BEFORE THE ENVIRONMENT COURT
AT CHRISTCHURCH

ENV-2010-CHC-115, 123, 124 AND 135

IN THE MATTER	**of Appeals pursuant to Section 120 of the Resource Management Act 1991**
BETWEEN	**WEST COAST ENT INC** **Appellant**
AND	**ROYAL FOREST AND BIRD PROTECTION SOCIETY OF NEW ZEALAND INC** **Appellant**
AND	**WHITE WATER NEW ZEALAND INC** **Appellant**
AND	**DIRECTOR GENERAL OF CONSERVATION** **Appellant**
AND	**WEST COAST REGIONAL COUNCIL AND BULLER DISTRICT COUNCIL** **Respondents**

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STATEMENT OF EVIDENCE OF
RUSSELL GEORGE DEATH
FOR DIRECTOR GENERAL OF CONSERVATION
Dated: 14 May 2012

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AND	**MERIDIAN ENERGY LIMITED** **Applicant**
AND	**FRIDA INTA** **Section 274 Party**
AND	**WHANAU PIHAWAI WEST – RICHARD WAYNE BARBER AND IRI MAY BARBER MILNER** **Section 274 Party**
AND	**J MacTAGGART** **Section 274 Party**
AND	**ORION ENERGY NZ LTD, ALPINE ENERGY LTD, MAIN POWER NZ LTD AND ELECTRICITY ASHBURTON LTD** **Section 274 Party**
AND	**NZ RAFTING INC** **Section 274 Party**
AND	**ANN SHERIDAN** **Section 274 Party**
AND	**BULLER ELECTRICITY** **Section 274 Party**

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1. QUALIFICATIONS AND EXPERIENCE

1.1. My full name is Russell George Death.

1.2. I have the following qualifications: BSc (Hons) and PhD in Zoology from the University of Canterbury.

1.3. My general area of expertise is the community ecology of stream invertebrates and fish. I have particular expertise in the area of high and low flow effects on riverine invertebrate communities. As part of this research I have also conducted research on the effects of flow and nutrients on periphyton communities. In 2007 I was one of thirteen scientists funded to attend a special symposium of the Royal Entomological Society in Edinburgh to review the current state of research on aquatic invertebrates. I was asked to review the effects of floods on aquatic invertebrates. I am a member of the Ecological Society of America, the New Zealand Freshwater Sciences Society and the North American Benthological Society.

1.4. I am currently an Associate Professor in freshwater ecology in the Institute of Natural Resources – Ecology at Massey University where I have been employed since 1993. Prior to that I was a Foundation for Research, Science and Technology postdoctoral fellow at Massey University (1991-93). I have 75 peer-reviewed publications in international scientific journals and books. I have written 40 plus consultancy reports and given

around 60 conference presentations. I have been the principal supervisor for 35 post-graduate research students. I have been a Quinney Visiting Fellow at Utah State University. I am on the editorial board of the journal Marine and Freshwater Research.

1.5. In preparing this evidence I have read a report by Dr's Suren and Kilroy from 2007 (CHC2007-111) and a brief outline from 2011 (Mokihinui River periphyton and invertebrates: new data collected in 2011). I have also reviewed the statements of evidence (Dated September 2011) of Dr Alastair Suren, Dr Catherine Kilroy, Dr Mark James, Mr Ned Norton and Mr Ian Jowett to which these proceedings relate.

1.6. I have read the Environment Court's Code of Conduct for Expert Witnesses, and I agree to comply with it. I confirm that the issues addressed in this brief of evidence are within my area of expertise.

1.7. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed. I have specified where my opinion is based on limited or partial information and identified any assumptions I have made in forming my opinions.

2. SCOPE OF EVIDENCE

2.1. My evidence will deal with the following:

a) Potential effects of the proposed Mokihinui Hydro Proposal (MHP) on the invertebrate and periphyton communities of aquatic habitats within the inundation zone and river downstream of the dam.

b) The findings and conclusions of evidence presented by Dr Alastair Suren (invertebrates) and Dr Catherine Kilroy (periphyton), on behalf of Meridian Energy Limited, on the potential effect of the MHP on the invertebrate and periphyton communities. I also consider the supporting evidence by Dr James, Mr Norton and Mr Jowett that refers to invertebrates and periphyton.

c) Potential effects of MHP construction activities on the invertebrate, and periphyton communities.

d) The likely effects of converting 14 km of river to a reservoir on the invertebrate and periphyton communities.

e) The potential effects of a change to the downstream flow regime of the Mokihinui River on the invertebrate and periphyton communities.

3. KEY FACTS AND OPINIONS

3.1. I agree with the majority of factual evidence presented by Dr's Suren and Kilroy (Meridian experts) but differ in my opinion on the significance and consequences of those facts.

3.2. The aquatic invertebrates and periphyton in the mainstem and larger tributaries of the Mokihinui River are characteristic of unmodified flood prone rivers. As such they represent a decreasingly common ecological type in New Zealand. In contrast the seeps and tributaries have an extremely unique and rare biota.

3.3. The change in physicochemical habitat, as a result of slowing the flow of a river to that in a reservoir, would result in the local extinction of the majority of riverine invertebrates and periphyton in the Mokihinui river mainstem. I concur with Dr Suren and Dr Kilroy that these taxa are likely to be present in other rivers in the region not affected by mining. However, as invertebrates are a crucial food resource for other aquatic (e.g., fish) and terrestrial (e.g., spiders, birds) species, this has the potential to significantly affect ecosystem functioning within the wider Mokihinui River catchment.

3.4. The ecological and physicochemical conditions that will develop in the reservoir behind the dam are unclear, and may not be as suitable an environment for Lake biota as Dr's Suren, Kilroy and James suggest (See evidence in chief Dr Schallenberg). However, even if a biota similar to other South Island landslide lakes develops it is important to realise that for the invertebrates it would be a less

diverse fauna than the river (24-41 taxa compared to 94 taxa in the mainstem and large tributaries and 124 taxa in the combined mainstem, tributaries and seeps) dominated by smaller pelagic or benthic organisms. For the periphyton communities the flora may be more diverse than currently in the mainstem and large tributaries but less than that in the combined mainstem, tributaries and seeps that would be lost by inundation.

3.5. Furthermore, if the anoxic conditions develop in the reservoir as Dr Schallenberg postulates, the discharge of this water to the lower reaches of the Mokihinui River is likely to be toxic to the invertebrates that can survive the high flow fluctuations this area will be experiencing with the dam operation.

3.6. Many of the aquatic habitats that Meridian's experts sampled yielded species that appear to be new to science. Dr Kilroy and Dr Suren (except in one case) do not refer to them directly as new species to science but as "indeterminate species" or "taxa that could not be assigned to known species" respectively. However, Mr Norton in his evidence does refer to them as "new to taxonomic science". I consider them as new to science with potentially restricted distributions to the Mokihinui seeps.

3.7. Many of the seeps and small tributaries that would be lost in the inundation zone of the MHP are unique (in fact at least 5 invertebrate species and 5 periphyton taxa new to science) and diverse ecosystems. I believe Dr Suren provides convincing evidence that these assemblages are different from other seepage faunas within the wider Mokihinui Catchment, nearby Karamea River catchment and elsewhere in the West Coast. Dr Suren concludes that

"the loss of seeps is a greater effect than loss of mainstem habitats, due to their more distinctive communities and uncertain knowledge". Despite this he concludes similar assemblages or their constituent taxa could be found somewhere if we just look hard enough. However, there is clearly no current evidence that these assemblages do occur elsewhere, and even if they do there is certainly no denying their rarity. In my expert opinion their loss cannot be mitigated.

3.8. The work associated with the physical construction of the dam, if conducted with due care and best management practice, would have a minor or short duration effect on the aquatic invertebrates and periphyton.

3.9. The Mokihinui River currently experiences regular and severe flood events and the invertebrates and periphyton inhabiting the river are well accustomed to such events. I concur with Mr Jowett that invertebrate productivity would be reduced by regular daily flow fluctuations (16-126 m^3/s) of the order planned for the MHP but disagree this may be balanced by reduction in fine sediments and increased substrate stability. I believe the MHP flow regime downstream of the dam would result in a faunal and florally denuded river for some considerable distance with concomitant effects on the fish and birds, that depend on them for food, in that downstream ecosystem.

3.10. I concur with Dr Kilroy that the MHP may increase the likelihood of didymo (Didymosphenia) geminate blooms. However, I believe the other environmental changes from the MHP (detailed above) are a greater risk for adverse ecological outcomes than an increase in the probability of didymo blooms.

4. INVERTEBRATES AND PERIPHYTON

4.1. Periphyton is the algae (often only visible microscopically or as a coating of slime) that forms the basis of stream and river food webs. Excess nutrients, and some species of invasive algae (i.e., didymo), can cause large filamentous growths that disrupt natural ecosystem function. Shear stress and substrate movement from high flow events can scour periphyton from stone surfaces and act as a control mechanism on excessive growth (Stevenson et al. 1996).

4.2. The flow regime of the Mokihinui River is likely to be the dominant controlling factor on periphyton communities as the river catchment is predominantly undeveloped and consequently leaches limited quantities of nutrients.

4.3. Aquatic invertebrates consume this periphyton either directly (along with other organic sources) or by predating the smaller grazing invertebrates.

4.4. The majority of river, stream and seep invertebrates (particularly in the Mokihinui) are insects and only aquatic as juveniles (larvae). They emerge from the water as flying adults. For most, only at this adult stage of their life can they be accurately identified to the species level.

4.5. Both as larvae within the river and as flying adults they form an important dietary component for both aquatic (e.g., fish (McDowall 1990)) and terrestrial (e.g., birds, spiders, bats (O`Donnell 2004, Polis et al. 2004, Burdon and Harding 2008)) food webs.

4.6. In New Zealand rivers the pattern of flow regime is one of the dominant controlling factors on the composition of river and stream invertebrate communities (Death 2008).

4.7. The diversity, composition and biomass of invertebrate communities are markedly different between running (rivers) and still water (lake or reservoir) habitats.

5. EXISTING ENVIRONMENT – ACTUAL AND POTENTIAL THREATS.

Mokihinui mainstem

5.1. As the terrestrial component of the catchment of the Mokihinui River is dominated by native vegetation the aquatic periphyton and invertebrates are those that characterise relatively unmodified flood prone rivers of the West Coast.

5.2. The dramatic reduction in flow from converting 14 km of river to a reservoir, and the associated change in physicochemical habitat would result in the local extinction of the majority of these periphyton and invertebrate taxa.

5.3. A number of the taxa, from the mainstem and larger tributaries, are likely to occur in other streams and tributaries not affected by mining elsewhere in the catchment or wider West Coast environment (D Kelly evidence in chief). However, it is difficult or impossible to identify many invertebrate taxa to the species level based on the juvenile forms collected from the water. It therefore remains possible that some rare or threatened taxa would be lost from the inundation of these habitats.

5.4. The biomass and productivity of these instream invertebrate larval stages and the associated terrestrial winged adult stages are likely to form a significant

component of the diets of other aquatic (e.g., fish) and terrestrial (e.g., spiders, birds) animals. Thus although the loss of these habitats and their associated fauna and flora may not represent the loss of rare or endangered species directly, it is likely to mean a reduction in both aquatic and terrestrial ecosystem productivity.

Seeps and small tributaries

5.5. The varial zone of the river channel has numerous small seep and tributary habitats often with extensive bryophyte cover.

5.6. Seeps were more abundant in the varial area of the Mokihinui to be inundated than in the North Branch or the nearby Karamea River.

5.7. As a result of the caveats raised around using larval forms of aquatic invertebrates to assess biodiversity in my initial hearing evidence (Evidence in Chief Dr Death 2008 Mokihinui Hydro Project Resource Consent Hearing) I had understood Meridians experts were planning to survey adult stages of the aquatic invertebrates in the vicinity of the Mokihinui River. They deployed 4 Malaise traps to address this but only recovered two. This is a much more limited assessment then I would consider appropriate to comprehensively assess the potential presence of rare or endangered taxa.

5.8. The seeps and small tributaries in the inundation zone have a diverse and unique biota of periphyton and invertebrates.

5.9. The invertebrate assemblages found in the seeps of the Mokihinui inundation zone are statistically distinct from those in other seeps in the North Branch (Figure 10; Suren

2011). Dr Suren states ".. the loss of a seep (*from the inundation zone of the Mokihinui*) is not balanced by *the* presence of other seeps.."[1] . I agree with this statement.

5.10. Periphyton assemblages in the seeps and small tributaries of the Mokihinui inundation zone were also unique with a high diversity (88 taxa compared to 44 in the mainstem) and high level of local endemism, with several taxa (5 indeterminate species that are likely new to science) that potentially only occur in these habitats.

5.11. The limited Malaise trapping found two mayfly and three caddisfly species that could not be assigned to previously recorded species. I assume this means they are new species to science. Thus although not listed by the Department of Conservation as of special conservation status they must be of conservation interest as they have never been recorded before.

5.12. The Malaise traps collected 2 new species of the mayfly *Deleatidium*, the first record of *Zephlebia borealis* from the South Island, the southernmost record of *Xenobiosella motueka*, a new species of *Cryptobiosella*, a new species of *Pycnocentria*, and a number of Hydroptilidae that may represent new genera. These taxa all represent significant, unique and important biodiversity with highly restricted distributions and some that only occur in the Mokihinui inundation zone.

5.13. The seeps in the Mokihinui inundation zone were distinctive in their invertebrate composition from those in either the North Branch or Karamea River sampled by

[1] My added text in italics

Suren (Figure 12 Suren 2011). This reinforces the distinctiveness of these habitats both within the Mokihinui catchment and the wider West Coast area.

Landslide lake biota

5.14. Assuming anoxic conditions do not occur in the reservoir the landslide lake invertebrate faunas that could potentially replace the riverine invertebrate communities with the MHP would be considerably less diverse (24 - 41 taxa per lake) compared to approximately 124 taxa that would be lost from the mainstem, tributaries and seeps by inundation.

5.15. Furthermore these communities would be dominated by small pelagic microcrustacea, molluscs, midges and oligochaetes that are energetically less valuable to fish and birds than the mayflies, stoneflies and caddisflies that dominate the river invertebrate communities (Hayes et al. 2000).

5.16. The periphyton flora of landslide lakes have between 36 and 54 taxa compared to 44 taxa in the large tributaries and mainstem of the Mokihinui River and 88 for the combined mainstem, tributaries and seeps. The result of the reservoir creation would therefore be a net loss in periphyton floral diversity.

5.17. Even within the reservoir, morphology, stratification and anoxic water (Schallenberg evidence in chief) may severely constrain the actual area that may be suitable for lake flora and fauna.

5.18. Comparison with compiled data from 51 studies (903 sample locations) on invertebrate communities in other rivers, seeps and small tributaries from the Northern South

Island still identified the Mokihinui inundation zone seeps as distinctive and unique assemblages.

Algal and Bryophyte assemblages

5.19. Dr Kilroy's (2011) conclusions about the uniqueness of the seep periphyton assemblages seem inconsistent. She has shown the seeps contain unique taxa (some new to science), and gives examples of other seep dwelling periphyton taxa in New Zealand with extremely limited distributions but then concludes it is impossible to say definitively that they do not occur elsewhere (because of low sampling effort). While a definitive answer may not be possible the weight of evidence clearly points to these seeps as having assemblages and species with very restricted distributions.

5.20. Dr Suren (2011) identified a small stream in Anderson Flat (that would be inundated by the MHP) as distinctive for its high bryophyte cover and richness. Only about 3% of streams surveyed for bryophytes in the South Island have greater cover. This is clearly of merit for its flora but is also a relatively rare habitat for stream invertebrate communities.

5.21. Didymo (*Didymosphenia geminate*) is present in the Mokihinui River catchment. I concur with Meridians experts that the MHP may increase the likelihood of didymo blooms. However, I believe the other environmental changes from the MHP (detailed above) are of greater adverse ecological consequence than an increase in the probability of didymo blooms.

6. THE DAM - ACTUAL AND POTENTIAL EFFECTS

Construction effects

6.1. There are likely to be increased sediment loads in the river during dam construction. The effects of increased turbidity and consequent deposited sediment have detrimental effects on stream biota by smothering plants, animals, their food and interstitial habitats (Waters 1995, Clapcott et al. 2012).

6.2. If the construction of the dam is conducted with due care and best management practice, the effects of this sediment would have a relatively minor or short duration effect on the aquatic invertebrates and periphyton.

Creation of the reservoir

6.3. The creation of the reservoir would result in the local, and for some rare taxa, potentially global extinction of biota in the mainstem (for approximately 14 km), large tributaries, seeps and small tributaries in this region of the Mokihinui River.

6.4. This is likely to have an effect on overall ecosystem function of the wider Mokihinui catchment as invertebrates from these habitats provide an energy efficient food resource for many species (e.g., fish, birds, and spiders) that may not directly be affected by the reservoir creation.

6.5. The quality of the habitat in the created reservoir may be considerably lower than that in a typical landslide lake because of decomposing vegetation and potential anoxia (Schallenberg evidence in chief). However, even if the reservoir eventually attains the water quality of a landslide

lake, the biota (invertebrates and periphyton) that may develop will be a less diverse biota more characteristic of such lakes that lacks the same level of endemism apparent in the aquatic habitats of the river valley currently.

6.6. Dr Suren (2011) comments on the finding of 5 new species of invertebrate taxa “Consequently, the new animals found in our survey may highlight a degree of local endemism within seeps and small tributaries in the area”. Clearly the finding of new species to science is a strong indication of the uniqueness of these habitats.

6.7. Mr Norton in his evidence states that the new invertebrate and periphyton species to science found in the NIWA surveys are unlikely to be unique to the catchment, but there is no evidence supporting this statement.

6.8. Dr Suren and Dr Kilroy provide convincing evidence that the seep assemblages that would be lost by inundation from the reservoir are unique within the West Coast region.

6.9. I disagree strongly with the conclusion of Dr Suren and Dr Kilroy that despite all their efforts to find similar seep assemblages within the catchment, nearby West Coast catchments and in 51 other data sources this means they must still be there but that we just have not looked hard enough. Although it is possible they do occur elsewhere in my opinion the weight of evidence (which is extremely comprehensive) points strongly at the fact these are unique habitats/assemblages for this region.

6.10. In comparison to the loss of a range of unique habitats, changes in mainstem habitat characteristics and dramatic change in downstream flow regime the effects of the dam

on upstream/downstream invertebrate migration are in my opinion not significant.

Altered flow regime

6.11. The current flow regime of the Mokihinui River is that of a typically flood prone New Zealand river and the invertebrates and periphyton are thus well suited to large flow events (Death 2008). However, the operation of the MHP would create daily fluctuations of between 16 and 126 m3s-1 downstream of the proposed dam. The biota of the Mokihinui River may experience frequent floods, however, even with frequent floods there is some inter-flood interval (days to weeks, not hours) that allows recolonisation of the biota (Death 2010). Daily fluctuations of this magnitude would not provide any opportunity for such recolonisation. My prediction based on 20 years research on flood effects on invertebrates is that such dramatic daily fluctuations would lead to the virtual defaunation of the varial zone and wetted bed of the river for some considerable distance below the dam (Death 2008). Only the hardiest invertebrates and periphyton would be able to survive.

6.12. The change in substrate, shear stress and flow regime directly below the proposed dam as a result of the MHP would result in a change to the downstream periphyton communities. How far downstream, and within the current wetted width this change would extend is difficult to predict. I agree with Dr Kilroy that the new varial zone is unlikely to be colonised by many, if any, periphyton taxa, but I am not convinced the periphyton biomass that would develop in the new downstream wetted channel would be what could be considered “moderate”. Certainly substrates

would be more stable and fine sediment abrasion reduced but I would expect the high shear stress from the flow releases to negate these positive influences (Biggs and Thomsen 1995, Stevenson et al. 1996).

6.13. I disagree with Dr Suren's conclusion that the effect of this flow regime on the invertebrate fauna would be minor. Furthermore, Mr Jowett (2011) has modelled the effect of this flow regime on the available habitat for a number of invertebrate species downstream of the dam and found predicted reductions in the habitat available for each species of between 20 and 60%. This supports my earlier contention (12.10) as the loss of this area of habitat is in my opinion a significant effect on these invertebrates, although Mr Jowett again does not consider the effect of the severly restricted re-colonisation time on the ability of the invertebrates to live/colonise this reduced habitat.

6.14. From my observations of the Mokihinui River substrate in the area of the proposed dam I do not believe any reduction in fine sediment (of which there does not seem much; see also Hudson evidence) would have any positive effect on the availability of suitable habitat for invertebrates let alone balance the loss from the large flow fluctuations.

7. CONCLUSIONS

7.1. I have no major disagreements with the factual evidence presented by Dr Suren and Kilroy but I strongly disagree with many of their opinions on the significance of those facts, or the consequences of the MHP with respect to these facts.

7.2. The inundation of the Mokihinui River Gorge would result in the loss of some unique habitats, biological assemblages and species. Dr Suren and Dr Kilroy present compelling evidence that some of these taxa and assemblages only occur in the inundation zone but conclude they probably occur elsewhere but we have just not looked hard enough. However, after a targeted effort to find such assemblages and the examination of data from 903 other sites in the region I believe the weight of evidence strongly supports the fact that these habitats and constituent species are highly unique. In her summary evidence Dr Kilroy does acknowledge the effects on the periphyton communities in the inundation region to be major and I agree with this statement.

7.3. Further support for this view is found in the fact that five new species of invertebrate (from only 2 samples) and 5 new species of periphyton to science were located in the seep habitats to be lost through the MHP.

7.4. The biological communities that would develop in the area should the MHP proceed would be consideranle less diverse lentic (still water) assemblages. I believe this may result in significant changes to the functioning of both the aquatic and terrestrial food web of the river catchment.

7.5. The change in flow regime and geomorphology as a result of the daily fluctuations from dam operation would also dramatically alter the downstream invertebrate and periphyton communities again with corresponding flow on effects for the ecosystem functioning of the wider catchment.

7.6. The MHP would dramatically alter the invertebrate and periphyton communities of the Mokihinui river gorge, result in the potential extinction of some of these species and may have far reaching effects on the functioning of the wider Mokihinui catchment ecosystem.

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