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 MARK JAMES ON BEHALF OF ALLIANCE GROUP LIMITED

4 July 2016

ANDERSON LLOYD
LAWYERS
DUNEDIN

Solicitor: S W Christensen

Level 10, Otago House
Cnr Moray & Princes Street,
Private Bag 1959,
DUNEDIN 9054
Tel 03 477 3973
Fax 03 477 3184

QUALIFICATIONS AND EXPERIENCE

1 My full name is Mark Richard James.

2 I am an aquatic ecologist holding the following degrees, BSc Victoria University, Wellington; BSc (Hons) Victoria University, Wellington and PhD (Aquatic Biology), University of Otago, Dunedin.

3 I have a background in basic and applied research in marine and freshwater ecology and biology with over 37 years' experience including research, consulting and management of science organisations.

4 Following two years with the Institute of Nuclear Sciences, Department of Scientific & Industrial Research (**DSIR**) I was employed in 1982 by the Taupo Research Laboratory, DSIR, then moved to Christchurch in 1992 as a scientist with the National Institute of Water & Atmospheric Research (**NIWA**). In 1994 I was appointed as a Project Director and led large multi-disciplinary Foundation for Research, Science & Technology (**FRST**) funded programmes including "Lake Ecosystems" and "Sustainability of coastal ecosystems". In 2000 I moved to Hamilton to take up the position of Regional Manager with NIWA and in 2002 was appointed as NIWA's Director Operations. In 2008 I retired from this position taking up a brief position as Chief Scientist for Environmental Information before leaving NIWA in late 2008 and setting up as an independent environmental consultant and ecotour operator.

5 Since 1982 I have been involved in research on the ecology of freshwater and marine systems. These studies aimed to gain a better understanding of ecological processes in lakes, rivers, coastal and open ocean systems. I have worked in New Zealand, Finland, Denmark, Australia and in Antarctica. My research has been published in over 45 papers in scientific journals and books. These publications have included scientific papers in international journals and book chapters on the ecology of freshwater and marine invertebrates, freshwater management, coastal sustainability as well as the effects of sediments, lake level management, and other anthropogenic activities on aquatic ecosystems.

6 During my 37 years' experience I have been involved with Regional Councils, government departments and industry in establishing guidelines for ecological assessments, providing descriptions of freshwater and marine communities and assessments of potential ecological effects for a wide range of projects throughout New Zealand.

7 I have been involved in the preparation work for the Alliance consent application since 2013 which has included:

(a) Reviewing previous reports on the ecology of the Makarewa and Alliance operations and scoping new work required for consents;

(b) Reviewing reports on new ecological studies carried out;

(c) Assessment of the effects of the Alliance Lorneville wastewater discharge on the receiving environment; and

(d) Preparation of a report on proposed monitoring.

8 I have visited the Alliance Lorneville processing plant and the Makarewa River and New River Estuary on a number of occasions.

9 In preparing this evidence I have reviewed published and unpublished reports and in particular the following which have been used in this assessment:

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

(i) Assessment of the receiving environment for Alliance Lorneville Treated Wastewater Discharge Ecology, Water Quality and Recreation in the Makarewa River, Oreti River and New River Estuary (Freshwater Solutions 2015a);

(ii) Makarewa River Site Specific Ammonia Receiving water assessment (Freshwater Solutions 2014);

(iii) Makarewa River Mixing Zone Assessment. (Freshwater Solutions 2015b);

(iv) Assessment of Effects of the Alliance Lorneville Wastewater Discharge on the Makarewa and Oreti Rivers and New River Estuary. (Freshwater Solutions/AES 2015); and

(v) Evidence in chief for Richard Montgomerie and Dr Fitzpatrick;

(b) The Section 42 Officers' Report;

(c) Evidence of Dr Greg Ryder; and

(d) Submission by Fish and Game.

10 The assessments also rely heavily on studies and reports on the New River Estuary carried out by Robertson and Stevens (2012a, b, c)

11 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

12 My evidence addresses the following matters:

(a) An assessment of the actual and potential effects of the discharge on the aquatic environment;

(b) Identifies appropriate target standards and guidelines;

(c) Assesses the effects against those targets and standards;

(d) Identifies proposed mitigation to meet the targets and guidelines; and

(e) Outlines a monitoring plan.

EXECUTIVE SUMMARY

Effects of the current discharge

13 The actual and potential effects of the current discharge can be summarised as:

(a) Increased ammonia-N levels which can cause toxicity effects for biota in the river (dealt with in evidence of Dr Fitzpatrick);

(b) Reduced dissolved oxygen levels that can impact directly on invertebrates and fish;

(c) Increases in nitrogen and phosphorus which can increase the risk of nuisance algae and eutrophication of rivers and the estuary;

(d) Reduced water clarity and generation of foams and scums which can affect aesthetics, recreation and ecological values; and

(e) Increased microbial contamination that can impact on aquatic health, recreation and cultural values and consumption of fish and shellfish.

14 The present discharge does not significantly adversely affect pH, temperature or dissolved oxygen (**DO**). Dissolved oxygen concentrations

in the immediate vicinity of the discharge are at times lowered by the discharge but not to a level that would impact on most invertebrates or fish. At times the discharge does elevate faecal coliforms and *E. coli* concentrations in the river. Algae in the discharge does reduce clarity by more than 33% at times (~5%). The current nitrate-nitrogen concentrations below the discharge are below the level expected to adversely affect aquatic biota through toxicity. The ammonia-N concentrations in the discharge rarely exceed the existing consent, which is based on acute ammonia-N effects, but consistently exceed various chronic ammonia-N limits, including the NPS bottom line annual median and ANZECC guidelines.

15 The discharge contributes 53% of the total nitrogen (**TN**) load and 68% of the total phosphorus (**TP**) load to the lower Makarewa River. The percent contribution of TN and TP load from the discharge to the New River Estuary has been estimated as an average of 4.0 % and 6.0 % respectively. Nutrients from the discharge potentially elevate river sediment nutrient concentrations immediately downstream and at times upstream of the discharge.

16 The total suspended solids (**TSS**) load to the river and estuary from point sources is very low and the contribution the discharge makes to sedimentation in the Estuary, mostly as algal material, is insignificant.

17 The tidal section of the lower Makarewa River, which includes the region where the discharge occurs, is unsuitable for periphyton growths because of unsuitable substrate and physical characteristics and thus any potential effect of the discharge on periphyton is assessed as minor. The discharge increases nitrogen and phosphorus concentrations in the water column and in river sediments and this is likely to contribute to macrophyte growths which provide important cover for eels, bullies and trout.

18 The habitat in the tidally influenced section of the lower Makarewa River is not suitable for freshwater mussels because of the finer substrate, variable water level and other anthropogenic activities such as channel straightening. No mussels were found during surveys in 2013 and 2014 and anecdotal evidence indicates that they have not been present in the lower Makarewa River for some time. The habitat in the tidally influenced section of the Makarewa River is also not suitable for the mayfly *Deleatidium*. The macroinvertebrate community and Macroinvertebrate

Community Index (**MCI**) score at Site D1, within the mixing zone, is similar to other Southland tidally influenced river sites. Given the highly modified state of the habitat, poor background water quality and the dominance of water and habitat tolerant taxa within the Makarewa River (including around the discharge) the effect of the discharge on benthic invertebrates is assessed as not more than minor.

19 The benthic macroinvertebrate communities in the Waihopai Arm and Daffodil Bay in the New River Estuary are severely degraded due to the muddy anoxic, sulphide rich sediments. The discharge makes a very small contribution to enrichment; thus any effect on estuarine benthic invertebrates is assessed as minor.

20 The fish community at sites immediately upstream and immediately downstream of the discharge are in the 'excellent' Southland Region Fish Integrated Biological Index (**IBI**) class. The effect of the discharge on clarity may cause some minor effect on the visual feeding efficiency of trout and some native fish species during late summer – early winter but this is unlikely to be more than minor.

21 The discharge results in some visible foams and scums at times within and immediately beyond the mixing zone and may reduce the enjoyment of some whitebaiters, anglers and duck hunters. Foams have also been observed when the plant is not discharging. The short section of river affected and the occasional nature of the effect, coupled with the small number of hunters, anglers and whitebaiters affected, suggests that the effect of the present discharge is no more than minor.

Effects of future discharges

22 The current discharge meets standards for temperature, pH, DO, BOD and nitrate toxicity (SRWP 2013, NIWA 2013, MFE 1992, MFE 2014) and these will continue to be met. Ammonia toxicity is dealt with in the evidence of Dr Fitzpatrick but an advanced treatment plant is proposed which would provide a significant improvement in water quality for both total nitrogen and ammonia-N in the Makarewa River downstream of the discharge and meet the required reductions.

23 The Southland Regional Water Plan (**SRWP**) requires at least a 10% reduction in nitrate and phosphorus before January 2020. Because of the very large contribution of nitrate and TN from diffuse sources within the Makarewa River Catchment the proposed improvement in discharge and

water quality alone, is not expected to deliver an observable or tangible improvement in estuarine quality. However, a 15% target for reduction in TN loads compared with a baseline from 2012/13 should be met in the short-term (by 2018/19) using a number of smaller upgrades to ensure there is a start made to improving in water quality and estuary health. The 10% reduction in phosphorus should be part of the larger long-term upgrade. Greater than 10% reduction for both N and P would be met with the new treatment plant.

24 The clarity of the lower Makarewa River is low due to a range of catchment scale influences and is unlikely to change because of the future improved discharge. Conspicuous discharge effects on recreational values are likely to be minor but the issue needs to be addressed as it is an RMA requirement. The proposed limits (<33% change compared with upstream) are considered appropriate for lowland waters.

Mitigation and monitoring

25 Overall the most significant potential effects of the discharge on the Makarewa and Oreti Rivers and New River Estuary relate to the potential ammonia-N toxicity and TN and TP loads. Three approaches will be taken:

(a) As the treatment plant will take some time to construct and become operational it is proposed that in the interim discharge limits be implemented at 95% of the results from the last 5 years (BOD_5, total suspended solids, total N, total P and faecal coliforms) to ensure that the water and receiving environment health will not become any worse as a result of operation of the Alliance plant and there should actually be an improvement;

(b) In the short-term (within 2 years) TN loads will also be reduced by 15%, compared with 2012/13; and

(c) New limits on N and P will be set following the commissioning of a new treatment plant to ensure that ammonia-N is reduced by 75% from the 2012/2013 baseline values to meet site specific limits and at least median NPS-FM limits and that there are significant reductions in TN (74%) and TP (45%) to the receiving environments.

26 The proposed upgrade in the long-term (within 15 years) with more advanced treatment will ensure that there is a significant reduction in N

(75% reduction) and P (45% reduction) from the Alliance plant but the goal of improving the health of the receiving waters will need a catchment wide approach.

27 Under the RMA and latest NPS-FM standards (set at Freshwater Management Unit not point discharges), water clarity and microbial levels also need to be addressed as they do not meet the required standards. However, these are catchment wide issues that need to be addressed at a wider scale with Alliance being one of the stakeholders required to address these matters longer term. The conditions include a requirement to review options for treatment to reduce microbial contaminants as part of a catchment-wide process.

28 Full details of the monitoring programme are provided in the Monitoring Plan and limits are detailed in the evidence of other witnesses and the conditions attached to John Kyle's evidence. Limits are provided for before and after the treatment upgrade with monitoring of the discharge to include physical, chemical, nutrient and microbial parameters.

29 Monitoring of the receiving waters will include physical parameters (temperature, pH, water clarity, DO and BOD), nutrients (nitrate and ammonia-N, dissolved reactive P, TN and TP), presence of foams and scums, to ensure interim standards are met, and new standards for N and P are met, following implementation of the new treatment plant.

30 Additional monitoring includes:

(a) Aquatic biological monitoring will be undertaken within 5 years of granting the consent, and then annually for 3 years following the commissioning of the new treatment plant;

(b) Monitoring levels of nutrients in sediments within 5 years of consent being granted and at 5 yearly interval after that;

(c) Fish health will be monitored within 5 years of granting of consent, immediately prior to the treatment plant upgrade and then within 2 years of commissioning of the new plant; and

(d) Microbial inputs will be reassessed and reviewed within a time period to be set out in the conditions, as part of a catchment-wide programme.

POTENTIAL ECOLOGICAL AND RECREATIONAL EFFECTS

31 The actual and potential effects of the current discharge on the receiving environment that were assessed included:

(a) Increased ammonia-N levels which can cause toxicity effects on biota in the river;

(b) Reduced dissolved oxygen levels that can impact directly on invertebrates and fish;

(c) Increases in nitrogen and phosphorus which can increase the risk of nuisance algae and eutrophication of rivers and the estuary;

(d) Reduced water clarity and generation of foams and scums which can affect aesthetics, recreation and ecological values; and

(e) Increased microbial contamination that can impact on aquatic health, recreation and cultural values and consumption of fish and shellfish.

32 The potential effects were identified through analysis of the available discharge and receiving environment data, expert advice, published and unpublished reports, and through consultation with Alliance's project team, SRC and the stakeholders' Technical Working Party (**TWP**).

Ammonia N Toxicity

33 Elevated ammonia-N has the potential to be toxic to a range of aquatic organisms and can contribute significantly to nitrogen enrichment. The issue of ammonia toxicity will be dealt with in the evidence of Dr Fitzpatrick.

Increased Nutrient Concentrations

34 Dissolved nitrogen and phosphorus can cause nuisance algal growths in some rivers while TP and TN can result in eutrophication effects such as nuisance macrophyte and macroalgal growths in the lower reaches of rivers and in estuaries.

35 The nitrogen and phosphorus load in the discharge has the potential to contribute to adverse cumulative effects as a result of elevated background nutrient concentrations in the water and sediment of the Makarewa River, the lower Oreti River and the New River Estuary. The combined nutrients in the discharge and the wider catchment will impact

on the lower Makarewa and Oreti Rivers (e.g., cyanobacteria blooms at the Wallacetown-Lorneville Highway Bridge) and the New River Estuary (e.g., macroalgae proliferations). The input of nutrients from the Alliance Plant will contribute to nutrient loads in the lower Makarewa, lower Oreti below the confluence with the Makarewa, and the New River Estuary.

Increased Bacteria Concentrations

36 Bacteria have the potential to cause human health issues directly through contact recreation and indirectly through contamination of fish and shellfish. The background faecal indicator bacteria concentrations in the Makarewa River, including the upper catchment, the lower Oreti River and the New River Estuary are elevated. Trout fishing, whitebaiting, eeling for cultural and commercial activities and game bird hunting occur in the lower Makarewa River. The New River Estuary is an important area for fishing and gathering of shellfish, and contact recreation and as a consequence faecal indicator bacteria in the discharge has the potential to adversely affect human health.

Reduced dissolved oxygen

37 Dissolved oxygen (**DO**) is critical to supporting healthy aquatic ecosystems with concentrations needing to be above 5 g/m^3 as a minimum over 7 days and above 4 g/m^3 as a one day minimum to avoid adverse effects. The discharge can occasionally contribute to low summertime DO concentrations below 5 g/m^3 in the lower Makarewa River and could potentially have an adverse effect on aquatic biota.

Altered Colour and Clarity, presence of foams and scums

38 Wastewater discharges have the potential to have aesthetic effects by altering colour and clarity and generating foams and scums. Downstream of the discharge the Makarewa River is used by duck hunters and fishermen and their enjoyment of fishing and hunting could be reduced by the presence of detectable changes in colour and clarity and presence of foams and scums.

Development of Nuisance Algal Growths

39 Nuisance algal growths, include sewage fungus, periphyton (algae growing on hard surfaces) and macrophtyes (large aquatic plants). The discharge location and elevated nutrient concentrations in the discharge

and receiving environment have the potential to elevate water and sediment nutrient levels, with the sediment levels in particular potentially leading to the proliferation of macrophytes. Large biomass of macrophytes can in turn alter pH and DO levels and affect habitat for a range of aquatic biota.

Altered Benthic Invertebrate Community

40 The benthic macroinvertebrate community (snails, bivalves, chironomid larvae, worms, caddisflies, and occasionally mayflies) in the lower Makarewa River reflects the location, land use and modification throughout the catchment. Although the soft bed and tidal nature of the receiving environment is not suited to water and habitat sensitive taxa (e.g., the mayfly *Deleatidium*) there is potential for the discharge to result in adverse effects in the lower Makarewa River, at least indirectly through altered habitat (e.g., increasing macrophyte cover) or directly through toxicity (e.g., ammonia-N toxicity effects).

Altered Fish Community

41 The lower Makarewa River supports significant shortfin eel and common bully populations and provides seasonal adult habitat and feeding areas for inanga, brown trout and black flounder. The discharge has the potential to have direct effects (e.g., through ammonia-N toxicity) on fish diversity and abundance within the mixing zone and the lower Makarewa River downstream of the discharge. It can also have indirect effects through altered habitat (e.g., macrophyte growths) and altered food sources (e.g., benthic invertebrate community composition) in the mixing zone, lower Makarewa River and New River Estuary. The lower Makarewa River is a migratory pathway for a range of whitebait species including inanga, banded kokopu, giant kokopu and koaro, trout and tuna. The ammonia-N concentrations within the discharge have the potential to affect fish migration within the mixing zone.

Reduced Cultural and Recreational Values

42 The faecal indicator bacteria load in the discharge could contribute to the cumulative negative effects of the wider catchment on the recreational values of these waterways by altering water quality and biological communities.

RECEIVING ENVIRONMENT QUALITY STANDARDS

43 The water quality and biological communities in the receiving environment, prior to and following the proposed wastewater treatment upgrade, were assessed against standards and targets derived from Southland Regional Water Plan (**SRWP**), National Policy Statement for Freshwater Management (**NPS-FM**), National Objectives Framework (**NOF**), RMA, ANZECC guidelines and specific targets developed for the Makarewa River. The targets were selected after a careful evaluation of the receiving environment, expert advice, the assessment of the effects of the discharge and following consultation with the working party. The rationale for the selection of each of the water quality and biological attributes is presented below.

Temperature

44 River water temperatures greater than 24°C have been shown to be stressful to a range of invertebrate taxa and fish species. At temperatures around 24–27°C some sensitive invertebrates, particularly some insects, would be severely stressed and some fish eliminated if such temperatures persisted. However, there is a low risk of the discharge adversely affecting water temperature in the Makarewa River, given the nature of the discharge. The river temperature guideline used for determining if there is a likely effect on biota in the receiving waters is a >3°C increase from upstream and with 23°C being the maximum temperature. This limit is commonly applied, and is protective of most aquatic organisms.

pH

45 pH is an important factor in determining ammonia-N toxicity risk. No limit is presently set for pH in the recently released NPS-FM. The SRWP has a limit of 6.5–9.0 and this has been selected as the target for the receiving environment.

Dissolved Oxygen

46 Low DO levels can reduce benthic invertebrate community diversity and abundance and cause stress in fish leading to mortality. The NPS-FM evaluation of DO effects has recognised the merits in setting DO concentration limits rather than saturation limits and for this reason it has been adopted for setting the target DO state for the lower Makarewa River. Dissolved oxygen can fluctuate widely in lowland rivers

draining agricultural catchments, such as the lower Makarewa River, and the current consent limit of 6 g/m^3 is conservative.

47 Recent work as part of the development of attribute states and limits in the NPS-FM has identified a 1-day minimum threshold to avoid acute levels for sensitive species and longer term 7 day minimum levels to avoid significant chronic impacts levels. Considering the invertebrate and fish community present in the lower Makarewa River, the NPS-FM bottom lines for DO are considered appropriate. Despite this a precautionary DO target of ≥ 6 g/m^3 (96% of samples) and > 5 g/m^3 (i.e. above the Bottom Line in the NPS-FM) on all occasions has been selected for assessing the effects of the discharge and for setting limits.

Clarity and Colour

48 The current consent clarity limit of <20% change between upstream and downstream appears to have been selected from MFE guidelines to meet class A water requirements. However, MFE (1994) states that 'for other waters: The visual clarity should not be changed by more than 33–50% depending on the site conditions'. Water clarity in the upper Makarewa River catchment is low and, as a result of this and the reduced sensitivity of lowland rivers draining agricultural catchments to changes in clarity, a <33% change has been selected as the appropriate clarity guideline for assessing the effects of the discharge.

Foams and Scums

49 Section 107 of the RMA requires that a discharge cannot be permitted, if after reasonable mixing, there is 'production of any conspicuous oil, or grease films, scums or foams of floatable or suspended materials'. The recreational use of the Makarewa River within and immediately beyond the mixing zone is thought to be limited so the proposed target for foams and scums is therefore 'no conspicuous foams and scums beyond the mixing zone (site at 350 m)'.

Ammonia toxicity

50 Ammonia toxicity is dealt with in the evidence of Dr Fitzpatrick.

Nitrate toxicity

51 Nitrate can be toxic to aquatic life with high levels resulting in inhibited growth, affecting immune systems and causing stress in a range of aquatic species. The lower Makarewa River receives significant nitrate

inputs from the surrounding catchment but nitrate levels are still well below the limits that would cause nitrate toxicity. For this reason values between Bands B and C for the NPS attribute state have been adopted for assessing the effects of the discharge and setting limits in the lower Makarewa River beyond the mixing zone. As nitrate can be a major component of nutrient load to estuaries and is readily taken up by algae an additional target state of a ≥10% improvement in nitrate concentrations, as identified as a policy in the SRWP, has also been adopted here.

Nutrient inputs

52 The SRWP states as a policy that there is a requirement to improve degraded lowland rivers by reducing nitrate and phosphorus by ≥10% before January 2020. This target has been used for assessing the effects of the discharge and setting targets. Given the declining state of the New River Estuary it is apparent that catchment-wide controls are likely to be required to arrest the current decline in quality of the Estuary.

53 It has been estimated that the discharge from the Alliance Plant contributes 53% of the total TN load and 68% of the total TP load to the lower Makarewa River, but the discharge currently contributes only approximately 4% of the total TN load to the New River Estuary, which needs a reduction in total TN load of between 69-84% to reach a 'moderate state'. As a consequence, reducing the TN load from the discharge alone will only result in a minor improvement in estuary health and is very unlikely to result in an observed or tangible improvement in the state of the New River Estuary. However there should be an improvement in the water quality of the Makarewa River.

Biochemical Oxygen Demand

54 Concentrations of soluble carbonaceous biological oxygen demand (**BOD**) >2 g/m^3 can result in sewage fungus and a receiving environment limit of <2 g/m^3 has therefore been used for assessing the effects of the discharge on the receiving environment.

Faecal Coliforms and E. coli

55 Faecal coliforms and *E. coli* are indicators of human health risk associated with contact recreation in freshwaters. The lower Makarewa River is used for a range of recreational purposes and so the SRWP FC limit of <1,000 cfu/100 mL (now analysed and reported as cfu) applies. Thus the

NPS-FM *E. coli* bottom line <1,000 bacteria/100 mL is appropriate for establishing the long-term target microbiological state in the Makarewa River and would be applied upstream and downstream of the discharge.

Macrophytes

56 Macrophytes in lowland streams are generally not limited by water column nutrient supply but more commonly by sediment nutrients, and in particular, nitrogen supply. Provisional guidelines have been recommended by NIWA for macrophyte cover but have not yet been accepted. Macrophytes provide important habitat for a range of invertebrates and fish species and with the mix of species and percentage cover they are not assessed as reaching nuisance levels at present in the lower Makarewa River. At this stage it is not considered appropriate to set targets for macrophyte cover and composition.

Benthic Invertebrates

57 The SRWP sets lowland river Macroinvertebrate Community Index (**MCI**) and Semi Quantitative Macroinvertebrate Community Index (**SQMCI**) scores of >80 and >3.5 respectively. However the MCI and Quantitative Macroinvertebrate Community Index (**QMCI**) are not well suited to the tidal section of the lower Makarewa River and are generally not applied to tidally influenced or non-wadeable rivers. The study design adopted for this assessment involved the selective sampling of gravel and cobble substrates using a Surber sampler. This design and sampling method was selected to control for habitat variables as much as possible and to ensure the collection of standardised quantitative samples across all the sampling sites. For these reasons hard bottom MCI and QMCI scores were used along with other indices and community composition data, to assess the effects of the discharge. The MCI and QMCI describe the type of community present, but for the reasons outlined above, no target state for the receiving environment has been set.

Fish

58 The NPS-FM and the SRWP set a range of water quality targets aimed at protecting fish. In addition, the SRWP and RMA sets 'avoiding rendering fish unsuitable for human consumption' as a target for lowland rivers and this has been set as the target state for the receiving environment and assessing the effects of the discharge.

EFFECTS OF THE CURRENT DISCHARGE

The effects of the current discharge on water and sediment quality

Makarewa and Oreti River

59 There is no apparent effect of the discharge on temperature in the Makarewa River, which was only very occasionally >3°C at the 350 m Site compared with the upstream Bridge Site. The maximum temperature recorded since 2001 was 21.5°C. A marginal increase in pH downstream of the discharge is apparent but on no occasion was the downstream pH outside the Class D Standard's pH range (6.0–9.0).

60 Dissolved oxygen concentrations in the Makarewa River have consistently been above the Class D Standard and NPS-FM 7-day mean minimum bottom line (5 g/m^3) at all sites monitored. The occasions when the reported DO was below 5 g/m^3 were infrequent and short-term, and have not been ecologically significant. In addition, BOD concentrations at all Makarewa River Sites were low and not expected to affect DO concentrations.

61 There is a consistent decrease in clarity of the Makarewa River downstream of the discharge compared with the upstream site. However, with the total suspended solids (**TSS**) loads in the discharge and median flows in the River the contribution downstream will be <1 g/m^3 (50x reduction beyond the mixing zone), which is considered insignificant in terms of a reduction in clarity or any effect on aquatic biota. It is considered the reduction in clarity is most likely attributed to the presence of algae in the discharge, originating from the treatment ponds.

62 Alliance has no consent condition for nitrate-nitrogen but the NPS-FM annual median bottom line for nitrate-nitrogen, which is based on toxicity to aquatic biota, is 6.9 g/m^3 and for Band B/C is <2.4 g/m^3. Based on the Makarewa River data the highest annual median level was 1.3 g/m^3, thus nitrate-nitrogen toxicity is unlikely to reach a level that would affect aquatic biota upstream or downstream of the discharge.

63 The discharge contains alkali and alkaline earth metals that are associated with meat processing wastes, and aluminium used in the wastewater treatment system. Aluminium concentrations were about 1.4 mg/L in the discharge and thus could be higher than in the ANZECC guidelines (27 µg/L) below the mixing zone, depending on the dilution. Aluminium is toxic to a range of aquatic organisms at low concentrations

in laboratory experiments, however in natural waters such as the Makarewa River other compounds and processes markedly reduce its toxicity to a level where no effects are observed.

64 The New Zealand guideline for water colour (**MFE**) states that Class A waters should not be changed by more than five points on the Munsell scale and for other waters the change should not be more than 10 points. When determined in March and April 2014 there were only two occasions where the colour differed at the 350 m Site compared with the upstream Bridge Site, with the Munsell scale difference being 2.5 points. Based on this evidence, the discharge is not causing a conspicuous change in water colour of the Makarewa River.

65 The current discharge does contribute to the presence of some foams and scums on occasions, at least within the mixing zone (350 m), and a small distance downstream. It should be noted that foams and scums have also been observed when no discharge is occurring. Although the effects of the current level of foams and scums could be assessed as potentially minor because of the limited recreational use of the lower Makarewa River, it is a requirement under the RMA and will thus need to be addressed as part of any future upgrade to the wastewater treatment system. There has been some new infrastructure already installed to address this issue as discussed by Frances Wise in her evidence.

66 The current discharge does result in elevated sediment nutrient concentrations in the vicinity of the discharge that may contribute to macrophyte growths.

67 The impact of microbial contaminants in the current discharge is variable, with some occasions when the level of faecal coliforms is higher below the discharge than upstream and other times when it is lower than upstream. The median annual levels of FC between 2001 and 2014 at the Bridge and 350 m Site downstream were 1,500 and 1,300 MPN/100 mL (cfu since 2005) respectively, which would breach the MFE guidelines and standards but is because of contamination from the upper catchment and not just the discharge. However there were occasions when levels were higher downstream of the discharge (e.g., annual medians were higher at the 350 m Site than Bridge Site for 6 of the last 13 years, annual maximums were higher 5 times in the last 13 years). *E.coli* has only been measured in the Makarewa River since 2012, with annual median levels of 280–750 cfu/100 mL at the 350 m Site. Medians were lower at the

350 m Site compared with Bridge Site in 2012/2013 but have been higher since then.

New River Estuary

68 Non-point discharges to the New River Estuary, in particular from agricultural land-use, are estimated to contribute over 99% of the TSS load[1], thus the relative contribution of the existing discharge to sedimentation in the estuary is considered to be insignificant.

69 Concentrations of key metal contaminants in estuary sediments are below guideline values and although nickel concentrations exceed low level sediment quality guidelines within the Oreti and Waihopai River mouths, these levels are likely caused by stormwater sources. Metal contaminants from the discharge are therefore not an issue in the New River Estuary.

70 Benthic invertebrate monitoring indicates that parts of the estuary are severely affected by nutrient inputs. High nutrient concentrations are detrimental and can potentially lead to nuisance phytoplankton and macroalgae blooms, reduced water quality and toxic effects. Nitrogen is the most common limiting nutrient in estuarine and coastal ecosystems and is the nutrient of most concern for the New River Estuary.

71 Nuisance macroalgae cover is most extensive in the Waihopai Arm, at Bushy Point and in Daffodil Bay, which is close to the mouth of the Oreti River where significant and worsening problems are being caused by rotting macroalgae and poorly oxygenated, sulfide rich sediments. In Daffodil Bay, macroalgae growth is limiting the natural removal of mud by reducing wave induced re-suspension, and as a consequence, sediments are becoming deeper, softer, and muddier in that area. Rotting macroalgae is releasing organic matter and nutrients into the sediments, reducing oxygenation and fuelling the growth of sulfide bacteria on the surface of the sediment. This is indicative of toxic conditions in which few animals can survive.

72 In the Waihopai Arm sediment conditions were so degraded that even the nuisance macroalgae were dying off due to over-enrichment. Underlying sediments at Bushy Point were still mostly sandy and relatively well oxygenated in 2012, but deposition of muds over an area of around 27 ha, was providing an early warning of deteriorating conditions.

[1] Appendix 6 to Freshwater Solutions 2015a Report

73 The existing discharge is estimated to contribute around 4% of the total nitrogen load to New River Estuary[2]. Other nitrogen sources including diffuse runoff (mainly from rural land uses); municipal wastewater treatment plants; and, other meat processing and rendering plants were estimated to contribute the remaining 96% of the nitrogen load. Diffuse sources provided the greatest input, and were estimated to account for around 81% of the total load, with point sources (including the discharge) providing 19% of the load. Thus the discharge from the Alliance plant will contribute to the deterioration but only to a relatively minor degree.

The effects of the current discharge on aquatic plants

Makarewa and Oreti Rivers

74 Low periphyton growths were observed in 2010 and while they were not observed in the more recent surveys may occur occasionally within the downstream mixing zone. This indicates the discharge will not result in significant periphyton growths in the lower river, due to the lack of suitable habitat.

75 Macrophyte growth in the Makarewa River is limited because of light attenuation but there is some evidence nutrient concentrations in the discharge elevate sediment nutrient concentrations (N and P) and indicate that the discharge may contribute to the stimulation of macrophyte growths. There is a reduction in median concentration of TN at the Boundary Site compared with the 350 m Site and a slight reduction in median TP concentrations that is mostly comprised of a reduction in DRP. It is considered the reduction in ammonia-N and DRP observed at the Boundary Site in the water and sediments compared with the 350 m Site is possibly due to uptake by macrophtyes, most likely directly from the sediments.

New River Estuary

76 Around 10.6% of the New River Estuary is covered with high to very high percentages of nuisance macroalgae. The dominant macroalgae are the red alga *Gracilaria chilensis* and the green alga *Ulva intestinalis*, both of which are known to respond positively to elevated nutrient concentrations.

[2] Appendix 6 to Freshwater Solutions 2015a Report

77 Nuisance macroalgae cover is most extensive in the Waihopai Arm, at Bushy Point and in Daffodil Bay (near the mouth of the Oreti River). 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 (RPD) 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.

78 Seagrass cover has also decreased by around 41% since 2001, with greatest losses occurring in the Waihopai Arm. Gross eutrophic conditions should not be present in estuaries like the New River Estuary, which have short water residence times, and this is a clear signal that the assimilative capacity of the estuary is being exceeded. The existing discharge may have a minor effect on stimulating macroalgal growth in New River Estuary because of the relatively low contribution.

The effects of the current discharge on benthic macroinvertebrates

Makarewa and Oreti Rivers

79 The discharge has the potential to adversely affect macroinvertebrates, however, there is only a minor, short term effect on downstream DO concentrations with concentrations very rarely <5 g/m^3. Temperatures rarely get above 20°C and never above 22°C**,** thus the discharge is not expected to adversely affect benthic invertebrates through alterations to the physical features of the water.

80 Nutrients and fine sediment are the key causes of declining benthic invertebrate community health in Southland's rivers and the SRC state:

The general trend throughout Southland is of good or very good macroinvertebrate indices in headwater and upper areas of catchments, with the indices steadily declining the further downstream the monitoring sites are located. This reflects the influence of increasing intensification of land use lower in catchments, and the effects of point-source and nonpoint source discharges to rivers and streams.

81 This description generally fits the Makarewa and Oreti Rivers where MCI scores decrease rapidly down the catchment. Lowland soft-bottomed rivers such as the lower Makarewa and Oreti Rivers typically support a benthic invertebrate community that is tolerant of a range of water and habitat conditions.

82 The median and MCI score at Site D1 (see **Figure 1**) which is within the mixing zone of the discharge based on recent surveys was 67 (range 60–76). The median MCI score at Site D1 is consistent with a community characteristic of a tidal depositional environment with fine, soft substrate and macrophyte dominance.

83 The Makarewa River water velocity in the vicinity of the discharge decreases and the water becomes still during periods of high tide (note that the water is not saline). Different indices are now available for soft and hardbottom streams and thus using indices to compare different habitats throughout the Makarewa River is not appropriate other than to assist in describing the communities and their tolerances. In the case of the Makarewa River, the hard-bottom indices were used but some of the differences are likely to be the result of the tidal influence and more depositional environment near the discharge and in the lower Makarewa River.

84 Ammonia toxicity is addressed by Dr Fitzpatrick but in terms of *Deleatidium* abundance the relatively high levels are not considered to be a major factor in the low abundance, more that there are no areas downstream or immediately upstream of the discharge that provide the habitat and water characteristics preferred by *Deleatidium* and similar taxa.

New River Estuary

85 Monitoring indicates that exposed sites with good habitat quality continue to support moderately abundant and diverse benthic communities in New River Estuary. Intertidal monitoring of sandy sites carried out in 2012 reported that numbers for species with a preference or strong preference for sand (including pipis) were low, while two species with a moderate preference for mud (a small spionid worm *Microspio maori* and *A. bifurca*) occurred in high numbers. High numbers of *Potamopyrgus* spp. (which have a strong preference for mud) also occurred at Bushy Point. Pipi numbers had declined since 2001 and were virtually absent in 2012. It has been suggested that this was possibly due to increasing amounts of mud and fine sediment from the catchments.

86 In contrast, benthic communities in grossly eutrophic sites within the Waihopai Arm and Daffodil Bay are severely degraded and are characterised by a limited number of pollution and mud tolerant, surface-

feeding taxa, including the amphipod *Paracorophium excavatum*, the scavenging-predator isopod *Exospheroma* sp., the small deposit-feeding bivalve *Arthritica bifurca*, the small estuarine snail *Potamopyrgus* sp., and the surface deposit-feeding spionid polychaete *Scolecolepides benhami*. This is consistent with ecological responses expected for sites with muddy, anoxic and sulfide-rich sediments. However, the discharge from the Alliance plant will make only a small contribution to the degradation of habitat in the Estuary.

The effects of the current discharge on fish

Makarewa and Oreti River

87 The lower Makarewa and Oreti Rivers are typical of lowland rivers and, despite their highly modified habitat, they support moderate-high native fish diversity, a whitebait fishery and a locally significant trout fishery. The Southland Region Fish Integrated Biological Index (**IBI**) score for the site immediately upstream (50 m – 2 km upstream) and downstream (150 m – 1.2 km downstream) was 58 placing the sites in the 'excellent' class.

88 The discharge has the potential to adversely affect fish by:

(a) Reducing the size or number of fish through low dissolved oxygen and elevated ammonia-N concentrations;

(b) Reducing the size and number of fish through reduced benthic invertebrate abundance and size, reduced small fish abundance and size and reduced clarity (reducing feeding efficiency); and

(c) Contributing to microbial contaminants that may affect fish health and human consumption.

89 Downstream DO concentrations were very rarely <5 g/m^3 and only occurred for very short durations, therefore any changes in DO are not expected to adversely affect fish.

90 There are no known contaminants in the discharge at levels that are expected, on their own, to result in fish from the lower Makarewa River, Oreti River or New River Estuary being rendered unsuitable for human consumption and therefore the discharge is expected to meet this target in the SRWP.

91 The Makarewa River supports a reasonable trout population but the extent to which sea run trout contribute to fish numbers is unknown, with

the poor water clarity preventing trout being surveyed by drift diving during the current study and trout population size in the lower Makarewa not being surveyed by Southland Fish and Game. The discharge does not appear to alter river water quality to the extent that it would be expected to affect resident trout or prevent trout migration.

92 The resident trout population will be adapted to feed on a range of invertebrate taxa including shrimps, worms, chironomids and snails along with common bully that are abundant in the lower Makarewa River. Resident and migratory trout will also feed on whitebait during late winter and spring. The potential for the discharge to affect trout size and number through altering their food sources beyond the mixing zone is limited and the effect on trout size and abundance is therefore assessed as minor.

93 The discharge does reduce water clarity by more than 33–50% on a small number of occasions (<5%). However the river water clarity is already naturally low upstream of the discharge and fish that rely heavily on visual feeding, such as brown trout, are therefore likely to have adapted their feeding behaviour and prey to the low water clarity in the river, so the effects of the discharge on trout feeding behaviour will be minor, noting that most of the TSS will be algal.

New River Estuary

94 The actual effects of the existing discharge on coastal fish within the New River Estuary are likely to be relatively minor compared with other land and marine based stressors. For instance, sediment and nitrogen affect seagrass by reducing the amount of light available for photosynthesis (the latter by promoting phytoplankton growth). Seagrass is a significant nursery habitat for some fish species and can underpin fisheries production through the provision of shelter and prey. While it still occurs in New River Estuary, seagrass cover has decreased by around 41% since 2001, with the greatest losses occurring in the areas most affected by sediment and nutrients. The discharge only makes a small contribution to nutrient loads to the Estuary.

The effects of the current discharge on recreational values

Makarewa and Oreti River

95 Duck hunting and whitebaiting are the most significant recreational values in the lower regions of both the Makarewa and Oreti Rivers. The

discharge has the potential to affect these activities, in addition to trout fishing in the lower Oreti River, by:

(a) Reducing the size or number of fish through low DO and elevated Amm-N concentrations;

(b) Reducing the size and number of fish through reduced benthic invertebrate abundance and reducing small fish abundance and size;

(c) Reducing the number of ducks by reducing food availability; and

(d) Aesthetic effects negatively affecting hunter and angler perceptions/enjoyment.

96 As outlined above, the current DO and ammonia-N concentrations or the effects of the discharge on benthic invertebrates and small fish abundance are unlikely to be adversely affecting trout in the lower Makarewa and Oreti Rivers and as a consequence the effect on angler enjoyment and satisfaction is expected to be minor.

97 Duck populations are tolerant of poor water quality and are more affected by climate, habitat quality, predation, disease and hunting pressure. It is unlikely that the discharge results in any effect on duck numbers within the lower Makarewa River or Oreti River.

98 The discharge results in some visible foams and scums at times within and immediately beyond the mixing zone and may reduce the enjoyment of some whitebaiters, anglers and duck hunters. The short section of river affected and the occasional nature of the effect coupled with the small number of hunters, anglers and whitebaiters affected suggests that the effect of the current discharge on recreational values is likely to be minor.

New River Estuary

99 Fishing, contact recreation (bathing and wading) and boating are likely to be the key recreational values in the New River Estuary potentially affected by the current water and habitat quality. Nutrients in the estuary water can cause macroalgae growths which can lead to odours, reduced diversity and abundance of shellfish in some areas such as Daffodil Bay and clogging of set and hand held nets used by fishermen. The extent to which any of these effects currently occurs has not been quantified but the small potential contributions that the discharge make to the overall TN

load and macroalgae growths in the estuary suggests that the effect of the discharge on recreational users is likely to be minor.

MAIN RISKS AND PROPOSED MITIGATION

100 The main risks and effects identified are as follows:

(a) The increase in ammonia levels below the discharge impacting directly on water quality and potentially through toxicity on the macroinvertebrate and fish communities;

(b) Inputs of TN and TP from the discharge contributing to growths of nuisance algae and eutrophication of the lower Makarewa and Oreti Rivers and New River Estuary;

(c) Development of foams and scums as a result of the discharge and their associated effects on aesthetics and recreation;

(d) Decrease in water clarity with its associated aesthetic and recreational impacts as well as potential for impacts through light attenuation on primary production and on physiological and feeding processes for macroinvertebrates and fish communities; and

(e) Increases in microbial contamination in the lower Makarewa River below the discharge, lower Oreti River and New River Estuary reducing aquatic health, cultural values and potentially rendering fish and shellfish unsafe for consumption.

101 These issues need to be addressed to improve the health of the receiving environments and to address limits/standards in the latest NPS-FM and regulatory standards in the SRWP and in the RMA.

Changes in water quality needed to meet target environment standards and guidelines

Makarewa and Oreti Rivers

102 With the present discharge, and keeping the discharge volume the same, then the targets for temperature, pH, DO, BOD and nitrate toxicity outlined earlier will continue to be met.

103 The major contributor to potential toxicity and to the TN loadings to the lower Makarewa and Oreti Rivers and the New River Estuary is ammonia-N, which typically contributes approximately 87% of the TN in the discharge. At present the concentrations in the river at the 350 m Site

(outside the mixing zone) meet the Alliance consent 99% of the time but the limits, which are required to avoid chronic toxicity effects for the more sensitive species, would require significant reductions in ammonia-N in the discharge. This is discussed in the evidence of Dr Fitzpatrick.

104 The recommended short-term (15% reduction in TN) and long-term reductions in ammonia-N and TN levels in the wastewater discharge of 75% will also address the key effects of the current discharge on nutrient loadings by significantly reducing nitrogen load in the Makarewa River and the New River Estuary.

105 Nutrient concentrations downstream of the discharge suggest the Makarewa River could be co-limited with respect to nitrogen and phosphorus. Thus it is important to eventually reduce P as well in the long-term by at least 10%.

106 The algal concentration in the discharge is the likely cause of reduced visual clarity of the Makarewa River in the immediate vicinity of the discharge (cf. upstream) by more than 33% on 5% of occasions. The clarity of the lower Makarewa River is low due to a range of catchment scale influences. The recommended future wastewater quality will be higher than the existing discharge but any change in algal concentrations and therefore influence on river water clarity is unlikely with the proposed improved treatment. The RMA requires that there is no conspicuous change in colour or clarity as a result of a discharge. At present, the time clarity is reduced by >33% (<5% of the time) is not considered significant based on the state of the Makarewa and the limited use of the lower Makarewa for recreation.

New River Estuary

107 The recommended reduction in N will significantly reduce the contribution that the discharge makes to the overall nitrogen load going to New River Estuary. As a result, the estimated contribution that the future discharge would make to the TN load to the estuary is estimated at <2%.

108 A reduction of this magnitude is significant in relation to the discharge. However, it is insignificant relative to the total reduction required to improve the trophic state of the estuary. The reduction of 69–84% recommended for the Estuary could only be achieved through a catchment-wide reduction of nitrogen loads.

Scums and foams

109 Although the lower Makarewa River below the discharge is not used extensively for recreation, it is recommended improvements be made to avoid, or at least minimise or mitigate, the production of scums and foams to meet the requirements of the RMA and SRWP. Changes have already been made to the discharge pipe to minimise foam creation.

Microbial

110 The annual median for faecal coliform counts in the discharge since 2001 has averaged 3,515 cfu/100 mL with the highest levels being 6,000 cfu/100 mL. Although for at least some of the time the current discharge does not appear to elevate faecal bacteria concentrations in the lower Makarewa River, there are occasions when counts are elevated above that recorded upstream. Further treatment of the effluent could on occasions reduce the microbial levels at the 350 m Site to <1,000 cfu / 100 mL but this would have only been effective in two of the last 13 years because of the high microbial levels above the discharge point. Thus any further treatment for microbial contamination would have to be part of a longer-term catchment-wide plan in order to be effective.

111 If there is a cost-effective way to treat the effluent further and a catchment-wide plan to reduce levels of microbial contaminants upstream developed then Alliance should consider available options in the next 5-8 years. It is also likely that such treatment would reduce the occasional high suspended solids levels as filtration is likely to be included in the treatment process.

Aquatic Plants

Makarewa and Oreti Rivers

112 Reducing nitrogen concentrations in the discharge may result in a small reduction in macrophyte growth and cover in the vicinity of the discharge but overall the effect of reducing the nitrogen load in the discharge to macrophyte growths in the lower Makarewa River is likely to be neutral.

New River Estuary

113 As indicated above, reducing the ammonia-N load in the discharge by 75% will significantly reduce the TN load and improve water quality in the River but on its own this is unlikely to have an observable effect on nuisance macroalgae in New River Estuary. A significant reduction in

nuisance macroalgae is only likely to be achieved through a major, catchment-wide reduction in total nitrogen loads.

Benthic Macroinvertebrates

Makarewa and Oreti Rivers

114 Reducing nutrient loads from the discharge will not change the habitat so there is unlikely to be any observable changes in the benthic invertebrate community. We have not recommended any target states for MCI or other indices because these are not appropriate for the tidal, depositional, soft-bottomed habitat that exists downstream of the discharge.

New River Estuary

115 Habitat quality is relatively good in exposed, sandy sites, which have moderately abundant and diverse benthic communities. Improving the discharge quality would help improve, but not necessarily prevent, the degradation of the benthic macroinvertebrate community in degraded areas, unless there is a whole of catchment reduction.

Fish

Makarewa and Oreti Rivers

116 Any change in macrophyte growths and the cover that they provide to fish is expected to be minor and no adverse effects on eels, trout or bullies associated with habitat changes are expected.

117 Based on the study findings the current ammonia-N concentrations in the discharge do not appear to be adversely affecting fish, with the Southland Fish IBI scores in the 'excellent' class immediately upstream and downstream of the discharge. A 75% reduction in ammonia-N inputs would provide further assurance that no adverse effects on fish populations or their ability to migrate upstream would occur.

118 Fish in the lower Makarewa River appear to be healthy. Any consideration of fish health would need to be part of a catchment-wide programme as water quality is already low, they are mobile and not confined to this stretch of river. However general fish health should be part of the overall monitoring plan.

New River Estuary

119 The potential impacts of both existing and recommended future discharges on coastal fish within New River Estuary will be relatively minor compared with other land and marine based stressors (including sediment, other sources of nutrients and fishing).

Recreation

Makarewa and Oreti Rivers

120 The recommended improvement in wastewater quality will lead to an improvement in water quality in the lower Makarewa River below the discharge, although the effects of these improvements on recreational values/users is expected to be minor and may not be observable. If the risk of microbial contaminants and formation of foams and scums is reduced longer-term then this would result in some potential improvement in recreational enjoyment and reduced risk of rendering of fish unsuitable for human consumption.

New River Estuary

121 The recommended future discharge quality will further reduce the already small relative contribution the discharge makes to the quality of the New River Estuary. As a consequence any positive effects of the recommended wastewater quality upgrade on recreational values within the estuary are expected to be minor.

MONITORING

Discharge Monitoring

122 Recommendations for monitoring in addition to current practices for the discharge water include:

(a) Adding E. *coli* to the weekly discharge sampling;

(b) Adding volatile TSS to the sampling programme and reassessing along with TSS after one year. This would help confirm the source of TSS in the discharge;

(c) TP and TN should be measured weekly when discharging to provide input to nutrient loading assessments downstream and demonstrate the reduction in P and N from the discharge; and

(d) The period when monitoring is reduced be changed to 1 June to 30 September which is more in keeping with current and future practices.

123 It is recommended that the existing limits for Faecal coliforms, TN, TP, TSS and BOD in the discharge be tightened up to be the 95th %ile from the last 5 years of monitoring as per Condition 8(a). This would ensure that the quality of the discharge will not get any worse than at present and the high levels will be reduced. Breaches of this limit would be assessed annually and would have to be reported to SRC. A second set of limits would apply post-Treatment Plant upgrade for TN and TP as per condition 16 (a) to ensure the 75% reductions in TN, and ammonia-N and the 45% reduction in TP. A smaller initial reduction in N load will also be achieved within the next 2 years through improved primary treatment.

Monitoring of receiving waters

Water Sampling and Analysis

124 Alliance currently monitors water quality at the Pipe Bridge upstream of the discharge, a site referred to as 200 m (downstream of the discharge) and 1.2 km downstream of the discharge (Boundary Site). It should be noted that the 200 m Site is actually ~350 m downstream and thus beyond the mixing zone but is used for practical and accessibility reasons. It is recommended that:

(a) The Pipe Bridge Site be replaced with a site that is largely beyond the influence of tidal changes (in the vicinity of Site U2 – see **Figure 1**). This site would be used for comparative conditions such as temperature change and changes in clarity. It is important that the final site chosen is accessible.

(b) The 200 m downstream site be renamed as 350 m or "compliance site" downstream of the discharge point. Sampling this site at the same time each day should be continued (noting the stage of the tide) and this should be the major site for compliance as it is beyond the mixing zone and the data provides representative conditions for receiving waters downstream. As above the site must be easily accessible for sampling. It should be noted that with a 200 m mixing zone the water will be fully mixed and dilutions under median flows will be ~50x, well before the compliance site.

(c) The Boundary Site be discontinued as a compliance site.

125 It is also recommended that:

(a) DO saturation readings be deleted from the daily monitoring as it is the absolute concentrations that are critical to biota;

(b) That observations of foams and scums are made at the point of discharge, the 350 m downstream site and the upstream site; and

(c) The reduced monitoring apply to the period 1 June – 30 September which is more in keeping with current and future practices as per the Schedules attached to the proposed Conditions.

126 In addition to samples that are currently collected and analysed weekly during the peak discharge period (Sept-Apr) and monthly during the rest of the discharge period (May-Aug) it is recommended that:

(a) Black disc readings be replaced by clarity tube readings (a continuation of a change made and agreed with SRC some time ago);

(b) That dissolved oxygen saturation readings be deleted from the monitoring plan as it is ambient concentration that is most important. BOD should be included in measurements at the compliance suite;

(c) That conductivity, pH, temperature, DO, foams, Amm-N, TON, TN and TP be monitored weekly throughout the whole year as the purpose of this monitoring is to assess contribution to catchment-wide loads which are now measured at a range of time scales. The TON measurements would also provide data to compare with NPS-FM limits for nitrate in receiving waters;

(d) E. *coli* be added to the sampling as E. *coli* is becoming the accepted standard;

(e) It is recommended that as the discharge period varies that all parameters be measured at least monthly at the upstream site and 350 m compliance site during the non-discharge period (some parameters will be weekly as above); and

(f) The reduced monitoring apply to the period 1 June – 30 September which is more in keeping with current and future practices.

Other recommended changes to the existing limits

127 The daily maximum water temperature, as a result of the discharge, shall be set as not greater than 3^{o}C above the temperature measured at the upstream site when the natural or existing temperature is 16^{o}C or less. If the natural or existing temperature is above 16^{o}C, then the natural or existing water temperature shall not be exceeded by more than 1^{o}C as a result of the discharge (as per SRWP). A maximum of 24^{o}C should not be exceeded. If this is exceeded then the cause of the high levels and upstream temperatures should be investigated. This is consistent with the attribute B/C boundary in the NPS-FM which is set to ensure there is no more than minor thermal stress on occasions in summer on aquatic animals.

128 Visual clarity as measured by Clarity Tube method shall not be below 33% of upstream values. This is to be consistent with the clarity in the Makarewa River upstream which is considered to be Class D waters, not the 20% for Class A waters of high water clarity. The SRWP provides that clarity in lowland water bodies shall not be less than 1.3 m when below median flow. This cannot be applied to the area below the discharge because the clarity upstream would not have met this over the last 15 years.

129 It is recommended that the DO limits reflect the limits in the NPS-FM as well as the existing consent conditions i.e. consistently maintained at not less than 6 g/m^3 (96% of samples throughout year) and an absolute minimum of >5 g/m^3, which is the attribute state which causes only occasional minor stress of lowered dissolved oxygen (B/C state i.e. above the Bottom Line, NPS-FM). Diurnal measurements of DO show that the minimum DO concentration occurs in mid-morning thus the daily sampling at 8-9 am would be precautionary. In addition to limits on DO it is recommended that a maximum limit for soluble BOD_5 concentrations of <2 mg/L for 90% of the samples on an annual basis be applied to the compliance site taking into account upstream concentrations.

130 The pH range 6.5-9.0 should be applied and met as it is consistent with the SRWP.

131 The assessment of ecological effects recommended that a 75% reduction in ammonia and TN would be required to meet the site specific ammonia levels developed by Freshwater Solutions and load reductions to the

New River Estuary. To make such a reduction is a major undertaking and investment by Alliance and thus is recommended as a long-term target within 15 years.

132 The assessment of ecological effects also noted the policy in the SRWP to reduce nitrate and phosphorus by >10% by 2020. Alliance has a programme in place for continual upgrades which would be expected to deliver a reduction in TN (and thus a similar level for nitrate). The magnitude of this reduction is unknown at present but is expected to be at least 15% within the next 2 years. The major improvement will be within 15 years when the aim is to reduce TN by 75% and TP by a significant amount (45%).

133 Nitrate can be toxic to humans and aquatic biota at high levels. It is recommended that the NPS-FM limits for Band B/C of an annual median of <2.4 g/m^3 and 95th%-ile of <3.5 g/m^3 (measured as TON-nitrate and nitrite) be adopted as a limit for consent purposes. It should be noted that total oxidised nitrogen (nitrate and nitrite) contributes only 1% of TN on average in the discharge and thus is not considered significant for nutrient loads to the estuary.

134 Target microbial attribute states are provided in the NPS-FM and SRWP as <1000 cfu/100ml for E. *coli* and <1000 MPN/100ml for faecal coliforms (more recently measured as cfu). While these are considered appropriate for lowland streams they are more aspirational because of the high levels in the upper catchment. Annual medians for the upstream Bridge site have ranged from 800-9600 cfu/100 ml and would only have met this criteria in one of the last 15 years. Such a target should be considered in the long-term (i.e. at least 15-20 years) as catchment-wide plans are implemented.

135 Sediment sampling was required within 18 months of the existing consent being granted. This would involve surveys of sediments 200m upstream and 200 m downstream of the discharge for TN, TP and TOC. It is recommended that this should be repeated every 5 years as levels appear to be elevated within the mixing zone and potentially stimulate macrophyte growth.

136 At present all measurements are made from grab samples. As best practice, monitoring approaches and technology develop, continuous monitoring of key parameters in the receiving waters should be

considered by Alliance. It should also be noted that there is little change over a day in quality of the discharge thus the value of continuous measurements would have to be considered.

Biological Sampling and Analysis

137 Benthic invertebrate monitoring is highly unlikely to be a useful long term tool for monitoring the discharge. Biological monitoring may be useful in the first 3 years following a major wastewater treatment system upgrade to determine what if any improvement in benthic invertebrate community health occurs. Baseline surveys would have to be carried out before major upgrades.

138 Biological monitoring in the vicinity of the discharge is complicated by the influence that the tide has on the river. If biological monitoring is required then it should be undertaken, during summer, following a period of low flow conditions at two sites upstream (Site U1 and U2) and two sites near the discharge (D1 and D2) for comparison with previous surveys. It is recommended that the monitoring comprise the following:

(a) Description of the physical habitat;

(b) Quantitative assessment of periphyton (if present), macrophyte cover and species diversity; and

(c) Quantitative assessment of benthic invertebrates living on the substrate and semiquantitative sampling of invertebrates on submerged macrophytes.

Other considerations

Fish health

139 Fish health is still under consideration but as a minimum Alliance should be part of any catchment-wide monitoring programmes developed for the Makarewa Catchment. This will be essential as although a number of species use the Makarewa River in the region of the discharge they are often mobile and will often be in transit through this part of the River as part of annual migrations to sea (in the case of diadromous species) or to the upper catchment.

140 A fish health survey for resident species such as tuna should be made within the first 5 years of consent being granted and then before and after the major upgrade, using appropriate measures of fish health. Guidelines

for monitoring tuna health are still being developed but it is recommended that consideration be given to the approach taken by Richardson (1998) which is the basis for monitoring around the Huntly Power Station. Full procedures and protocols are provided in Richardson (1998).

SUBMISSIONS

Section 42A Consent Officers' Report and evidence of Dr Ryder

141 Alliance has received the Consent Officers' report and key points, which are relevant to my area of expertise and my responses, are set out below. It is noted that this report covers the points raised by Dr Ryder who provided technical advice to Environment Southland. Issues with ammonia toxicity are dealt with in the evidence of Dr Fitzpatrick.

142 There are several references to the lack of improvement in water quality pre-upgrade. However there is no acknowledgement that the discharge limits are set as the 95th%ile of previous measurements thus ensuring minor improvements immediately. Longer term the improvement will be substantial with 75% reduction in ammonia-N and total nitrogen and 45% for phosphorus. In the interim Alliance have now committed to at least a 15% reduction in N load within the next 2 years. The Officers Report states that these reductions have been assumed and the actual magnitude is unknown at present. However Alliance have committed to ensuring they meet these targets and thus significantly improve the quality of the discharge and what enters the receiving environments, and the reductions need to be realised to ensure compliance with the conditions Alliance is putting forward

143 The Officers' Report and evidence of Dr Ryder has queried the less stringent visual clarity conditions from >20% change to >33% change and has submitted that it is unclear what that means in terms of effects on the receiving waters. As discussed, the >20% change criteria applies to Class A waters where water clarity is an important characteristic, whereas it is considered that the >33% change criteria (is actually 33-50% but Alliance have taken a more conservative level) applies here as the Makarewa River is more like a Class D water (where it is not such an important characteristic). As noted in the Officers Report the SRWP has a water quality standard for the Makarewa River of >1.3 m visual clarity. However as noted above black disc data consistently shows maximum clarity since 2006 at the Bridge site, well upstream of the discharge, has

been <0.8 m thus such a condition cannot be applied to the Alliance discharge.

144 As noted in the Officers Report the Makarewa River suffers low oxygen levels at times above and below the discharge. The maximum BOD_5 level in the discharge, which can affect oxygen processes downstream, has been set at the 95th%ile of the last 5 years and limits placed at the compliance site to ensure at least some improvement in DO levels. The proposed levels in the Makarewa River are not NPS bottom line, which is a 7 day mean summer minimum of 5.0 mg/L and 1-day minimum of 4 mg/L. Alliance is proposing a minimum limit of 5 mg/L which is the B/C Band boundary.

145 Regarding microbial contamination I agree that at times the discharge does raise levels in the river above the 1000 cfu/100ml but equally levels upstream can already be above this limit. Alliance needs to investigate how it might reduce the discharge levels as part of a catchment-wide response. It is proposed that microbial loads be reassessed within the next 5-8 years to determine if further treatment is required as part of a catchment-wide programme.

146 Although the 4 and 6% contribution to N and P loads reaching the New River Estuary (as assessed by Dr Fitzpatrick) may be regarded as significant point source discharges, the discharge of total nitrogen will be reduced by 15% in the short-term and 75 and 45% for TN and TP in the long-term. These will improve the water quality below the discharge and significantly reduce the contribution made to the New River Estuary loadings.

147 DRP levels are higher downstream of the discharge than upstream and need to be reduced. The proposed longer–term 45% reduction in P will result in a significant reduction in phosphorus both total and dissolved.

148 The issue of foams has already been mitigated with changes to the outfall structure, as noted in the Officers Report.

149 In my evidence and the assessment report I have recommended benthic monitoring over a summer at below annual median flows but agree with comments in the Officers Report and evidence of Dr Ryder that these should ideally be at summer low flows.

150 There are concerns expressed in Dr Ryder's evidence about the extent of the mixing zone to 350 m for compliance. It should be noted however that

this site has been chosen for practical purposes and that mixing zone tests showed the river to be fully mixed at 200 m. The limits on the discharge is the only way Alliance have to control their inputs and thus reductions in those limits will reduce effects throughout the mixing zone and beyond. The level of dilution based on median flows will be ~50x (median river flow 7.65 m^3/s cf 0.14 m^3/s in the discharge) with the degree of dilution increasing from the point of discharge down to 200 m.

151 The suggestion of a mid-River diffuser was made by Dr Ryder and this should be investigated by Alliance as it would improve the immediate mixing of any contaminants.

Fish and Game Southland

152 Alliance received a submission in opposition from Fish and Game Southland (**Fish and Game**). The key points of Fish and Game's submission, which are relevant to my area of expertise and my responses, are generally covered above or are set out below.

153 Periphyton – Fish and Game submit that the draft consent conditions do not include any reference to periphyton and associated limits or provide for compliance with the national bottom line set out in the NPS-FM. As I outlined earlier in this evidence, there is lack of suitable habitat for periphyton in the lower river. Accordingly I consider that the discharge will not result in significant periphyton growth and limits in the conditions are not seen as necessary.

154 Nitrogen – the submission says that consideration needs to be given to reducing the nitrogen load to the New River Estuary in order to restore ecological functioning. As I mentioned earlier in my evidence and discussed above in relation to the Officers Report, the recommended short-term and long-term reduction in ammonia-N levels will significantly reduce TN and TP in the Makarewa River and the New River Estuary from the Alliance discharge. However, in my opinion, the trophic state of the estuary could only be improved through a catchment-wide reduction of nitrogen levels because of the relatively small contribution.

155 Dissolved oxygen – Fish and Game also queried why compliance with the national bottom line is considered appropriate as adverse effects may be experienced above the bottom line. The proposed limits of an absolute minimum of 5 mg/L is not the bottom line in the NPS-FM (4 mg/L is the national bottom line). Fish and Game also says that there are indications

of a DO 'sag' effect whereby DO levels further down in the receiving waters are less than further upstream near the discharge point. This would be very difficult to assess and would require an extensive modelling and field exercise. It should also be noted that there are other inputs which could affect DO processes. Following comments from Fish and Game and Dr Ryder I have added BOD_5 to the downstream monitoring with the recommended limit for 90% of the samples per annum of <2 mg/L.

156 E. *coli* – no limits are proposed for E. *coli*. The submission says the Applicant should be aiming for an improvement in the downstream receiving waters and ensure that levels of E. *coli* are suitable for contact recreation. There is a review condition to further assess the need for reductions in E. *coli* in the discharge. As discussed above at present Alliance could not be compliant at its downstream site because of high levels in the upper catchment that are beyond Alliance's control, thus it needs to be part of any future catchment wide approach.

157 Visual clarity – covered above

158 pH – the applicable conditions do not comply with the water quality standards in the RWP. The limits were changed some time ago to 6.5-9.0 for pH to meet the SRWP.

159 Foams and scums – the increase in the mixing zone will increase the area for scums and foams to be permitted. As I have already noted, changes have been made to the discharge pipe to minimise foam creation. The compliance site is the same as at present and is based on accessibility.

CONCLUSION

160 The Makarewa River is already degraded before it reaches the Alliance discharge point in terms of water clarity, microbial and nutrient contaminants. The River downstream is characterised by soft sediments and macrophytes which will limit the type of biological communities present. The discharge does cause further degradation for some parameters (notably water clarity, microbial components, ammonia and DRP) for which Alliance have recommended a number of improvements or approaches to improvements, which I agree with.

161 The main issues identified with the discharge of wastewater from the Alliance Lorneville plant are ammonia toxicity and N and P loads to the lower Makarewa and Oreti Rivers and the New River Estuary.

162 The risk of ammonia-N toxicity will be significantly reduced with the proposed treatment upgrade and will meet the site-specific standards, as outlined in Dr Fitzpatrick's evidence.

163 The Makarewa River below the discharge will continue to meet SRWP and NPS-FM standards for temperature, pH, nitrate toxicity, and DO with the latter two meeting standards above the NPS-FM national bottom line.

164 The recommended level of TN, TP and ammonia-N reduction for the future discharge are significant and are expected to have positive effects on water quality and ecological health in the immediate downstream receiving environment. This will assist in meeting the future water quality targets set by the NPS and SRC for the Freshwater Management Unit within which the Alliance discharge occurs. However, although the reductions would result in some improvement, it is not likely to be observable without a catchment-wide approach.

165 In the short-term interim reductions of 15% for TN have also been put forward by Alliance which I consider will address the issue of time until the main upgrades are implemented. In addition to these targets Alliance has also reduced the discharge limits for a number of parameters to 95th%ile of the data for the last 5 years to ensure that the discharge quality will not decline.

166 The issues with water clarity and microbial contamination will be reviewed and treatment options assessed. Alliance are committed to investigating options to reduce microbial contaminants and increase water clarity as a result of their discharge and should be part of any catchment-wide programme.

Mark James
4 July 2016

REFERENCES:

Freshwater Solutions (2014). Makarewa River Site Specific Ammonia Receiving water Evaluation. Report prepared for Alliance Group Ltd. October 2013

Freshwater Solutions (2015a). Assessment of the Receiving Environment for Alliance Lorneville's Treated Wastewater Discharge. Report prepared for Alliance Group Ltd. October 2014.

Freshwater Solutions (2015b). Makarewa River Mixing Zone Assessment. Report prepared for Alliance Group Ltd. September 2014.

Freshwater Solutions/AES (2015). Assessment of Effects of the Alliance Lorneville Wastewater Discharge on the Makarewa and Oreti Rivers and New River Estuary. Report prepared for Alliance Group Ltd.

MFE (1992). Water Quality Guidelines No.1: Guidelines for the control of undesirable biological growths in water.

MFE (2014). National Policy Statement 2014: for Freshwater Management 2014, issued by notice in gazette on 4 July 2014.

NIWA (2013). National Objectives Framework - Temperature, Dissolved Oxygen and pH - Proposed thresholds for discussion.

Robertson, B., Stevens, L. (2012a). New River Estuary: Fine scale monitoring of highly eutrophic arms 2011/12. Wiggle Ltd., Nelson. 30 pp.

Robertson, B., Stevens, L. (2012b). New River Estuary: Intertidal fine scale monitoring 2009/10. Report prepared for Environment Southland Wiggle Ltd., Nelson. 34 pp.

Robertson, B., Stevens, L. (2013). New River Estuary: Preliminary nutrient and sediment load estimates 2012/13. Report prepared for Alliance Group Ltd, Wiggle Ltd., Nelson. 14 pp.

SRWP (2013). Southland Regional Council Water Plan.

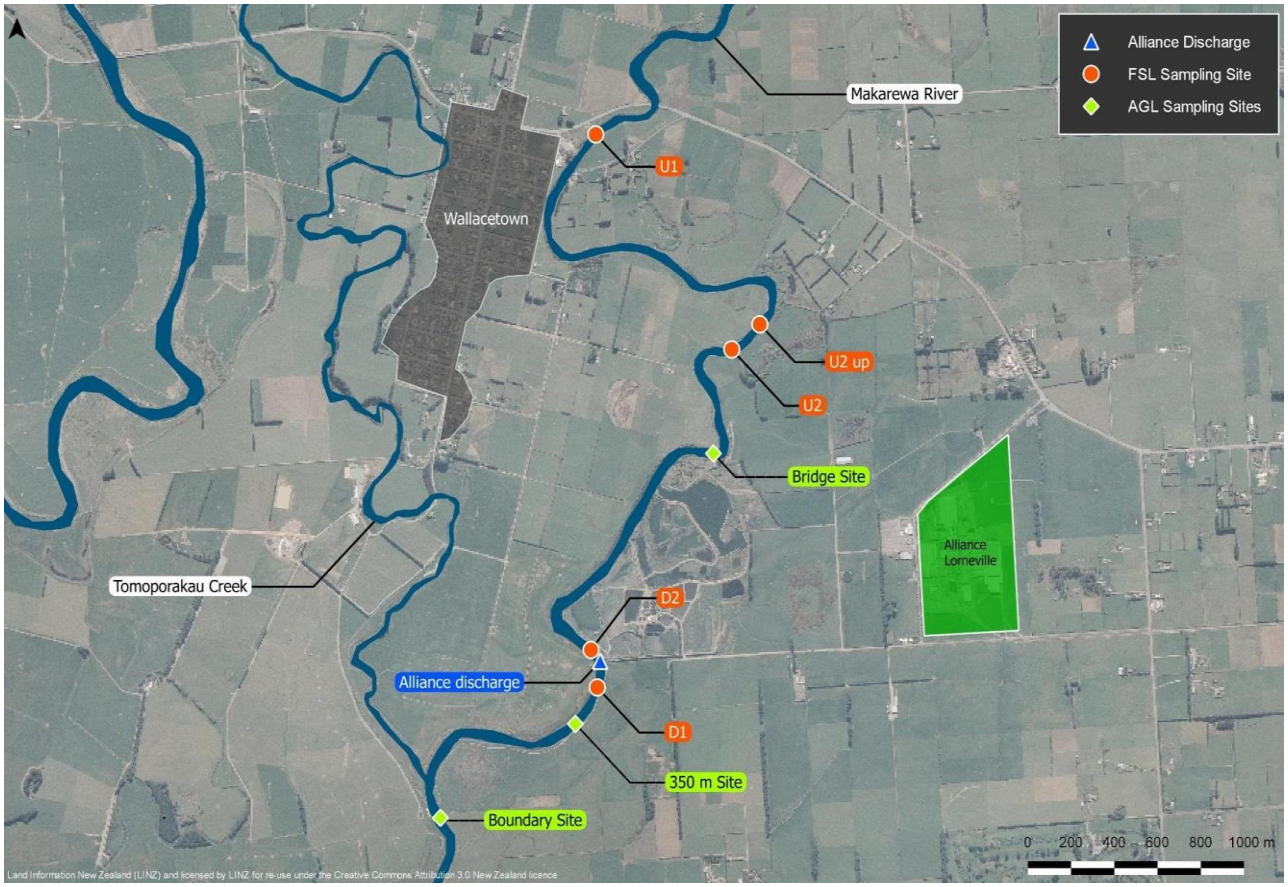

Figure 1. Map showing locations of monitoring sites.