2006 and 2012/2013.

96 Based on ammoniacal nitrogen in the discharge consistently accounting for approximately 85% of total nitrogen discharged, Alliance has contributed a median total nitrogen load of approximately 170 tonnes/season to the Makarewa River.

97 Downstream of the Alliance discharge the median contribution of total nitrogen to the Makarewa River between 2001 and 2014 was approximately 53% of the total river load. Based on data from selected seasons Robertson and Stevens (2013), estimated that the mean annual load of total nitrogen to the New River Estuary is approximately 4,531 tonnes/year (Robertson and Stevens 2013). Accordingly, this would mean the contribution of the Plant to the load in the New River Estuary is approximately 3.8%.

98 Median biochemical oxygen demand concentration at the Bridge Site between December 2001 and June 2014 was <2 g/m^3 and 5%-ile to 95%-ile was <1 g/m^3 to <2 g/m^3. A similar pattern was observed at the 350 m

and Boundary Sites where the median biochemical oxygen demand was <2 g/ m^3 and 5%-ile to 95%-ile was <1 g/m^3 to 2 g/m^3.

99 The median total phosphorus load in the discharge for the entire monitoring period was 140 kg/day (5%-ile-95%-ile: 43–250 kg/day) on days when discharge occurred. The estimated median seasonal total phosphorus load is 18.4 tonnes/season based on 130 days of discharge per season. The magnitude of seasonal total phosphorus loads mirrors that observed for ammoniacal loads, i.e., highest loads in 2001/2002, 2002/2003, 2005/2006, 2012/2013 and 2013/2014, following the 2005/2006 season but prior to the 2012/2013 season.

100 Downstream of the discharge the median contribution of total phosphorus to the Makarewa River between 2001 and 2014 was approximately 68.1% of the total river total phosphorus load. According to Robertson and Stevens (2013) the mean annual load of total phosphorus to the New River Estuary is approximately 370 tonnes/year. Hence, the total phosphorus contribution from the Plant to the New River Estuary is approximately 5.0%.

101 The Regional Water Plan for Southland stipulates a faecal coliform target of 1,000 MPN/100mL for lowland surface water bodies (excluding popular bathing sites). Between December 2001 and June 2014 the faecal coliform counts at the Bridge Site (median = 1,500 MPN/100mL) and the 350 m Site (median = 1,300 MPN/100mL) were consistently similar, but were lower at the Boundary Site (median = 885 MPN/100 mL).

102 The median faecal coliform counts were lower at the 350 m Site compared to the Bridge Site on 56% of sampling occasions. The annual median faecal coliform count was higher at the Bridge Site compared to the 350 m Site on 8 out of the 14 years analysed.

103 Monitoring from March 2013 to June 2014 indicated median *E. coli* concentrations of 500, 700 and 480 cfu/100 mL at the Bridge, 350 m and Boundary Sites, respectively. This defines the Makarewa River in the vicinity of the Alliance discharge as Microbiological Assessment Category C (261–550 cfu/100mL, MfE/MoH, 2003).

104 The MfE/MOH Category D *E. coli* limit of < 550 cfu/100 ml was exceeded at the Bridge Site on 22 out of 47 sampling occasions while at the 350 m Site it was exceeded on 24 out of 47 sampling occasions.

105 River sediment sample textures, nutrient concentrations and total organic carbon, total nitrogen and total phosphorus were assessed in 2002 and June 2014. The survey results from the two surveys indicated a similar pattern with an increase in all parameters downstream of the discharge.

106 ANZECC has not derived sediment nutrient guidelines, but according to the condition ratings developed by for Southland estuaries (e.g., Robertson & Stevens, 2013), Makarewa River sediments are rated as very good for total organic carbon (<1%) at all sites sampled in 2014. For total nitrogen, upstream sites in 2014 are rated as very good (<0.05%) and downstream sites in 2014 are rated as good (0.05–0.2%).

107 Alliance collected water quality samples from the boiler ditch and the Tomoporakau Stream between mid-December 2013 and late January 2014 to assess what contribution these streams make to the nutrient loads in the river. The boiler ditch receives the discharge approximately 30 m upstream of its confluence with the Makarewa River. The Tomoporakau Stream joins the Makarewa River between the 350 m Site and the Boundary Site.

108 The boiler ditch water quality was characterised by low dissolved oxygen, high nutrients and moderate microbiological counts. The Tomoporakau Stream water quality was characterised by moderate dissolved oxygen, high nutrients and moderate microbiological counts.

MAKAREWA RIVER ECOLOGY

Habitat

109 The Plant's discharge point is located near the upper end of the tidally influenced section of the river. There is a decreasing gradient of tidal influence from Site D1 to Site U2 (Figure 3). Site U1 near the Wallacetown Bridge is unaffected by the tidal cycle which affects river level and water velocity but does not change the salinity of the river. The changes that occur in an upstream direction between Sites D1 and U2 include an increase in coarse substrate, an increase in riffle habitat, decreased macrophyte cover and decreased river water level variation (Figures 4 - 7).

110 The in-stream habitat in the vicinity and downstream of the discharge reflected the low gradient, tidal and highly modified nature of the lower Makarewa River. In-stream habitat also reflects the gradient of influence that tide, channel gradient and morphology has between the upstream

and downstream sites. Sites D1 and D2 were characterised by a large (1.0–1.5 m) difference in river water level and water velocity (0.0–1.2 m/s) between low and high tide. There was a slight change in river water level (0.1 m) and velocity between low and high tide at Site U2.

111 The Makarewa River, downstream of the discharge is a meandering low gradient river characterised by soft river bed and bank sediments and gently flowing run and pool habitat dominated by submerged macrophytes. The lower Makarewa River is strongly influenced by the tide and has been heavily modified by flood control works and agriculture. The riparian zone comprises grazed and rank pasture grasses.

112 The limited amount of suitable habitat downstream of the discharge, differences in the physical habitat, tidal influence and the extent of the mixing zone made it very difficult to select biological monitoring sites upstream and downstream with similar physical habitat conditions.

Aquatic Plant Community

113 Periphyton cover results from Site U1 (upstream of the discharge) differed from the other sites on all 4 sampling occasions with a greater cover of thick mats and long filamentous green algae compared to the thin films and macrophyte dominated community at Sites U2, D2 (upstream of the discharge) and Site D1 (downstream of the discharge). The MfE (2000) periphyton cover guidelines were exceeded at Site U1 in the November 2013 and February 2014 surveys. The MfE (2000) long filamentous green algae cover guideline was exceeded at Site U2 in the February 2014 survey.

114 Total macrophyte cover was lower at Site U1 across all 4 surveys (range 5–22%) compared to Site U2 (range 35–85%), Site D1 (range 50–88%) and Site D2 (50–85%) and shows that there is a significant increase in macrophyte cover between the most upstream site (Site U1) and the most downstream site (Site D1).

115 Total macrophyte cover exceeded the MfE (2012) recommended provisional guidelines of ≤50% cover of river bed area or river surface area at Sites U2, D1 and D2 in March 2013 and November 2013. Total macrophyte cover also exceeded the MfE (2012) recommended provisional guidelines at Sites D1 and D2 in February 2014.

Benthic Invertebrate Community

116 The benthic invertebrate community was dominated by water and habitat quality tolerant taxa at all sites during the three surveys (two during discharge periods and one outside of the discharge period). Key features of the benthic invertebrate community at Site D1, within the downstream mixing zone, were the high numbers of cladocerans and hydra in March 2013 and March 2014 which are most likely to have come from the wastewater treatment ponds, the absence of *Deleatidium* (water and habitat quality sensitive mayfly) which prefer clean, fast flowing stony bed rivers and the presence of 'clean water' caddisfly taxa that tolerate low water velocity. In contrast the community composition at Site D2, within the upstream mixing zone, remained stable across the three surveys with crustaceans, worms and molluscs dominating the community.

117 When assessed in combination, the benthic invertebrate indices scores indicate that invertebrate community health was lower at Sites D1 and D2 compared to upstream sites in March 2013 and March 2014.

118 The benthic invertebrate indices scores during the off season, in November 2013, were lower at upstream and downstream sites compared to March 2013 and March 2014 during the processing season. There was no clear trend in indices scores, in November 2013, between upstream and downstream sites. When assessed in combination the benthic invertebrate indices scores indicate that invertebrate community health was lower at Sites D1 and D2 compared to upstream sites in November 2013. This decline in invertebrate community health is likely due to a lack of suitable habitat for supporting habitat sensitive taxa such as mayflies and caddisflies which generally prefer shallow cobble bed, fast flowing habitats.

119 The invertebrate communities recorded from downstream Sites D1 and D2 in November 2013, when there was no discharge occurring, were similar to the downstream communities in March 2013 and 2014 when the discharge was occurring. This indicates that factors other than discharge water quality may be shaping the communities at downstream sites. Upstream communities were characterised by caddisfly taxa, mayfly taxa and chironomids. There was a downstream shift in the community to taxa such as snails, amphipods, Platyhelminthes and Cladocera, which prefer macrophyte dominated still water environments.

120 Sites D1 and D2 in November 2013 and March 2014 were most associated with macrophyte cover while the community at Site D1 in March 2014 was also less strongly associated with higher ammoniacal nitrogen, dissolved inorganic nitrogen and dissolved reactive phosphorus concentrations.

121 Unsuitable habitat is likely to exclude koura and mussels from the lower Makarewa River.

Fish Community

122 The Makarewa River supports high native fish diversity despite its highly modified state including five species; longfin eel, koaro, giant kokopu, banded kokopu and lamprey with an 'At Risk-Declining' conservation status (see Goodman et al. 2014). The most commonly occurring and abundant fish species in the vicinity of the discharge are shortfin eels and common bully.

123 The lower Makarewa and lower Oreti Rivers support very productive shortfin and to a lesser extent longfin eel fisheries. Despite the historical channelisation and modification of habitat in the lower Makarewa River, the river provides very good eel habitat and in particular the extensive macrophyte beds provide important cover for shortfin eels. Some of the native fish found in the Makarewa River use the lower Makarewa River as a migratory path to adult habitat while others such as īnanga, shortfin eels, trout and black flounder use the lower Makarewa River to feed and grow.

124 The Makarewa River downstream of the Plant provides habitat for adult brown trout but is unsuitable as spawning/rearing habitat due to the lack of gravel substrate and riffle habitat.

125 Most juvenile fish migration in the lower Makarewa River occurs when discharge loads from the plant are low (late winter – late spring) (Table 3).

126 In summary the results of the assessment of the receiving environment demonstrate that the lower Makarewa River is a typical lowland river draining a catchment that has been almost fully developed for agriculture. The lower Makarewa River is a silty slow flowing macrophyte dominated river with a benthic invertebrate community that is dominated by water and habitat tolerant taxa that prefer slow flowing macrophyte dominated habitat. The lower Makarewa River is an important migratory pathway for a range of native fish and also supports a diverse native fish assemblage

including species with a threat classification. The fish community is dominated by common bully and shortfin eel with brown trout also present.

PART B:

ORETI RIVER ABSTRACTION

Assessment Approach

127 Alliance currently has a consent to take water from the Oreti River with a maximum daily volume of 22,500 l/s at a maximum rate of 260 l/s.

128 The effects of Alliance's water take from the Oreti River were assessed using a combination of desktop and field survey results. Water quality, periphyton and benthic invertebrates were surveyed at four sites on 8 December 2015 (Figure 8). Sites with very similar habitat (substrate size distribution, depth and velocity) were selected to minimise the effect of habitat differences on biological sampling results.

129 The assessment of effects considered the following:

(a) Spawning and rearing habitat;

(b) Habitat for food sources;

(c) Adult habitat and cover;

(d) Access to spawning and rearing areas;

(e) Passage for adults and juveniles; and

(f) Water quality and temperature.

130 The approach to the assessment of effects was selected because of:

(a) The small size of the take relative to the large flow in the river;

(b) The short section of non-tidally influenced river potentially affected;

(c) The insensitivity of the lower Oreti River due to channel morphology and tidal influence; and

(d) The very minor effects that the abstraction has on key environmental flow characteristics due to the duration of minimum flow, accrual period length and small and medium flood frequency.

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

(a) River flow record;

(b) Water quality and ecological information collected by Environment Southland;

(c) Water quality guidelines set out in the Environment Southland Regional Plan;

(d) Nutrient and flow guidelines in the MfE periphyton guidelines (Biggs 2000);

(e) Aquatic habitat assessment upstream of the Riverton-Wallacetown Highway Bridge (Ryder Consulting 2001); and

(f) Results of a water quality and ecology survey of the Oreti River immediately upstream and downstream of the water take on 8 December 2015.

Water Take Location and Structure

132 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 Figures 9 to 12.

Hydrology

133 The key Oreti River hydrological statistics based on flow data from the Wallacetown recorder are:

(a) Mean flow: Measured = 40.06 m^3/s; Naturalised (gauged flow taking into account net abstractions and discharges upstream of gauging station) = 40.41 m^3/s;

(b) Median flow: Measured = 27.54 m^3/s; Naturalised = 28.16 m^3/s;

(c) Minimum flow: Measured = 2.60 m^3/s; Naturalised = 2.97 m^3/s;

(d) 7 Day Mean Annual Low Flow: Measured = 7.38 m^3/s; Naturalised = 7.70 m^3/s; and

(e) FRE3 (number of flow events/year exceeding 3 times annual median flow): 8.9.

134 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.

Water Quality

135 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.

Instream Habitat

136 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.

Aquatic Plants

137 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. The periphyton community in December 2015 was characterised by the dominance of thin diatoms.

Benthic Invertebrate Community

138 Water quality and aquatic habitat conditions in the Oreti River are suited to supporting a moderately healthy benthic macroinvertebrate community. The median Macroinvertebrate Community Index 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 at sites upstream and downstream of Alliance's take in December 2015 was dominated by mayflies, had low diversity and Quantitative Macroinvertebrate Community scores that ranged from 'good' downstream to 'excellent' upstream.

Fish Community

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

popular along the tidal reach of the Oreti River. The Oreti River supports a nationally significant brown trout fishery that receives moderate-high use.

Assessment of Effects of the Abstraction

Hydrology

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

(a) Any potential effects are likely to occur only in the approximately 2.8 km reach downstream of the abstraction site before tidal influence becomes much more dominant;

(b) There are unlikely to be any changes to existing flow flat-lining, environmental flow frequency and accrual periods; and

(c) The only identified effect on the river due to this abstraction was a likely small (9%) increase in the number of days flows were below the natural 7DMALF. In my opinion this is very unlikely to result in water quality and ecological effects as outlined below.

Water Quality

141 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 in my opinion is not expected to 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.

Instream Habitat and Biological Communities

142 Alliance's 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. The results of the RYHABSIM modelling in a nearby more sensitive reach of the Oreti River which showed little, if any, effect from the Invercargill City Council 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:

(a) Periphyton growth and cover;

(b) Benthic invertebrate community habitat and health;

(c) Fish spawning and rearing habitat;

(d) Fish migration; and

(e) Adult fish habitat and production.

143 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 Alliance's take is likely to be much reduced. The period of greatest effect of Alliance's abstraction on in-stream habitat in the tidal reach is likely to occur during low tide although in my opinion these effects are still likely to be minor based on the analysis of the effects of the take on river flow and water level.

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

145 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. It is in these shallow riffle areas with stable substrate where the effects of Alliance’s water take on water levels and algal proliferations could increase slightly.

146 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 in my opinion support the conclusion that the effect of the abstraction on the periphyton community is very minor.

147 The benthic invertebrate survey results from the December 2015 survey indicated that the abundance of worms did increase downstream of the abstraction causing a slight decrease in Quantitative Macroinvertebrate

Community Index scores at Sites D1 and D2. The slight decrease in Quantitative Macroinvertebrate Community Index 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 resulting in greater worm abundance. Given the very small influence of the abstraction on key river flow statistics the minor differences in benthic invertebrate community observed at Sites D1 and D2 in December 2015 are, in my opinion, unlikely to be related to the effect of the abstraction.

148 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. In my opinion the water abstraction is very unlikely to influence īnanga spawning habitat.

149 There are very few cobble dominated riffles, preferred by many native fish species between the Alliance take and the tidal zone. In my opinion 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.

150 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) indicates that effects on fish migration are likely to be less than minor.

151 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.

152 The lower Oreti River is tidally influenced from approximately 400 m downstream of the Alliance take. The effects I have just described relate mostly to periods of low or outgoing tide. The effects during high or incoming tides would be less than what I have described here as the effect of the tide is expected to be significantly greater than any water level effect associated with the take.

Fish Entrainment

153 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.

154 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, in my opinion, unlikely to be regularly used by juvenile migratory fish or most of the riffle dwelling fish species present in the river.

155 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. 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 have been observed during cleaning of the reservoir, and only a single eel was observed at the water treatment plant. No fish have been seen by water treatment operators or maintenance staff since 2005.

156 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.

157 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.

Intake Channel Maintenance

158 The water take is located at the head of a 45 m long, 8 m wide artificial intake channel as shown in Figures 9 - 12. The intake channel supports

macrophytes that are likely to provide cover for eels and the channel itself may provide a refuge for trout and native fish during flood events.

159 The artificial intake channel requires cleaning approximately annually and this 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, in my opinion, minor given the very large areas of natural undisturbed habitat upstream and downstream of the intake channel.

160 The effect of removing a small number of eels and possibly other native fish during channel maintenance activities is in my opinion also a minor adverse effect. My recommendation is that the effect on eels and other native fish be minimised by:

(a) Ensuring that the contractor that undertakes the channel clearing works is prepared to capture and return any native fish and trout, removed during maintenance activities, to the river.

(b) That channel cleaning works avoid the key migration period between 1 December and 30 June.

161 In summary the Oreti River in vicinity of Alliance's intake channel supports a healthy aquatic plant and benthic invertebrate community. At times of extended low flow nuisance algal growths do occur that reduce the diversity of water and habitat sensitive benthic invertebrate taxa. The only identified effect on the river due to Alliance’s abstraction was a likely small (9%) increase in the number of days flows were below the natural 7DMALF. In my opinion this is very unlikely to result in water quality and ecological effects as I have outlined.

SECTION 42A REPORT MATTERS

162 I have reviewed the Section 42A Report and the only matter I wish to comment on relates to the timing of the replacement of the fish screen on the intake structure. Dr Greg Ryder has suggested that the modifications to the screen should be undertaken within two years and Condition 5 in the Water Take Permit in the Section 42A Report sets out the requirements.

163 I do not agree with Dr Ryder on the timeframe for the upgrade to the screen. I base my opinion on the assessment of effects that I undertook that indicated that the risk of entrainment of small fish or impingement of larger fish is low. In my opinion undertaking the upgrade within 5 years of the granting of the consent is appropriate.

MATTERS RAISED BY SUBMITTERS

164 In its submission, Southland Fish & Game (**F&G**) says that Alliance should be required to have a specified reduction in the Oreti river take when flows fall below 7-day MALF at Wallacetown. F&G note that other users are typically required to cease or reduce their takes when flows fall below 7-day MALF at Wallacetown. My understanding is that Alliance's take during very low river flows is critical to the plant's operation and ensuring that farmers are able to destock their farms during drought to avoid stock suffering.

165 F&G also requested improvements to fish screening and fish return. As discussed above, Alliance proposes to replace the inner screen with a 2 mm bar and an approach velocity not exceeding 0.12 m/s. This is consistent with the NIWA recommendations which F&G refers to in its submission. I support the proposed upgrade to the fish screen but as I outline in my evidence in my opinion a 5 year timeframe for the upgrade is appropriate.

CONCLUSION

166 The lower Makarewa River is a typical lowland river draining a catchment that has been almost fully developed for agriculture. The lower river is a silty slow flowing macrophyte dominated river with a benthic invertebrate community that is dominated by water and habitat tolerant taxa that prefer slow flowing macrophyte dominated habitat. The lower Makarewa River supports a diverse native fish assemblage dominated by common bully and shortfin eel. The lower Makarewa River is an important migratory pathway for a range of native fish including some threatened species such as giant kokopu. Brown trout are also present.

167 The Oreti River in vicinity of Alliance's intake channel supports a healthy aquatic plant and benthic invertebrate community although at times of extended low flow nuisance algal growths do occur that reduce the diversity of water and habitat sensitive benthic invertebrate taxa. The only identified effect on the river due to Alliance's abstraction was a likely small

(9%) increase in the number of days flows were below the natural 7DMALF. In my opinion this is very unlikely to result in water quality and ecological effects as I have outlined.

Richard Montgomerie

4 July 2016

APPENDIX 1 – TABLES

Table 1: Summary of biological assessments.

Survey Date	Total periphyton cover	Total macrophyte cover	Macrophyte species cover	Benthic invertebrates	Native fish
8 March 2013	Y	Y	N	Y	Y+
7 November 2013	Y	Y	N	Y	N
6 February 2014	Y	Y	Y*	N	N
12 March 2014	Y	Y	N	Y	Y+

Note: + = Site U1 was excluded from the fish surveys.

Table 2: Discharge period between December 2001 and June 2014 for each season.

Season	Start	End
2001/02	11 December 2001	27 May 2002
2002/03	8 October 2002	28 July 2003
2003/04	3 November 2003	6 July 2004
2004/05	14 December 2004	11 August 2005
2005/06	4 October 2005	28 August 2006
2006/07	17 October 2006	14 September 2007
2007/08	30 October 2007	16 July 2008
2008/09	7 October 2008	18 September 2009
2009/10	30 November 2009	16 September 2010
2010/11	1 November 2010	26 July 2011
2011/12	11 October 2011	13 September 2012
2012/13	24 October 2012	20 September 2013
2013/14	6 December 2013	25 June 2014

Table 3: Migratory periods for migratory fish found in the Makarewa River.

Common name	Life stage	Direction	Peak migration period	Discharge load
Longfin eel	Glass eel	Up (as far as estuary)	Aug - Oct	low
	Juvenile	Up	Dec - Mar	med - high
	Adult	Down	Mar - May	high
Shortfin eel	Glass eel	Up (as far as estuary)	Sept - Nov	low
	Juvenile	Up	Dec - Mar	med - high
	Adult	Down	Feb - May	med - high
Lamprey	Juvenile	Down	Aug	low
	Adult	Up	Jan - Dec	low, med, high
Common bully	Juvenile	Up	Dec - Mar	med
	Larvae	Down	Oct - Nov	low
Īnanga	Juvenile	Up	Aug - Nov	low
	Larvae	Down	Mar - Aug	high - low
Smelt	Juvenile	Up	Sept - Oct	low
	Larvae	Down	Apr - Jun	high - med
Giant kokopu	Juvenile	Up	Oct - Dec	low - med
	Larvae	Down	May - Sept	high - low
Banded kokopu	Juvenile	Up	Sep - Oct	low
	Larvae	Down	Jun - Jul	high
Koaro	Juvenile	Up	Sept - Oct	low
	Larvae	Down	May - Jun	high
Brown trout	Adult	Up	Dec - May	med - high
	Juvenile	Down	Jan - Dec	low, med, high

Note: Migration periods are for the full range of months identified in MPI (2015).

APPENDIX 2 – FIGURES

Figure 1: Aerial map of lower Makarewa River, Oreti River and the New River Estuary.

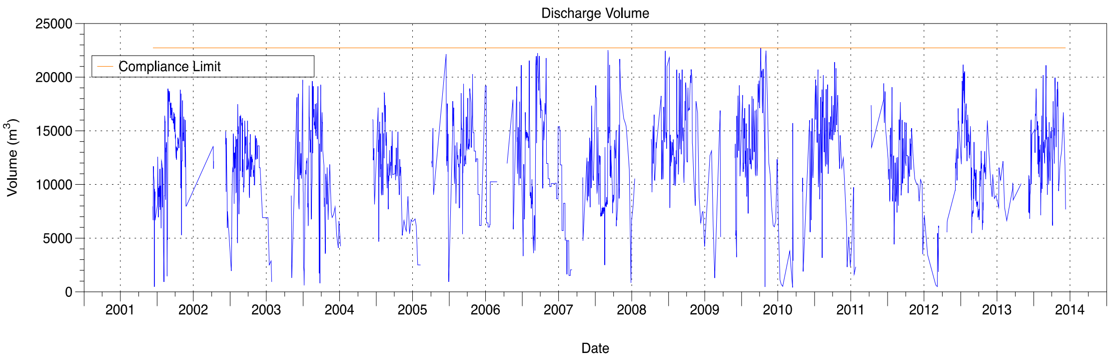

Figure 2: Discharge volumes between December 2001 and June 2014.

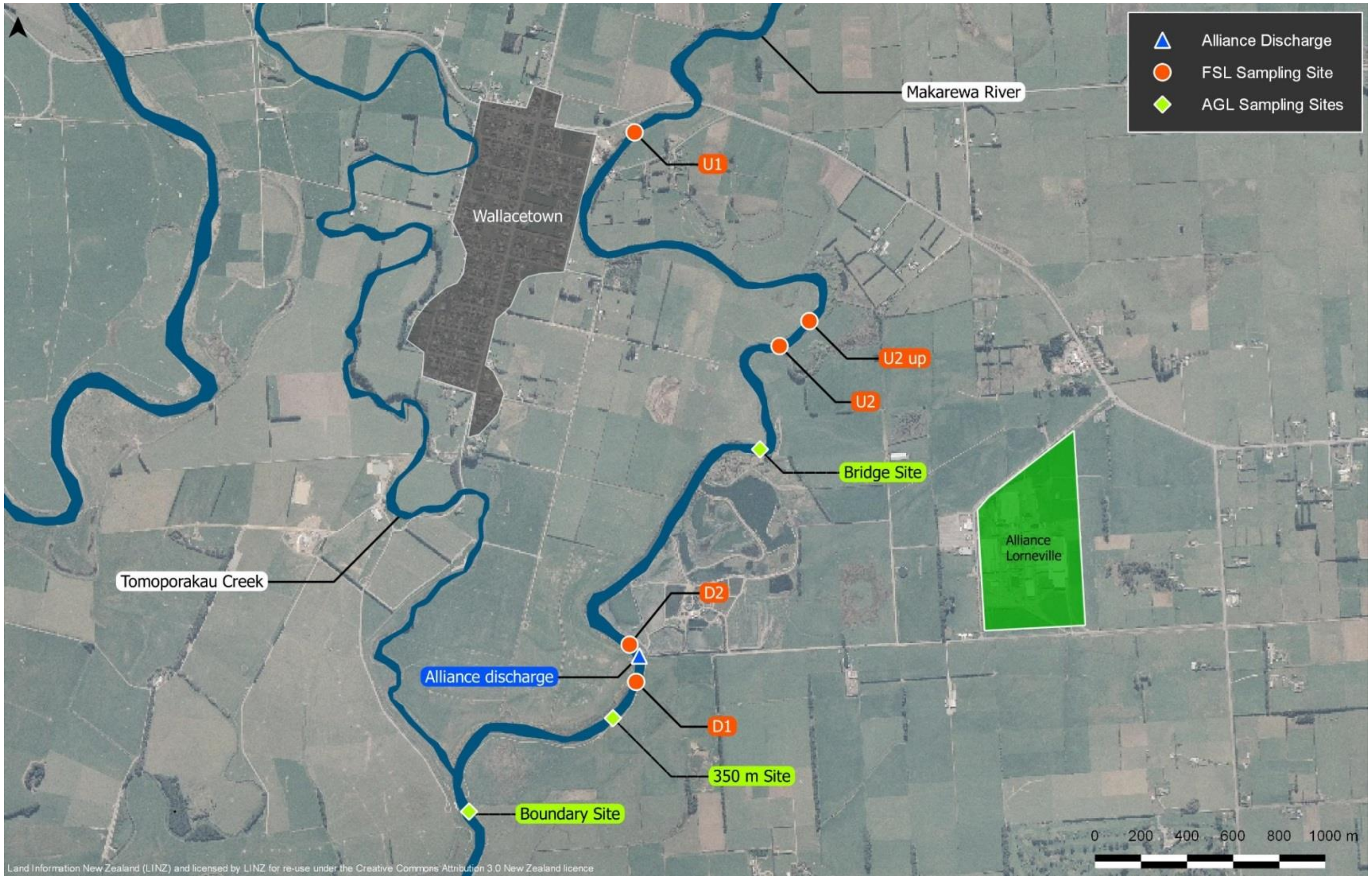

Figure 3: Sampling Locations

Spring 2013

Summer 2013

Summer 2014

Figure 4: View of Site U1 during the spring 2013, summer 2013 and summer 2014 biological surveys.

Spring 2013

Summer 2013

Summer 2014

Figure 5: View of Site U2 during the spring 2013, summer 2013 and summer 2014 biological surveys.

Spring 2013 **Summer 2013** **Summer 2014**

Figure 6: View of Site D2 during the spring 2013, summer 2013 and summer 2014 biological surveys.

Spring 2013 **Summer 2013** **Summer 2014**

Figure 7: View of Site D1 during the spring 2013, summer 2013 and summer 2014 biological surveys.

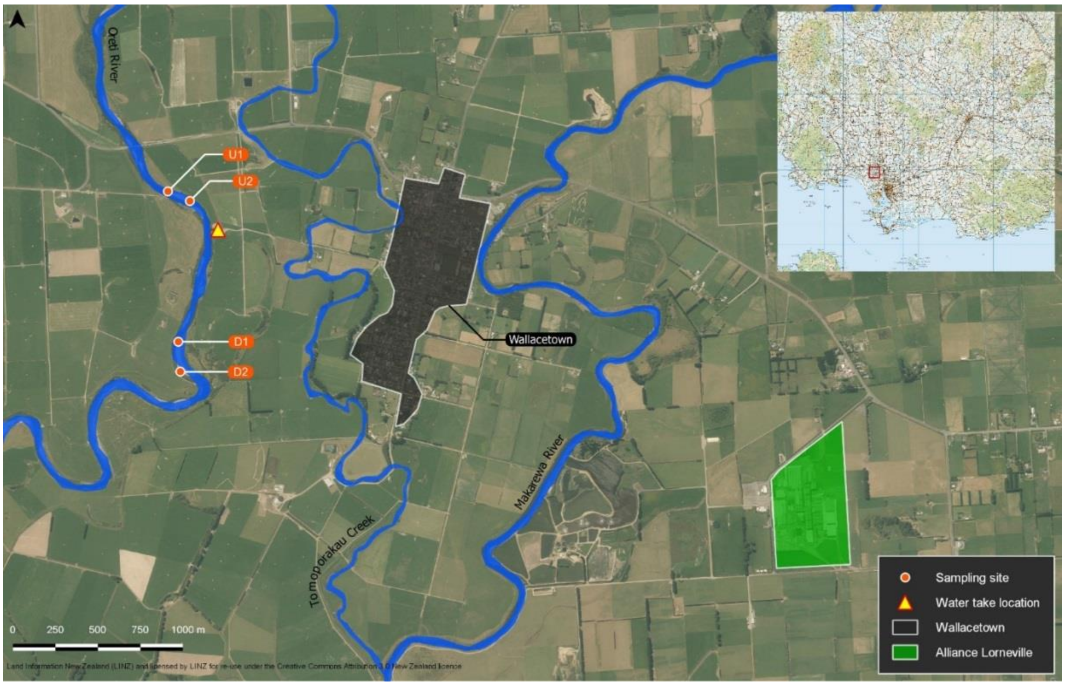

Figure 8: December 2015 Oreti River sampling site locations.

Figure 9: View of the Alliance water take from the Oreti River.

Figure 10: View of the Alliance water take and Wallacetown Highway Bridge.

Figure 11: View of the artificial channel from which Alliance takes water.

Figure 12: View of the Alliance water take structure.