

**IN THE MATTER** of the Resource Management  
Act 1991

**AND**

**IN THE MATTER** of applications for resource  
consent by various applicants  
to take and use water from  
the upper Waitaki River  
Catchment.

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**STATEMENT OF EVIDENCE OF JONATHON PETER BRAY ON BEHALF  
OF THE DIRECTOR GENERAL OF CONSERVATION**

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Dated: 16 September 2009

**DIRECTOR GENERAL OF  
CONSERVATION**

DEPARTMENT OF CONSERVATION

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## INTRODUCTION

### Qualifications and experience:

1. My full name is Jonathan Peter Bray.
2. I hold the position of Technical Support Officer for the Department of Conservation, and have been employed by the Department since October 2008. I am a PhD candidate at the University of Canterbury, and hold the qualifications of Masters of Science with Honors in Freshwater Ecology, Bachelor of Science (Ecology/Evolutionary Biology) from the University of Canterbury, and have a National Diploma in Science (Biology, Microbiology and Chemistry) from Christchurch Polytechnic Institute of Technology.
3. I have published in a peer reviewed scientific journal, and have assisted in producing a number of scientific documents, both as a primary author and co-author. I have presented scientific findings at the New Zealand Freshwater Sciences Society conference, of which I am a member. I have also worked as a Freshwater Ecologist for Aquatic Ecology Limited, a Christchurch based consultancy. I am a member of the Environment Canterbury led, Fish Barriers Working Group, and a member of both the Department of Conservation's Mudfish and Non-migratory Galaxiid Recovery Groups.
4. I have a degree of familiarity with the Upper Waitaki catchment and its freshwater ecosystems and I am familiar with the threatened fish species within this area, having carried out monitoring on these species and otherwise assisting with their recovery.
5. I have read the Environment Court's Code of Conduct for Expert Witnesses [as set out in the Environment Court Consolidated Practice Note 2006], and I agree to comply with it.
6. In preparing this evidence I have reviewed:
  - a) The planning assessment prepared by Mitchell Partnerships (May 2009) for Mackenzie Water Research Limited;
  - b) The report titled "Cumulative Water Quality Effects of Nutrients from Agricultural Intensification in the Upper Waitaki Catchment" (August 2009) and relevant background documents;
  - c) Periphyton growth and nutrient limitation in the upper Waitaki catchment prepared by T. Wilks and N. Norton for Environment Canterbury
  - d) Relevant evidence of experts appearing for the applicant, in particular Brian Thomas Coffey.
  - e) Relevant evidence of experts including Peter James Ravenscroft and Antonius Hugh Snelder.
  - f) Relevant s42 Officers Reports, in particular Adrian Selwyn Meredith.

I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

### **Scope of my evidence:**

7. My evidence will address the following water quality issues in the Upper Waitaki River Catchment:
  - The scope of the consents
  - The scope of the AEE and documents received
  - The existing environment and ecosystems in question and potential impacts with regard to:
    - Groundwater
    - Lakes
    - Streams and springs
  - The Periphyton guidelines suitability for assessing nutrient flux
  - The ANZECC suitability for assessing nutrient flux
  - The mitigations toolkit
  - Summary comments

### **The scope of the consents:**

8. An agreement was made between Mackenzie Irrigation Company (MIC) and Meridian Energy Limited (MEL) that has allowed MIC to take 150 Mm<sup>3</sup> per year.
9. This 150Mm<sup>3</sup> means an additional 25,000 ha of land may be irrigated in the near future. This means the potential exists for a total of ~35,501 ha to be irrigated within the Mackenzie basin. It has been stated (GHD 2009) that the likely intensification on the proposed irrigated areas will go from 1-3 stocking units/ha to up to 15 stocking units/ha.
10. There exists potential for future development and intensification where these consents are allowed. The impacts of both the current proposed and future activities are deemed to be minimal or acceptable by the applicants.
11. The proposed consents are significant in scope and this intensification stands to significantly change the surrounding freshwater environments.

### **The scope of the AEE and documents received:**

12. The Cumulative Water Quality Effects report (GHD 2009) and the Mitigations Toolkit report (GHD 2009) discusses nutrient flux to streams but is narrow in scope and does little to document or account for likely impacts of intensification in broad or fine terms on freshwater ecosystems and species in the Upper Waitaki catchment.
13. Specifically changes in nutrient status and agricultural intensification are not linked back to the ecosystems in question, their habitats and species that are likely to be impacted.
14. Land intensification needs to be considered generally. It has a number of specific stressors not considered by the applicants (Parkyn and Wilcock 2004). These include (but are not limited to):

- a. Alteration to the physical habitat, alteration to riparian vegetation and riparian structure, substrate alteration through stock damage, bed widening, bank profile changes, bed texture degradation.
  - b. Point and diffuse inputs of N and P, where N and P among other nutrients (e.g. Fe) will enter waterways. Where they are diffuse entering through ground water connectivity or at specific points where discharges have been applied for.
  - c. Point and diffuse inputs of sediments, through stock encroachment leading to pugging, sediments from overland flows, removal/alteration of riparian vegetation, and the discharges applied for.
  - d. Point and diffuse inputs of agrichemicals. A number of novel contaminants will be introduced including, pesticides, fungicides, herbicides and insecticides.
  - e. Faecal coliform inputs and organic waste inputs.
15. With many of these stressors there exists the potential for fish and macroinvertebrate deaths and/or sub lethal effects.
16. Critically, there will in my opinion be alteration to the habitat, alteration to community composition, and ultimately ecosystem function. Degradation of these habitats for fish will then potentially result in the loss of key populations and may result in the extinction of certain fish taxa. I will explain this more fully within the coming evidence.
17. Without taking into account other effects based factors associated with agricultural intensification of this nature as laid out above, and without taking into account the effects these factors have on ecosystems (habitats, communities and species), then it must be recognised that the applicants have not properly assessed the impact of these applications.

**The existing environment and ecosystems and potential impacts:**

18. To understand freshwater ecosystems it is important to understand that they are a product of their catchments. This is a basic, and possibly the most important tenet of freshwater ecology (Hynes 1975; Parkyn and Wilcock 2004).
19. The Upper Waitaki Catchment consists of an extensive area of inland pristine grassland areas with an existing area of 107,580 ha low intensity (1-3 stocking units) dryland farming (GHD 2009b). This relatively low intensity farming means the surrounding freshwater ecosystems within the Mackenzie basin, are relatively pristine.

**Groundwaters**

20. Groundwater quality in the Upper Waitaki catchment is high with nitrate concentrations in 90 of bores showing that 98% of those had N concentrations below 1mg/L, indicating very high quality groundwater sources, that may be considered ‘unaffected’ by agricultural practices (Burden 1980; GHD 2009a).

21. Evidence suggests there is considerable groundwater flow and dilution from highland inputs. A groundwater threshold was set at 1mg/L and where this was expected to be exceeded by proposed land use intensification, further modelling was conducted to determine whether this exceedence would have minor effects or not on receiving environments. Secondary thresholds were considered necessary and it was thought that mitigation would be required to address the significantly greater nutrient inputs with intensification of this nature. This will undoubtedly have flow on effects to, lakes, rivers and critically the groundwater fed springs.
22. Large deficits of N and P in certain catchments are thought to be required by the applicant under current conditions to meet ANZECC (2000) trigger guidelines, and the periphyton guidelines (GHD 2009a, Biggs 2000). Stone River Node, Omarama Stream Node, Willow Burn, all exceed the ANZECC trigger guidelines.
23. Moreover an increase in intensification of (dairy) systems tends to increase 'leakiness' (or the rate of transport or loss of N and P from soils to ground water) of future losses (Monaghan et al. 2004 and Ledgard et al. 2004 in GHD 2009b).

#### **Lakes**

24. An internationally recognised measure to characterise water quality in lakes, the Trophic Level Index (TLI), has been adopted by the applicants to describe the downstream lakes in the catchment (GHD 2009a).
25. The calculated TLI from measured lake quality information indicates that the current trophic status in Lake Benmore is generally Microtrophic in the Northern Arm and Oligotrophic in the Ahuriri Arm. The TLI levels of Lake Benmore have not shown any significant change from 2002 to 2008. Lakes Waitaki, Aviemore and Ruataniwha are calculated to be in the Microtrophic to Oligotrophic range and the Wairepo Arm of Lake Ruataniwha is calculated to be in a Mesotrophic state (GHD 2009a).
26. Burns et al. (2000) proposed the following classification based on the international literature, classifying the Trophic Lake Index into seven trophic states indicating increasing nutrient enrichment, and factors associated with this (Table 1).

Table 1. Classification based on the TLI (Burns et al. 2000).

Trophic state	Nutrient enrichment category	Trophic Level	Chla (mg/m <sup>3</sup> )	Secchi depth (m)	TP (mg/L)	TN(mg/L)
Ultramicrotrophic	Practically Pure	0 to 1	< 0.33	>25	< 0.002	<34
Microtrophic	Very Low	1 to 2	0.33 - 0.82	25 - 15	0.002 - 0.004	0.034 – 0.073
Oligotrophic	Low	2 to 3	0.82 - 2.0	15 - 7.0	0.004-0.009	0.073 -0.16
Mesotrophic	Medium	3 to 4	2.0 - 5.0	7.0 - 2.8	0.009-0.020	0.16 – 0.34
Eutrophic	High	4 to 5	5.0 - 12	2.8 - 1.1	0.020-0.043	0.34 – 0.73
Supertrophic	Very High	5 to 6	13 - 31	1.1 - 0.4	0.043-0.096	0.73 - 1.6
Hypertrophic	Saturated	> 6	> 31	< 0.4	> 0.096	> 1.6

27. Hayward et al. (2009) stated that all of the large high country lakes (both natural and controlled) score microtrophic (or less) and these lakes with the exception of the Wairepo Arm of Lake Ruataniwha, which is mesotrophic have a very low nutrient status with characteristic high water quality.
28. These authors also note these lakes are also highly valued for a range of values, ecological, amenity and recreational (Daly 2004 in Hayward et al. 2009). Generally, these values are a function of low nutrient status and high water quality.
29. Hayward et al. (2009) made a general recommendation that these high country lakes as microtrophic or better systems should be maintained in at least the oligotrophic state.
30. These lakes are a series of relatively unique low nutrient (micro-oligotrophic) systems. Most importantly to biodiversity, changes affecting these lakes will create change to surrounding freshwater systems and vice versa. That is to say that changes that affect the ground waters, streams, springs and lakes will through their hydrologic connectivity (vertical, lateral and longitudinal) influence other habitats.

### Rivers and springs

31. A recent download from the Freshwater Fish Database of the Waitaki River (mainstem) and several major tributaries may be seen in Appendix 1. Twenty four fish species were returned from this download.
32. The draft threat rankings described in Appendix 1 are thought to be final according to a member of the review panel (pers. comm. P. Ravenscroft). This new ranking ranks 50 native extant fish species, placing 34 of them within threat category. Thus 68% of New Zealand's native freshwater fish species are now within some sort of threat category, where each species has been considered by experts to be at some risk of extinction. Many species have been upgraded or added as threatened within these new rankings, as the Department

of Conservation and conservation scientists gain more knowledge on population states and on fish taxonomy.

33. Many of these species would stand to be impacted by land use intensification and its stressors as outlined above where upstream impacts influence downstream environs (Vannote et al. 1980). This includes sports fish and other native fish potentially within downstream reaches, included in Appendix 1. However, the primary concern to biodiversity is the impact that this land intensification will have on three species of endangered fish. These are as follows:
  - f. Waitaki Lowland longjaw (*Galaxias aff. cobitinis* (Waitaki)) is endemic to the area and has the threat status Nationally Critical. Thus it is only found in the Waitaki, has the highest threat status the Department of Conservation applies, and is reliant on the integrity of these freshwater ecosystems for its persistence (DOC 2004).
  - g. Bignose galaxias is also endemic to this region, and is known from only around 12 locations. These sites are distributed though out the upper Waitaki basin (DOC 2004). It has been upgraded from the 2007 ranking for 5-Gradual Decline to 2-Nationally Vulnerable.
  - h. Waitaki Upland longjaw galaxias (*Galaxias aff. prognathus* (Waitaki)) has like Waitaki Lowland longjaw been considered distinct enough through its genetic divergence and allopatric distributions to be considered a) a distinct ESU or evolutionary significant unit, but also b) has been divided into a sub-species. Thus this sub-species is also regionally endemic to the Waitaki and like the other taxa covered, has populations that stand to be impacted by the proposed consents (Appendix 2).
34. All three species are non-migratory, and while they are found within the main braids of rivers they may only use this habitat sporadically. Their primary habitats are high water quality, small, spring fed streams, where they may use upwellings as a critical feature of their life cycle (Ravenscroft 2009).
35. They are termed pencil galaxiids and are generally under pressure as a group from extinction due to a range of threats. Abstraction and dewatering are thought to be a significant factor involved in threatening the population viability of some galaxiids (Allibone, 2000), while the ubiquitous, predatory, competitively superior trout have also been implicated. The impacts of trout are known to be most severe on galaxiids such as *G. cobitinis* and *G. macronasus*, that inhabit stable spring fed streams such as those in the Upper Waitaki (Allibone and McIntosh 1999).
36. The influence of such large scale intensification surrounding the critical habitats of these regionally endemic taxa can only be considered a direct threat to their persistence.
37. As has been covered, a host of factors associated with intensification have not been considered, nor have the effects of this intensification on these endemic threatened fish been considered. This intensification may change a waterway through time such as;

- with nutrient changes, causing increased productivity and making the bed impermeable as discussed in Mr Ravenscroft's evidence, or
  - a single pulse of a high clay sediment, from overland flows could conceivably cause site extinction, where plowing followed by a rain fall event could produce a large pulse of sediments, where little in the way of riparian vegetation would exist to stop or mitigate this
  - stock encroachment, leading to changes in bank morphology and riparian structure with general degradation of substrate and habitat quality.
38. I believe of range of factors will play a role, in making the habitat of these threatened fish unsuitable, where intensification is allowed to proceed. The habitat degradation, primarily sediments and nutrients will degrade water and habitat quality.
39. As Mr. Ravenscroft states, flows recorded from an annual monitoring site set up within such a spring head do not reach the FRE3 value (Biggs 2000) stated to flush periphyton, which coincidentally is a value related to velocity and thus sheer stress and are not directly comparable. Three times the median flow of year round stable system such as a spring fed creek, may generally not create sufficient sheer stress to a) move sand and more coarse bed material present to a lesser degree in these systems and, b) cause sloughing. FRE3 was a value created for larger systems with variable flows (Biggs 2000).
40. The overriding physical factor associated with spring fed systems is their stability. High stability translates to moderated flood events, which means that these systems do not get the habitat maintaining (FRE3) hydrologic events, that 'reset' the primary producers (algae and macrophytes). They also do not receive the coarse sediments that are also critical in this scouring process (Biggs et al. 2008).
41. Degradation of fish habitat will occur with proliferations of either algae or macrophytes. Algae proliferations encountered within waterways, can negatively influence dissolved oxygen over a diel period where during night, these growths can contribute to anoxia near the bed. Anoxic periods in a spring fed system that may already have low dissolved oxygen, and may become choked with macrophytes or algae and may cause or contribute to the disappearance of subpopulations. This has been noted at a site that became choked with a macrophyte as in P. Ravenscroft's evidence.
42. Such proliferations of either macrophytes or algae could also impair the spawning, rearing, feeding and refuge habitats of native fish. Where extensive proliferations develop due to increased nutrient inputs and are able to develop where there are no significant flushing flows and sediment inputs, a number of changes occur to the habitat and the invertebrate fauna and subsequently the fish community. As has been stated anoxia overnight can occur, the substrate of these streams, due to the breakdown of these primary producers can remain

permanently hypoxic (without oxygen), and sediments can accumulate. This changes the invertebrate community to one adapted to these conditions.

43. So markedly increased nutrient concentrations may alter a springs fed system, its substrate and substrate physicochemical conditions, stream physicochemical conditions and the fauna and flora present inclusive of fish.
44. Increased sediment that makes its way into surface water will have a range of negative effects on any fish community present. In itself it is a stressor with in some instances lethal and often sublethal direct effects. Sediment inputs will also have a range of indirect negative effects through degrading habitat quality, for breeding, and macroinvertebrates and thus food sources for fish.
45. The typically very low nutrient nature of these systems makes them unique, observed within the water quality report that noted nutrients were below detectable levels in some instances (GHD 2009a). This is also corroborated by the fact that these communities are comprised of cyanobacterial mats, (e.g. *Nostoc* spp., *Oscillatoria* spp.), as these species are capable of fixing nitrogen and are characteristic of nutrient poor waters.
46. These findings are reflected within the periphyton community, where significantly higher biomass was obtained with the addition of nutrients as with the use of nutrient diffusing substrates (Wilks and Norton draft).
47. These systems may also be considered autothously driven systems, that is they are driven by periphyton productivity, and composition. Changes in nutrients within these systems especially in nutrient limited systems will have changes that percolate up through food webs.
48. Changes to the endemic fish fauna have not been commented on in any of the applicant's background reports, nor have potential changes to sports fish. With increasing productivity it may be that sports fish abundance/densities increase within the lakes and braided rivers, which may have spill over effects into the spring fed tributaries with potential consequences for non-migratory galaxiids, where their effects are known to be severe (Allibone and McIntosh 1999, DOC unpublished data).
49. It may also be considered that increased nutrients and the effects of dams may increase the likelihood of toxic algal blooms, as has been noted in other catchments with greater agricultural development also influenced by the dams (eg. The Opuia and *Phormidium* blooms).

**Periphyton guidelines suitability for assessing nutrient flux:**

50. The New Zealand Periphyton guidelines are a subjective index (MfE 2000) that may be used to assess the degree of nutrient change within a freshwater ecosystem. This index was developed for hill-country fed rivers which are different systems from those within the Upper Waitaki catchment. There appear to be a number of flaws with using this method to assess the nutrient status of freshwater ecosystems in the Upper Waitaki catchment.

51. One of the primary concerns is that the New Zealand Periphyton Guidelines were not created for high country, nutrient poor systems such as this, with the disturbance regime of the Upper Waitaki and given the current low levels of intensification. Even for use within systems where it was designed it may in certain instances I believe produce spurious results.
52. It relies on the use of FRE3 (the mean number of flood events per year that exceed three times the median flow) that is not well established for the Upper Waitaki systems.
53. Periphyton assemblages are complex and vary in time and space dependant on a wide range of environmental and biological factors of which nutrient flux is one variable (Biggs and Kilroy 2004; Peterson 2007). These factors may be considered hierarchical in nature (Biggs 2000) with ultimate (primary variables) such as catchment, and proximate (secondary) variables such as land use secondarily defining the community. Light (DeNicola et al. 1992), nutrients (Biggs and Close 1989), temperature (DeNicola 1996), water velocity (Poff et al. 1990), the magnitude of physical disturbance and time since last disturbance (Biggs and Close 1989), competition (Peterson 2007) and invertebrate grazing (Peterson et al. 2001) and thus the structure and then predatory control on these grazers, are all factors affecting periphyton structure and biomass accrual.
54. Meredith and Hayward (2002) have also established that excessive periphyton growths have not been as prevalent as predicted by the nutrient status of Canterbury rivers generally.
55. As stated within the guidelines themselves *“In practice, linking periphyton biomass to stream nutrient concentrations is very difficult. This is because of:*
  - i. *the dynamic nature of biomass accrual and loss processes*
  - j. *the concentrations of dissolved nutrients measured in solution mainly reflecting nutrients that are left over after the periphyton have removed what they need and not the supply concentration*
  - k. *the difficulty of isolating seepage and groundwater upwelling zones to quantify the local supply of nutrients to periphyton on the stream bed.”*
56. I have personally investigated periphyton indices as an indicator of land use impacts and while in many instances they are a superior measure of ecological integrity and stream health (Stark et al. 2001), I believe spurious results would be gained leading to potentially significant environmental degradation, by only using the Periphyton guidelines in this manner. This personal experience with creation of a periphyton index (Bray, 2007), found physical measurements gave a more robust, more reliable indicator of land use effects given the host of factors that influence algal composition and biomass.
57. As pointed out by A. Meredith in his Officer’s Report, biomass accrual differs markedly dependant on nutrient status, in terms of growth forms and community composition. Where periphyton accumulates under high nutrient conditions large green algal blooms are likely to develop, and large proliferations of this nature, or for that matter prolific macrophytes growth due

to nutrient enrichment as has been noted at one Waitaki lowland longjaw site already degrade water and habitat quality.

58. The periphyton biomass data collected by Coffey (2008 and 2009) should be treated with caution, no hydrograph was supplied and no mention of sampling date, or time since last disturbance was mentioned. During the middle of summer within an autochthonously driven system such as these are, that are currently undergoing a low flow period, with resulting high temperatures and stable flows, may naturally have high biomass to the level that such growths could be considered conspicuous or nuisance. This is however natural and occurs every summer and in many instances is a natural process (Biggs and Kilroy 2000). This information is realised by phycologists and I believe raises doubt as to the validity of using the Periphyton guidelines (Biggs 2000).

### **The ANZECC guidelines suitability for assessing nutrient flux**

59. I agree with Adrian Meredith's statement in the Officer's report (paragraph. 17) that the water quality for streams within the upper Waitaki catchment are very different from those summarised in ANZECC 2000, Table 3.3.10. I further agree that it is thus inappropriate to use these values as guidelines where they would allow for significant degradation of water quality and thus ecosystem integrity.
60. As stated within the opening paragraph of Chapter 3 of the Guidelines, it must be noted that the guidelines are themselves, just that, guidelines. Thus as was stated they may need to be adjusted to suit conditions of any particular site physicochemical conditions (in this case oligotrophic-microtrophic systems) and also the degree of threat (in this case high threat with a number of highly threatened endemic species present) associated with an activity (ANZECC 2000).
61. Using the ANZECC guidelines but not the 'threshold values' themselves set up in a robust manner such as the ANZECC (ANZECC 2000) and using repeated spot water chemistry sampling and measurement is the only way to definitively assess nutrients themselves. Other physical measurements or habitat assessments, or proven recognised biological indices e.g., Stark et al. (2001) when applied correctly could also used to give a more definitive indication of nutrient flux and ecosystem health.
62. As has also been noted by A. Meredith in his Officer's report, monitoring should always follow the correct protocols in order to correctly collect representative data and thus avoid misrepresentation of the biological variable of interest, this appears to have occurred for both the collection of macroinvertebrates and algae.
63. I agree with A. Snelder in his evidence that the use of the Periphyton Guidelines here does not effectively account for the fact that using this methodology where dams are present may produce anomolous results, where dams make down stream reaches more stable, reduce the flux of sediments downstream and these systems may be considered more stable in themselves.

64. Metrics such as MCI, QMCI, EPT and %EPT that were noted from within the water quality report (GHD 2009a) from a number of nodes, indicated lower ecosystem quality than may be expected. However the sampling protocols stated within the appendices to the evidence by Coffey (2009) and the data used within the water quality report (GHD 2009a) stated many of the nodes sampled for macroinvertebrate were soft bottomed. The indices used (Stark et al. 2001 and Stark and Maxted 2007 in Coffey 2009) should not be used for meandering sections of a stream as appears to be the case here as they have developed specifically for wadeable hard bottomed streams, and are now recognised to be inapplicable to streams with soft substrate and the applicable sb(MCI) index should have been used. Further more it is necessary to establish the time since last disturbance as appears to not have been the case (Coffey 2009 and appendices).
65. I believe the applicants have inappropriately assessed the ecological state of the area, missing key biological values, painting a false picture of the environment. Furthermore the applicants have inappropriately used both the Periphyton and the ANZECC, subsequently and have subsequently not examined the real effects of the proposed intensification and greatly underestimated to the ability of these low nutrient water bodies and associated ecosystems to absorb change with out major effects.

#### **The mitigations toolkit.**

66. Paraphrased from the mitigations toolkit. *“The responsibility for meeting the nutrient reduction requirement set out by the WQS and the implementation and monitoring of the FEMP (Farm Environmental Management Plan) lies with the farmer. The efficacy of the mitigations depends on their implementation and other site factors, therefore reductions are indicative only and monitoring is essential”*
67. The mitigations toolkit is a set of best management practices and methods commonly used to reduce intensification impacts, and will be voluntary.
68. Again the toolkit focuses its assessment on diffuse nutrient pollution. Diffuse pollution of this nature is very hard to mitigate for. It enters ground waters at variable speeds, undergoes a degree of denitrification which may be variable dependant on a number of factors in itself (GHD 2009b).
69. The impact to the environment may be significant in terms of the scale of intensification of this nature, but without proper controls on the other factors discussed. Stock encroachment leading to fine sediment inputs, bank erosion due to pugging, leading to substrate degradation, may quickly cause local extinctions of vulnerable galaxiids reliant on high water quality, and high quality habitat in order to complete their life cycle.
70. Even where mitigation is taken up and is implemented by each consentee, given the soil types and, the expected nutrient loading, the potential exists for

mitigation no matter how strict, how well it is adhered to, to be ineffective (Monaghan et al. 2004 and Ledgard et al. 2004 in GHD 2009b).

### **Conclusions:**

71. The water quality reports and applicants evidence for the Upper Waitaki consent applications fail to account for a range of factors associated with land use of this nature and scale, fail to recognise the habitats (springs and smaller streams) most in jeopardy and fail to recognise the species most in jeopardy, some of which may face local extinction and thus potentially extinction completely, given they are regionally endemic and in an already very perilous state (e.g. Waitaki Lowland Longjaw - Nationally Critical).
72. Recommendations from (Hayward et al. 2009) are that these lakes should be kept in an oligotrophic or better state, however nutrient deficits (as modelled) are required in certain catchments to maintain this.
73. Without a thorough analysis, carried out in a robust manner, of the freshwater values I have described, and linking the specific stressors (primarily substrate degradation, sediment inputs, and nutrient inputs) I have described and their likely impacts I believe it is impossible to assess the real impact of these consents on freshwater ecosystems and values.
74. The state of the existing environment has not been correctly established and subsequently the guidelines both Periphyton and ANZECC have been incorrectly implemented, the thresholds that have then been set on this information would enable significant environmental degradation.
75. The mitigation toolbox is a step in the right direction for minimising impacts. However the lack of specifics at a region wide level as to actual design details, implementation and monitoring feedback provides no base against which known effects can be assessed in terms of proposed mitigation.
76. The proposed intensification, the type of land use, the extent of the proposals, the location of the proposed areas to be irrigated, the fragile state of these ecosystems and the tenuous state of the endemic fish within the area, suggest to me that with this intensification there will be a significant impact on freshwater biodiversity within the area, and the otherwise relatively pristine nature of these ecosystems (lakes, streams, wetlands, and groundwaters).

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