BEFORE THE CANTERBURY REGIONAL COUNCIL

IN THE MATTER OF	The Resource Management Act 1991
AND	
IN THE MATTER OF	104 applications for water permits and associated consents in the Upper Waitaki catchment

---

REPORT AND DECISION OF HEARING COMMISSIONERS PAUL ROGERS, MICHAEL BOWDEN, DR JAMES COOKE AND EDWARD ELLISON

PART A – CATCHMENT WIDE ISSUES

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Paul Rogers (Chair), Michael Bowden, Dr James Cooke and Edward Ellison were appointed as independent hearings Commissioners by the Canterbury Regional Council under section 34A(1) of the Resource Management Act 1991 (the RMA) to hear and decide 104 applications for water permits and associated consents in the Upper Waitaki catchment.

1.2 The applications were heard at Christchurch between 21 September 2009 and 30 April 2010. By the end of January 2011 we had received all of the proposed conditions for all of these applications. A process was agreed between all participants as to how proposed conditions would be developed. This did not occur during the actual hearing time, but subsequent to it. The process involved applicants, submitters, and reporting officers, and enabled all participants to put forward their view in relation to the proposed conditions. Thus, we were in a position to fully commence our deliberations by early February 2011.

1.3 In addition to the evidence and submissions provided by the applicants and submitters at the hearing, we record that we have all read and taken full account of the application documents, including the assessments of effects on the environment (AEE) and all of the written submissions. Although not every witness and submission is referred to in our decisions, this does not mean that they have not been considered, simply that we have endeavoured to focus on key issues and avoid repetition in our decisions where possible.

1.4 We recognise the length of time it has taken to issue decisions on these applications. There have been a range of reasons for this, including the number and complexity of the applications, along with significant disruption caused the Canterbury earthquakes of 2010 and 2011. We thank all participants for their patience in these circumstances and for the contribution all parties have made towards our consideration of the applications.

2 STRUCTURE AND NATURE OF THE DECISION

2.1 As signalled in our earlier minutes to the parties[1], we have separated our decision on these applications into two separate parts:

(a) **Part A** – dealing with catchment wide issues and matters common to multiple applications; and

(b) **Part B** – site specific decisions on individual applications and proposals.

2.2 The primary reasons for this approach is that it reflects the way in which the case was presented to us and the cumulative nature of the effects involved. As discussed in further detail below, a key component of the case presented to us was the Water Quality Study (WQS) by Mackenzie Water Research Limited (MWRL). The purpose of this study was to investigate the cumulative effects of increased nutrients from the proposed irrigation on water bodies in the Upper Waitaki catchment.

2.3 Water quality has been a critical consideration for us in a large number of the applications. We therefore considered that it was necessary to make a finding on the cumulative effects as proposed in the WQS before we could consider individual applications. Similarly there were other key effects on landscape (and related issues), tangata whenua values and economics that we considered should be addressed as part of a catchment wide approach. Our Part A decision fulfils this role.

2.4 For each issue, we have considered the relevant evidence and submissions from applicants, submitters and s42A reporting officers to inform our findings. All relevant material has been considered, even if not specifically referred to in this Decision. In particular, several submitters in opposition raised ecological concerns that are closely tied to the issue of water quality[2]. Given our findings on water quality, we have not discussed

[1] The 28th Minute of the Commissioners – 6 December 2010

[2] In particular, we refer to the evidence of the Department of Conservation, the Central South Island Fish and Game Council and the Royal Forest and Bird Protection Society of New Zealand Incorporated

this evidence in detail, but have taken it into account as part our overall consideration. Further reference is made to site specific evidence and submissions in our Part B decisions as relevant.

2.5 In addition to consideration of catchment wide issues, Part A also explains the general approach we have adopted for the Part B decisions, including an outline of the statutory context and relevant planning instruments. It also comments on a number of issues that are common to multiple applications in order to avoid unnecessary duplication.

2.6 Part A and B combined make up the final decision on the applications and proposals before us. In the instance that Part A and B decisions are issued together the decision should be treated as a final decision. However, in the instance that Part A is issued without an accompanying Part B then in the interim while the Part B decision is awaited, Part A should be treated as an interim decision only. This is to avoid the need of interested parties (should they wish to do so) lodging appeals on Part A while they are still awaiting the release of the relevant Part B decision(s).

2.7 In summary, this Part A decision sets out our findings on the key catchment wide issues arising from the applications, including cumulative water quality effects, landscape effects (and related issues), effects on tangata whenua values and economic effects. In addition it sets out our general approach to Part B decisions and covers a number of issues common to multiple applications. It should be read in combination with the relevant Part B decisions to understand our findings on specific applications and proposals.

3 EXECUTIVE SUMMARY

3.1 This Part A decision provides our overall findings on the key catchment wide issues that arose from the applications. In broad terms, these issues related to water quality, landscape, economic effects and tangata whenua values. We summarise our overall conclusions on these issues below, along with our general findings on the relevant planning instruments and the approach we have adopted to consideration of the individual applications in our Part B decisions.

Planning framework

3.2 There is a wide range of planning instruments that are relevant to the proposals before us. In combination with the requirements of the RMA, these planning instruments provided a helpful framework to guide our consideration of the applications.

3.3 Overall we consider that the WCWARP is the key planning instrument, particularly for applications to take and use water. Some of the core considerations under this plan are the amount of water being taken, the efficiency of the use of water, and the implications of the use on water quality, including the associated ecological and cultural values.

3.4 The WCWARP must be read in combination with the other relevant planning documents, particularly the NRRP. The NRRP contains rules that apply to discharge permits and applications for structures in the beds of lakes and rivers. It also contains a range of objectives and policies covering other relevant issues, such as landscape, erosion and flooding, and updated water quality objectives.

3.5 The above regional plans are consistent with the applicable higher order documents including the proposed and operative regional policy statements and various national policy documents on discrete issues. In addition, the district plans provide some helpful context for consideration of landscape issues. We have considered and referred to all of these documents when making our decisions on individual applications and considering the catchment-wide issues discussed below.

Water quality

3.6 Of all the issues we have considered, the most critical is that of water quality. We consider that the main potential for adverse environmental effects resulting from the granting of the consents applications before us is the enrichment of surface waters due to leaching and/or

transport of nutrients (nitrogen and phosphorus) from the irrigated pasture surface through to groundwater, and then to streams, rivers, and lakes. This could have serious adverse consequences for the environment and our findings on these issues have had a significant influence on whether or not a particular proposal has been granted consent.

3.7 Throughout this decision, we have set out our conclusions on the key aspects of the water quality issue, including groundwater flow paths, effects on lakes and rivers, predicting nutrient loss from soils, and the suitability of an adaptive management regime to manage potential adverse effects. These conclusions are summarised below.

Hydrology and Geohydrology

3.8 The hydrological and groundwater assessment completed by MWRL provides a useful conceptual understanding, but it lacks the field data necessary to provide a reliable verification of the distribution of existing and modelled nutrient concentrations in groundwater throughout the catchment and the pattern of emergence in surface waterways, other than a broad-brush average assessment of nutrients entering the waterways and Lake Benmore.

3.9 In our opinion the study in many respects merely presents the type of assessment one would expect from a scoping study. It lacks the data, precision and clearly defined error limits on predictions, which would have provided a solid foundation for predictions of the effects of increased nutrient load on the sensitive streams, rivers and lakes that characterise the Mackenzie Basin.

Effects on lakes

3.10 Based on the evidence presented to us we conclude that the Ahuriri Arm of Lake Benmore is close to the oligotrophic-mesotrophic boundary and that no significant net increase in nutrient load should be permitted. Similarly we conclude that the Wairepo Arm of Lake Ruataniwha is close to the mesotrophic-eutrophic boundary and no significant net increase in nutrient load should be permitted.

3.11 In respect of the Haldon Arm of Lake Benmore, we conclude that there is sufficient buffering capacity to assimilate an increased nutrient load from the granting of consents before us (with mitigation) and remain within an oligotrophic state.

3.12 We acknowledge that MWRL arrived at substantially the same conclusion by the end of the hearing and that their case rests on the ability to develop the proposed farming systems without any increase in net nutrient load (in the Ahuriri catchment).

Effects on rivers and streams

3.13 The information presented by MWRL experts on the current state of streams and rivers is inadequate for a proposal of this scale. Systematic monitoring over 12-18 months is needed to give a basic understanding on the biota within affected streams and rivers, and to provide a baseline state of the existing environment. There is some evidence that existing irrigation is already resulting in nuisance growths of periphyton, though the scale of the problem has not been adequately assessed.

3.14 There is good evidence that periphyton growth in streams and rivers of the Upper Waitaki catchment are nutrient limited by nitrogen, or phosphorus, and sometimes a combination of both nutrients. Because of this nutrient limitation, together with the relatively stable hydrology, we consider that many of the rivers and streams of the Upper Waitaki are likely to be very sensitive to nutrient inputs; much more so than predicted by MWRL.

3.15 We consider the default nutrient trigger values for slightly disturbed upland streams given in ANZECC (2000) guidelines will not protect streams in the Basin from excessive periphyton growths. We also reject MWRL's alternative guideline for an up to 25% increase in annual maximum periphyton biomass. We find that their suggested method is unnecessary, not based on sound scientific method, and would allow a deterioration in the state of streams and rivers. We consider that the best guidelines to use are the MfE NZ

Periphyton Guidelines and disagree with MWRL that these guidelines are not appropriate in the Mackenzie Basin.

Predicting nutrient losses

3.16 OVERSEER was the method proposed by MWRL for estimating nutrient loads (particularly nitrate) resulting from changing farm systems and management. With respect to this specific application of OVERSEER in the Mackenzie basin we have concerns about the following issues, among others:

(a) The absence of any Mackenzie basin sites (or other sites with similar climate and soils) in the OVERSEER database;

(b) The ability of OVERSEER to estimate nutrient losses from farms in rapid transition (as will be the case with large areas of currently undeveloped land), and the absence of guidance on how long it will take before an equilibrium state is reached; and

(c) Lack of clarity over which Farming Systems proposed by the applicants cannot currently be modelled; and

(d) A lack of validation and field measurements to support the assumptions and theoretical modelling used in OVERSEER.

3.17 While we acknowledge that the Farm Systems modelling approach in general, and OVERSEER in particular is the best tool currently available for estimating nitrogen loss from farms in New Zealand, our view is that has significant shortcomings for these particular applications at this particular location. These shortcomings are likely to have resulted in a significant underestimation of leaching losses in the WQS, particularly on the shallow skeletal soils that characterise much of the Basin. In our view further research and development of OVERSEER is required in the Mackenzie Basin before it can be utilised confidently to manage NDAs in this sensitive environment.

Adaptive Management

3.18 To overcome some of the shortcomings and uncertainties associated with potential effects on water quality, an adaptive management regime was proposed by the applicants. We recognise that adaptive management can be a valuable tool for managing large complex systems where the ecological responses to perturbations in the system are not fully understood. However our view is that using adaptive management as a method for controlling nutrient discharges to rivers and lakes in the Upper Waitaki catchment as a whole is not appropriate and will not protect the water resources in the catchment with any measure of certainty.

3.19 The primary reasons for us arriving at this conclusion are:

(a) We have rejected the MWRL case that all consents can be granted with conditions, without causing cumulative water quality effects;

(b) MWRL has not satisfied us that their proposed adaptive management can meet the criteria set out by the Court as being necessary for it to be a viable strategy;

(c) The monitoring programme as proposed would be unlikely to detect adverse effects, and if it did, it could be too late to institute meaningful mitigation options;

(d) Due to the number of applicants involved, the diversity of farming practices, and the complexity of the catchment, the conditions relating to adaptive management would be neither practicable nor enforceable.

3.20 Overall, we consider that granting consents with adaptive management conditions is not appropriate in this case, as to do so could not guarantee that adverse environmental effects would be avoided, remedied, or mitigated. We do not think the experimenting with

adaptive management in these catchments is consistent with a precautionary approach (as required under the CRPS) given the significant consequences to water quality and aquatic ecosystems that could result, which would be extremely difficult to reverse.

Landscape Values

3.21 We accept that the Mackenzie and Waitaki Basins represent an outstanding natural landscape that is iconic and highly valued. However it is a landscape that is also highly variable, degraded in parts, and has been visibly modified by human intervention over many years. We have taken into account this existing state of the environment and its history of change when considering the appropriate future use.

3.22 All parties accept that there will inevitably be changes to the landscape as a consequence of irrigation, particularly the "greening" effects and the presence of structures. However it does not necessary follow that these changes will be adverse if properly managed. There may also be positive benefits for the ecological health of the landscape as a consequence of this change.

3.23 We consider that the primary features that give the landscape its values are its vertical elements, namely the mountains and ranges of the basins. Overall, we consider that, subject to appropriate mitigation, allowing further irrigation on the basin floors will not significantly detract from the legibility or aesthetic appreciation of the landscape.

3.24 In reaching this view, we have primarily focused on the visibility of the landscape when viewed from public viewing points and main roads, as these are the most common areas from which the landscape is appreciated. Mitigation measures will be required in some of these areas to ensure that any adverse effects on landscape values are adequately addressed.

3.25 Overall, we are not persuaded that there should be no further irrigation in the Mackenzie Basin. We consider that this conclusion is consistent with the requirements of the relevant planning instruments and the RMA and reflects the common opinion of many of the expert landscape architects that appeared before us.

3.26 Notwithstanding the above, we stress that this does not mean that the landscape effects of all the proposals will be acceptable. Each proposal needs to be considered on its merits, taking into account the environment in which it is located, the nature of the activities, and any proposed mitigation measures.

Tangata Whenua Values

3.27 The evidence on cultural matters provided by Mr Mikaere for MWRL and Ngāi Tahu witnesses in response reach different conclusions. Mr Mikaere asserted that the cultural interest could be addressed through the FEMP's, which is underpinned by the WQS and associated mitigation measures, whereas Ngāi Tahu remained unconvinced in the applicants' capacity to address subcatchment, cumulative water quality and quantity issues arising from the proposed expansion of irrigable lands and large scale intensification.

3.28 It is clear that Ngāi Tahu are the kaitiaki for Te Manahuna (Mackenzie Basin), with specific responsibilities apportioned to the local Papatipu Runanga. The nature and extent of kaitiakitanga is something that only tangata whenua can determine according to place and context of the relationship they traditionally hold according to customs. Having particular regard to kaitiakitanga in this context means paying special regard to the views of Ngāi Tahu about the appropriate manner in which natural and physical resources should be husbanded.

3.29 The principal objective of the Ngāi Tahu approach to the irrigation proposals was to protect the potential to restore mahinga kai resources and related cultural activities in the Ahuriri Delta, Lower Tekapo River and Haldon arm of Lake Benmore. Ngāi Tahu engaged in on farm visits and consultation, and in the process narrowed their scope to the large scale and intensive proposals that were of immediate and greatest concern to them.

3.30 The applicant's case is dependent on the efficacy of the WQS and avoiding any change in the trophic status of the receiving environments including the Ahuriri Arm of Lake Benmore. However the problem with this approach is that it assumes the applicant's evidence was complete and accurate. For the reasons discussed above, we consider the WQS to be deficient in that it gives us no certainty that its conclusions are correct.

3.31 Given the position we have reached on the efficacy of the WQS to address the cumulative effects of all proposals, we therefore find that the effects on tangata whenua cultural and spiritual values will be more than minor. In particular, we consider that the effects on the areas identified for mahinga kai restoration will compromise the aspirations of Ngāi Tahu if granted in total.

Economic effects

3.32 We consider that the applicant's approach to assessing economic impacts or benefits of the irrigation proposal was useful. It enabled us to have a level of understanding about the economic benefits that would result if all consents were granted. It seemed to us it did take into account at an appropriate level the costs of implementing the consents and, in particular, it had some regard to the costs of putting in place the mitigation measures.

3.33 In the end we noted that there was a useful level of agreement between economic experts around the approach, process, and content of the various views expressed to us.

3.34 Overall, we considered we had sufficient material to recognise the real economic benefits that could accrue from the grants of the applications before us. While accepting the economic benefits only one of the issues for us to consider, we can and do record our view that we accepted the economic benefits of irrigation as put forward by MWRL on behalf of all of the applicants.

Our approach to Part B

3.35 In addition to these catchment wide issues, this decision sets out the approach we have adopted to consideration of the individual applications in our Part B decisions. The reason for doing this was to demonstrate a consistent approach to our decision making and avoid repetition of discussion in multiple separate decisions.

3.36 There were several recurrent issues that arose where common findings were possible. These included our approach for determining the status of the activity and the requirement for additional consents under the myriad of relevant planning instruments. We also considered the issues of stockwater and replacement consents that were relevant to many proposals and set out the approach we applied to issues such as priority, derogation, term, conditions and the number of decisions per proposal. Without repeating all of our conclusions on these issues, we consider that the approach we have adopted on these matters take into account the evidence and submissions presented to us and is consistent with the requirements under the RMA.

4 THE APPLICATIONS

4.1 Given the number of applicants and organisations involved with the applications, we have provided some general comments below about the nature of the different entities and their relationship with each other. This is illustrated in a flow diagram attached at **Appendix A** to this decision that was helpfully provided to us by Mackenzie Water Research Limited (MWRL). We also provide some general comment on the Water Quality Study completed by MWRL, which was a core component of the joint case presented to us.

Mackenzie Water Research Limited and the Mackenzie Irrigation Company

4.1 Mackenzie Water Research Limited (MWRL), is not itself an applicant, but was established in January 2008 to investigate the cumulative effects of increased nutrients from the proposed irrigation on water bodies in the Upper Waitaki catchment. The three shareholders in MWRL who are all applicants are:

(a) Southdown Holdings Limited;

(b) Five Rivers Limited; and

(c) Pūkaki Irrigation Company Limited.

4.2 The MWRL work, Mr Whata told us, was funded by the three shareholders, the Upper Waitaki Applicant Group (UWAG), and four other individual applicants[3]. The MWRL case is presented on behalf of all of these applicants.

4.3 There are only four applicants that are not part of the MWRL case, being:

(a) Falconer, Massey and Cook, Allen, Gibson Trustee Co Limited;

(b) Dennis FE & AE; and

(c) Upper Waitaki Community Irrigation Company Limited; and

(d) Munro SJB

4.4 In respect of those four exceptions we can say that the application by Dennis was withdrawn. In addition we have already issued separate decisions on the applications by Upper Waitaki Community Irrigation Company Limited and Munro. The reason for these separate decisions is covered in our 31st Minute of Commissioners dated 22 September 2011.

4.5 Mr Whata presented opening submissions on behalf of MWRL and informed us the purpose of the MRWL case was to set out the general assessment framework in relation to the following two key issues:

(a) Does the total amount of water to be taken fall within the ambit of the relevant allocation thresholds?

(b) What are the relevant water quality thresholds that need to be met, and can these met on a cumulative basis if the total amount of irrigation is implemented?

4.6 Mr Whata noted that there are 60 separate applications that seek to take water to irrigate a total of 18,165 hectares in the Upper Waitaki catchment. He told us while each application must be assessed on its own merits, the purpose of the MWRL case is to set out the general assessment framework for the two key issues as described above.

4.7 Mr Whata then turned to inform us about the Mackenzie Irrigation Company (MIC). MIC was established in 2003 to represent the interest of farmers of the Upper Waitaki catchment who wished to irrigate land located in the Upper Waitaki catchment. MIC entered into agreements with Meridian Energy Limited (Meridian) on 31 October 2006, which provide for 150M m^3 water/yr. This water is allocated to Meridian through its resource consents for operation of the Waitaki Power Scheme in the Upper Waitaki catchment. This water is to be made available to the shareholders of MIC to be used for irrigation of land in the Upper Waitaki catchment. The water take is controlled in terms of time and space to ensure that the impact of the proposed takes on power generation does not exceed a predetermined threshold. Catchment is divided into eight sub-catchments, which are each allowed volumetric take limits. No water is allocated by Meridian to a farm applicant unless the farm applicant holds MIC shares. All of the applicants before us hold MIC shares. We note these details in relation to MIC are confirmed in the evidence of Murray Valentine for Simons Pass Station Limited and Simons Hill Station Limited.[4]

4.8 Mr Whata told us that MIC had issued shares for just over two-thirds of the 150M m3 per year of water available. In order to obtain derogation approval from Meridian, applicants

[3] Rosehip Orchards NZ Limited, High Country Rosehip Orchards Limited, Lone Star Farms Limited and Killermont Station Limited

[4] See also submissions of Ms Jo Appleyard for Meridian and the evidence of Raewyn Moss for Meridian.

must agree to comply with a proposed rate of development in order to meet the tranching limits. Mr Whata told us all necessary derogation approvals had been granted by Meridian at the time of his presentation. We were told the MIC agreement does not apply to applications for irrigation development when an applicant is replacing an existing consent on a 'like-for-like' basis.[5] We return to the issue of derogation towards the end of this decision.

The applicant groups

4.9 In terms of the applicants themselves, they can be broken down into four broad groupings.

4.10 The first group are the larger applicants (in terms of water takes and size and scale) represented by Mr Christian Whata and included Southdown Holdings Limited, Killermont Station Limited and Five Rivers Limited.

4.11 The second group (which also included some large applications) were represented by Mr Kelvin Reid and included High Country Rosehip Orchards Limited, Rosehip Orchards NZ Limited, Pūkaki Irrigation Company Limited, Simons Pass Limited, Simons Hill Limited and Lone Star Farms Limited.

4.12 The next grouping gained the title of UWAG, being the Upper Waitaki Applicant Group. UWAG are made up of, largely, the traditional high country farms and includes 22 separate applicants that presented a joint case on common issues[6]. They make up a significant proportion of the replacement consent applications before us. They were primarily represented by Mr Ewan Chapman, with one UWAG member (Haldon Station (1991) Limited) represented separately by Ms Rachel Dunningham.

4.13 The only applicant that does not fit into any the above categories is Falconer, Massey and Cook, Allen, Gibson Trustee Co Limited, which was presented by Mr David Power.

Water Quality Study

4.14 Mr Whata introduced the Water Quality Study (WQS) completed by MWRL. He explained that, in his submission, there was no regional assessment or planning instrument that identified relevant sustainable nutrient levels that should apply in the Mackenzie Basin. MRWL therefore commissioned GHD[7] to undertake a comprehensive water quality study to assess the existing and future water quality of the lakes, rivers, streams, and groundwater in the Upper Waitaki catchment.

4.15 In more detail, the purpose of the water quality was to:

(a) identify the impacts of the existing environment on the lakes and rivers in terms of:

(i) water quality; and

(ii) instream habitat.

(b) identify the level of existing abstractions and farming activities in the Basin for the purpose of establishing a baseline of the nutrient concentrations at nodal points;

(c) quantify the likely increase in nutrient (nitrogen and/or phosphorus) concentrations in surface-water and groundwater bodies if the irrigation sought is implemented;

(d) assess the potential effects of this increase on aquatic systems and water quality;

[5] See evidence of Mr Richard Turner, paragraph 72.
[6] Refer to Appendix A for a list of the applicants that form part of UWAG
[7] GHD is a multidisciplinary international consultancy company with headquarters in Australia. GHD were the principal contractors providing technical support for the WQS.

(e) select appropriate environmental thresholds to which the effects of irrigation needs to be mitigated to ensure that the effects are no more than minor; and

(f) identify mitigation methods to ensure the thresholds will be met where they are likely to be exceeded.

4.16 Mr Whata told us that GHD's study commenced in October 2007. He outlined a team of more than 14 scientists who were commissioned to undertake the work under the general overview of GHD. Much of the material comprising and supporting the GHD study was presented to us in evidence. Mr Whata outlined what he termed an extensive programme of consultation between GHD and Environment Canterbury officers.

4.17 He informed us that water quality monitoring commenced in early 2008 and over a total more than 90 days was spent by GHD and subcontractors in the field collecting data. He also informed us that further data collection was undertaken by Upper Waitaki Water Quality Trust (WQT).

4.18 Mr Whata informed us there was a comprehensive consultation process with Environment Canterbury and a thorough peer review of the WQS undertaken by independent experts such as Dr Bright dealing with water quality; Dr Ryder dealing with aquatic ecology; and Mr Leong dealing with hydrology.

4.19 Mr Whata then moved on to address the Section 42A Reports. The key point he made was in his submission was that the WQS had only become necessary because he contended Environment Canterbury had failed to undertake a comparable exercise as part of its statutory planning duties. Mr Whata contended that this should be compared to the recent efforts undertaken by Environment Waikato and the Environment Bay of Plenty to address the cumulative effects of nutrient loading.

4.20 Mr Whata did acknowledge that Environment Canterbury had produced the NIWA study referred to in the memorandum of Meridian Energy dated 4 September 2009. He considered this was belated attempt to deal with the issue of water quality. He noted that it was outside the normal statutory process.

4.21 Mr Whata, while acknowledging that the NIWA study was a significant piece of work, submitted that it only addressed one of the receiving environments in the Upper Waitaki catchment, namely Lake Benmore. He was of the view that the NIWA study could only be viewed as a piecemeal addendum to the WQS.

4.22 Mr Whata was critical of Environment Canterbury's approach to water quality, noting that Environment Canterbury had ample opportunity to drive a proper regional study as part of its responsibilities under the RMA and it had not done so. He was critical of Environment Canterbury in that he contended it should engage collaboratively to assist in reaching a regional solution working with the WQS team and not simply criticising from the sideline. Mr Whata contended that the real issue in this case was not a lack of information, but a lack of earnest engagement.

4.23 Mr Whata then proceeded to further describe the role of the WQS. He told us that it provides the framework for assessment of the cumulative effects of all of the applications. He told us it would avoid the need for us to endeavour to draw together up to 60 different assessments of effects to determine what effect on water quality might be as a result of allowing all of the applications. He told us that all of the applicants - except potentially two in the Upper Waitaki catchment who had not funded the WQS - are able to fully meet the thresholds per property set out in the WQS or thresholds that counter the same degree of environmental protection for farm management purposes. Thus, he said, questions of priority become less important.

4.24 He told us that the WQS establishes the nutrient loadings that will result from the existing and additional irrigation and the thresholds that need to be met on a sub-catchment and catchment-wide basis to ensure that the overall effects of the intensification of land use associated with the irrigation are no more than minor. He told us in a practical sense this will manifest itself in a nutrient discharge allowance for each farm. It includes, he said, a toolbox of mitigation measures that will be effective in ensuring thresholds are met. He

informed us that even if we did accept the WQS thresholds, the WQS does not replace the need to assess the merits of individual applications in terms of farm management, monitoring, and mitigation.

4.25 Mr Whata then set out for us the WQS methodology, referring to a core bundle of documents he produced for that purpose. In summary, the modelling undertaken involved the following steps:

(a) The land that contributes to each node point and the locations where water quality was measured was shown in a map located at tab 4 of the core bundle;

(b) Current nutrient levels at each node point were determined by:

(i) measuring water quality at each node point; and

(ii) modelling the effects of land-use activities on water quality by:

(A) assessing the generation of stream flow, groundwater flow, and nutrient loading on a sub-catchment basis; and

(B) determining the route of the water and nutrients down through a sequence of catchments to Lake Benmore.

(c) The effects of the existing and proposed production figures were modelled to determine the predicted nutrient loads on a sub-catchment and catchment basis, assuming good agricultural practice;

(d) The WQS sets out thresholds for each node throughout the catchment and for Lake Benmore. This was shown on tab 5 of the core bundle. Where the nutrient load threshold at the node was predicted to exceed the nutrient "*overburden*", the overburden has been divided equally between all hectares of new and receiving irrigation draining to that node. The maximum permitted nutrient discharge levels for each farm is calculated to be the predicted nutrient loss minus that farm's share of the nutrient "*overburden*". The maximum permitted nutrient discharge level is referred to as the Nutrient Discharge Allowance (NDA). Each farm has a NDA for nitrogen (N) and phosphorus (P); and

(e) Each farm was provided with an estimate of nutrient generation on their whole property under existing conditions and with the proposed irrigation in place and, most importantly, with their NDAs for N and P. Where assimilative capacity for a farm was exceeded in its catchment, the mitigation requirement was divided equally between all areas of land draining to the node without regard to the particular land use associated with any property.

4.26 Mr Whata told us that the assumptions adopted in calculating the NDAs on a sub-catchment and catchment-wide basis were inherently conservative. He told us the calculations were based on 25,000 hectares of additional irrigation area, whereas only 18,000 hectares were applied for under the current applications. He told us it was assumed that the additional area, which we take to mean the difference between the 18,000 and 25,000 hectares, would be used for sheep and beef farming. He told us provided the NDAs for each farm can be met we can have confidence that the water quality in the Upper Waitaki catchment will be maintained.

4.27 In addition to this, he told us the conditions of consent will ensure that thresholds are monitored and met on an ongoing basis. He further submitted that the key advantage of this approach is that it provides Environment Canterbury with a mechanism to regulate nutrient losses from approximately 80% of the Mackenzie Basin.

5 SITE VISITS

5.1 To assist our consideration of the applications we carried out a helicopter flight inspection and land based site visits to specific locations. These site visits are discussed further below and referred to in our Part B decisions as relevant.

Helicopter Flight Inspection

5.2 The commissioners undertook a helicopter flight with Heliworks Ltd over the Mackenzie Basin on the 17th November, 2009. This inspection was timed to follow a one day sitting in the Twizel Community Hall to receive evidence from locals and applicants who wished to be heard in the catchment.

5.3 The aerial inspection was undertaken in perfect flying conditions which afforded excellent viewing of relevant waterways, landscape, hydro systems and farming properties. The flight departure point was the Twizel airfield and followed an anti-clockwise flight path returning to the Twizel Airfield without any put downs.

5.4 The flight path was influenced by the advice commissioners sought and received from Christian Whata on behalf applicants in a memo (22 September, 2009), which identified the following relevant locations;

(a) All nodal points (where accessible)

(b) Key water bodies:

(i) Streams and rivers – Omārama, Otamatapaeo, Wairepo, Quailburn, Henburn, Serpentine, Mānuka, Grays, Tekapo, Ōhau, Twizel, Ahuriri, Godley

(ii) Lakes – Lake Benmore, Lake Ōhau

(c) Vantage points to view basin, it was recommended that the best way to achieve an overview of the Basin was by helicopter.

(d) Meridian sites of interest:

(i) Ōhau B & C power stations;

(ii) Wairepo Arm (i.e.; Salmon farm site);

(iii) Lower Ōhau River (close to Lake Benmore)

(iv) Tekapo River (Lake George Scott and lower reaches close to Lake Benmore)

5.5 Twizel Airfield to Lake Ōhau – the first phase of the flight went west taking us over the Twizel and Fraser Rivers and on to the Ōhau Canal, continuing along the path of the canal to Lake Ōhau, providing a clear view of the Ōhau River and controlled flows. We gained a clear perspective of the interlinking hydro-electric system of dams, canals, power stations and Lake Ruataniwha and the physical location of natural and modified rivers.

5.6 Lake Ōhau to Ahuriri River – At Lake Ōhau we had a flight past the control structures at the outlet of Lake Ōhau for the canal and the Ōhau River weir and then onward to view Māori Bay (Boat Harbour) to view the general location of the proposed galleries, pumping station and pipeline to take water for irrigation purposes on Five Rivers and Glen Eyrie Stations. We flew over the QEII Covenant on Five Rivers Station and sighted the wetlands and lagoons in that locality including Swan and Raupō Lagoons. From there we flew across Ōhau Downs and on to the Wairepo Kettleholes Conservation Area located in the middle of Glen Eyrie Station. We were able to identify several waterways with difficulty given the extensive landscape of rolling to flat lands to the south of Lake Ōhau including Māori

Creek, 6 Mile Creek, Wairepo Creek, Serpentine Creek and the Quail Burn. We also gained a good perspective of the extensive area cleared of wilding pines on Glen Eyrie Downs Station (Southdown Holdings Ltd).

5.7 From the Quailburn Creek we flew SW along the east face of the Diadem Range, across the Henburn Basin, and past Ben Ōhau and Ahuriri Downs Stations, to the Ahuriri Gorge at the approximate point of the proposed Southdown Holdings upper diversion to take water out of the Ahuriri River. From there we flew upstream over Ribbonwood Station and the confluence of the East Branch of the Ahuriri and Ribbonwood Creek and on to Quailburn Station. From there we turned back downstream and flew to Killermont Station where a good perspective was gained of the extensive and semi-arid flat lands that stretched toward Omārama. We turned south over Killermont Station to follow the foothills of Dunstan Range to sight the Frosty Gully dam and the Mānuka Creek intake and races.

5.8 We then flew SE over the lower reaches of Twin Peaks and above Clifton Swamp which is largely developed farmland with centre pivots operating. From there we flew on up the valley to the irrigated area of Dunstan Peaks and sighted the diversions, header dams (off Little Omārama and Omārama Stream), border dyke and flood irrigation systems at the head of the gully and Twaddle Stream diversion. We followed the Omārama Stream down the catchment and on past Tara Hills noting the water race running across the Killermont Flats from the Ahuriri River.

5.9 At Omārama we sighted the oxidation ponds and below that the general area of the proposed Ahuriri node upstream of the SH8 bridge, from there we flew over SH8 toward the Ahuriri Delta, passing over a centre pivot development in progress located below SH8 on the true left of the Ahuriri River, and then onward over the Buscot Station centre pivot irrigation. We flew over Ben Omar Station as we followed the Ahuriri River complex to the Ahuriri Delta and Ahuriri Arm of Lake Benmore, gaining a good visual perspective of the wetlands and relative water clarity. We then flew up the lower reaches of the Otamatapaio River to gain an appreciation of the existing irrigation system and proposed extensions in the lower catchment area.

5.10 We flew through the narrows of Lake Benmore that link the Ahuriri and Haldon Arms, noting the visible changes of water colour defining the glacial waters of the Haldon Arm and the darker blue waters of the Ahuriri Arm. We were able to sight the irrigation systems on Totara and Peak Valley Stations. From there we flew past Black Forest Station and on to Haldon Station over the flood, border dyke and centre pivot irrigation systems of Haldon Station and up to the mid reaches of Stony River to the diversion point that feeds the Haldon Station irrigation system.

5.11 From Haldon Station we flew north over Grays Hills past The Grampians and followed for a time Grays River and associated irrigated paddocks of the Grampians Station and then crossing over the extensive flats of Grays Hills Station with a clear view of the extensive flat and dry terrain as far as Lake Tekapo, with the dry Tekapo River bed interrupting the scroll of flat land. We then flew NW toward the Tekapo Canal crossing the Maryburn Station and on to the Wolds where we turned west to follow the canal to the power station at Lake Pūkaki, noting as we did the points at which the Irishman and Maryburn Creeks culverts pass under the Tekapo canal.

5.12 We then flew south on the west side of Maryburn Range and had a panoramic view of the land from the Wolds, south over Maryburn Station and the vast flat terrain of the Pūkaki Flats and beyond to Lake Benmore. Turning west we flew over the undulating land at the northern end of Simons Pass and on to Glentanner Station and then crossing the Pūkaki spillway and river bed, and onward to sight the lake Pūkaki Dam structure and canal system.

5.13 Before landing at Twizel airfield we flew over the southern end of Lake Ruataniwha, Wairepo Arm and Kellands Pond to orient ourselves with that part of the hydro system of lakes and reservoirs and also observe the Benmore Station centre pivot irrigation system, settling pond and dairy farm located adjacent to Kellands Pond.

Land based site visits

5.14 In addition to a memo from Mr Whata (Sep 2009) advising on points of interest to visit during the site visits, we also invited submitters to recommend points of interest the commissioners could include in the January 2010 site visit.

5.15 We made a land based site inspection of the Mackenzie Basin on the 28th and 29th January 2010. We drove into Mackenzie basin via Burkes Pass on the afternoon of 27th January taking the opportunity to sight the hydro structures and canals of Meridian Energy at Tekapo and along SH8 between Tekapo and Pūkaki. We noted the location of various applicant stations, also rivers and Creeks that flow from the highlands to the north of SH8, under the Tekapo Canal and onward down the catchment to eventually join the Tekapo. Note was also made of various options proposed for drawing water from the Tekapo Canal, Pūkaki Canal or Lake Pūkaki by an applicant group.

Ahuriri Basin (28/1/2010)

5.16 On Thursday 28th January, 2010 we started our day with a site inspection of the Wairepo and Kellands Ponds noting the distinct difference in water appearance and algal growth between the two waterways. Wairepo is connected directly to Lake Ruataniwha and Ōhau B Canal with a good amount of interface and flow sharing resulting in the Wairepo Pond (Arm) expressing similar visible characteristics as Lake Ruataniwha. However the connection of Kellands Pond with Wairepo Arm is via a single culvert pipe under SH8 allowing minimal mixing of waters. Kellands Pond a former borrow pit (as is Wairepo Arm) is located at the lower end of a large plain that is irrigated with Benmore Irrigation Company scheme water and supports a large dairy farm. The water clarity and algal growth on the bed of Kellands Pond would be unattractive to recreationalists and is likely to compromise aquatic biodiversity.

5.17 From there we drove south on SH8 to Clearburn the approximate dividing point between the Wairepo and Ahuriri catchments, looking at the point where the Wairepo Creek bed (dry) passes under SH8 and also the diversion point on Benmore Station where the Wairepo Creek is diverted into the Benmore Station irrigation race effectively taking water destined for the Lower Wairepo catchment into the Ahuriri catchment. The natural bed of the Wairepo Creek some hundred or so metres below the diversion point is ephemeral and its appearance is such this is likely to be a natural condition for lengthy periods of time. We then drove along Lake Ōhau Road to the point where the road meets Lake Ōhau, identifying on route Māori Creek, and the gate leading to Māori Bay. We had seen Māori Bay from the helicopter flight in November 2009, and decided that had given us adequate understanding of that site.

5.18 From there we travelled to meet with the manager of Ōhau Downs Station at the shearing shed, who took us up on to a nearby hill top to gain a view over the bulk of the station and give a panorama of the expansive flat terrain of the Station and area proposed for irrigation. A number of photos taken from this point illustrate the terrain well.

5.19 From this point we travelled back out to SH8 and south toward Omārama turning off on to the Quailburn Road and driving into the foothills of the Diadem Range, stopping to observe the DOC Conservation Area, Quail Burn and Serpentine Creek at various points along the way. We gained a good perspective of Glen Eyrie Station and sighted areas deforested of wilding pines. Returning back down Quailburn Road, we were able to identify the Henburn Creek below Cloud Hill. From there, we drove to the public picnic area upstream of the SH8 bridge over the Ahuriri River, noting the limited amount of algae or periphyton growths in the strong flowing Ahuriri River at that point.

5.20 Following this, we drove to Killermont Station and met the owners Keryn and Daniel Thomas who guided us to points of interest, including the Mānuka Creek diversion and Frosty Gully dam site, noting the ephemeral nature of the creek beds directly below Frosty Gully and Mānuka Creek, a feature of this terrain.

5.21 We spent some time traversing the extensive outwash plains of Killermont Station including a harvested crop area nearer the homestead, the grazing area further out and the un-utilised area well out toward the mid section of the WHL Killermont site. At several

points and over several terrace levels near the middle of the plains we sunk an auger to observe the nature of the subsoil, the results were consistent showing a very fine, light and powdery subsoil that would be prone to wind erosion if exposed . The surface of the plains was arid with significant hieracium cover.

5.22 We drove east along a public road 'short cut road' that traverses the middle of the Killermont Flats coming out near the Berwen Station homestead by the Omārama Stream, we turned right and travelled up Broken Hut Road as far as the bridge over the Omārama Stream located just below Dunstan Peaks farm buildings, observing water flow, quality and irrigation activity. On the way back down Broken Hut Road we stopped to observe the flow under the Bridge over the Omārama Stream which is a short distance below where drainage water from Clifton Swamp joins the Omārama Stream.

5.23 From that point we drove past Tara Hills sighting the water race across Killermont Flats, we continued on past Omārama to Buscot Station Road below SH8 and drove down to the Ahuriri Delta through Ben Omar Station on the true left of the Ahuriri River. We sighted the considerable area of wetlands and waterways which became more prolific as we got closer to Lake Benmore, noting also that the clarity of water was good.

5.24 We returned to SH8 and drove to the DOC Area Office at Twizel to meet the DOC Ranger who guided us through the DOC Conservation area in the Ōhau River bed and site of the Black Stilt Aviary and Longjaw Galaxid habitats located below the High Country Rosehip Orchard terraces. The source of water that flows through the wetlands complex is principally leakage from Lake Ruataniwha, while the Ōhau River receives residual water from Lake Ruataniwha by way of a spillway. We also sighted the approximate location of the Rosehip Orchards proposed Canal B intake and irrigation pipeline route across the bed of the Ōhau River at a point just below the DOC wetlands

5.25 From there we drove around the area of the Wairepo Salmon Farm, Ōhau B and C power stations, Ōhau B and C Canals, and then back to Twizel where we walked from the hotel accommodation to the Twizel River on the northern outskirts of the town.

Simons Hill, Simons Pass and Haldon Stations (29/1/2010)

5.26 On our site visit to Simons Pass and Simons Hill Stations we were guided by Peter Glasson, starting from Twizel we drove north on SH8 stopping at various points to look at the proposed buffer zones on Simons Pass adjacent to SH8 and to view also the remnant moraine outcrops downland from SH8. We also gained an impression of the areas likely to be irrigated on the Simons Pass area of Pūkaki Flats. We also took particular notice of the landscape and irrigated areas around the Simons Pass Homestead and farm buildings as we approached the Simons Pass section of SH8 which were subject to submissions re landscape issues.

5.27 We drove over Mary Range emerging on the Maryburn side of the Pass, stopped and identified Simons Pass Station irrigated land on the north side of SH8 and Simons Hills Station on the south side of SH8. From there we drove into Simons Hills Station to meet the owner Denis Fastier, drove up House Hill from where we gained a very good panoramic view of the Mackenzie Basin in many directions, with the Maryburn and Tekapo Rivers visible to the east of House Hill. We drove from there around House Hill to some extensive flats that were being irrigated by centre pivot with Maryburn water. The Maryburn River flows along the NE boundary of the station and adjacent to the irrigated flats of Simons Hill Station.

5.28 We continued from there around the large hill "Simons Hill" emerging onto the eastern side of the vast Pūkaki Flats, driving in a SW direction roughly along the boundary between Simons Pass and Simons Hill Station parallel and slightly to the south of the power pylons that cross Simons Pass Station. As we drove out onto the flats it was noticeably dry and absent of any grazing values, the weed hieracium predominated with intermittent outcrops of wilding pines which were subject to a control programme judging by the dead and uprooted wilding pines we saw. We continued out to about the centre of the flats stopping at the historic Rabbit Proof Fence built in the 1880's. At that point we used the auger to drill several holes and assess the characteristics of the soil substrate which was very loose, light, dry with little structure. From that point also we took the opportunity to orient

ourselves with surrounding landmarks and noting the considerable distances involved in traversing the Pūkaki Flats.

5.29 From there we drove in a southerly direction to the southern tip of the flats to look at attempts to establish rosehip plantings on the lower terraces next to the Pūkaki River. We then drove east at the southern end of the Pūkaki Flats toward Simon Hill noting the wilding pine control occurring activity. At the foothills we left the Pūkaki Flats and followed a track along the edge of Tekapo River heading downstream to the very southern tip of the Pūkaki Flats and Simons Hill Station. At that point we crossed by bridge over the Tekapo River not far upstream from its confluence with the Pūkaki River, and followed a rough track for some distance eventually arriving at a fisherman's camp site on Haldon Station close to the Haldon Arm of Lake Benmore.

5.30 We drove on to Haldon Station and met the manager Paddy Boyd who then guided us around the irrigation systems of Haldon Station. Starting at the weir and fish screen we followed the system in a down gradient fashion looking at water races, border dyke, centre pivot irrigation, storage ponds and by wash collection ponds, pump and eventual discharge point of bywash back into Stony Creek.

5.31 Following the visit and lunch at Haldon Station we took the Haldon Road north to meet up with SH8 and on to Christchurch, on the Haldon Road however we were able to view the Grampians, Grays Hill, location of the Grays River and the extensive terrain of the plains situated between Grays River and Tekapo River. The land based site visit complementing well the earlier helicopter site visit of Mackenzie Basin.

Value of Site Visits

5.32 The manoeuvrability of the helicopter provided us the opportunity to easily traverse the expansive territory of the Basin and hover or rotate where particular points of interest required it; we gained a full appreciation of the interlinking yet distinctive compartments of an iconic landscape. A landscape dominated by the Southern Alps to the west, glacial lakes and extensive outwash plains through which natural waterways and artificial canals wend their way to the manmade hydro lakes to the southeast. Interspersed in this landscape are mountains and ranges that separate vast plains that even in a helicopter stretch into the distance. A distinctive and overriding impression was gained of the Mackenzie Basins natural brown colours and how they contrast with the lakes and braided river beds that intersect the landscape.

5.33 The flight was made two months into the hearings and provided us with a good opportunity to orientate to points of topicality that arose during the hearing. This included identifying waterways, water takes, existing and replacement irrigation systems, stations, nodal points and the sensitive receiving points of Lake Benmore, particularly the Ahuriri Arm.

5.34 This was particularly important for example where we had questions in our mind about particular operations, water takes, nature of the landscape and how some water reticulating systems actually worked on the ground. Visually absorbing and understanding the separate and distinct parts of the landscape, interconnectedness, relevant waterways and the matrix of properties was invaluable.

5.35 We also visually assessed existing irrigation activity against the semi arid extensive landscape to understand better the degree of the greening effect of those operations. It was evident that much of the basin floor has had historical agricultural development and incremental change occurring to the landscape particularly where water is available. This is evident where upgrading of existing and installation of new irrigation systems is introducing physical structures into the landscape such as centre pivots. The visual extent of existing irrigation and the knowledge we had of the proposed activities allowed us to conceptualise and gain a context for the degree of greening that might result and how that would be balanced by the significant areas of the catchment areas that would remain in their "natural state".

5.36 The flight was also helpful in gaining a full appreciation of the impressive hydro electricity system of control structures, canals, reservoirs or lakes and power stations that traverse

the landscape, and the controlled or dewatered watercourses of the Tekapo, Pūkaki and Ōhau Rivers. The vast distances over which the hydro system extends make it difficult to fully comprehend the system when on the ground, whereas the helicopter flight provided an excellent opportunity to conceptualise and understand the hydro network from the glacial lakes to the sea.

5.37 The Land based visits impressed us with the sheer scale of the landscape and the extent of hydro electricity infrastructural development. Much of the roading network we travelled on was built as part of the hydro development scheme in the Upper Waitaki; hence we were afforded a particularly close inspection of the control structure, canal, power station and manmade reservoir network that traversed the landscape. We sighted the culverts where natural high country waterways pass under the hydro canal system unimpeded and also inspected the waters of the modified natural rivers that once flowed from the glacial lakes in full force.

5.38 A point of interest during our inspection was the Wairepo Arm and Kellands Pond waters where we noted the remarkable difference in water quality between the two waterways, the enclosed Kellands Pond displaying considerable water quality issues compared to the Wairepo Arm which is linked to Lake Ruataniwha and hydro canal inflows. Of interest also was the extensive area of irrigation on a dairy farm upstream of Kellands Pond and considering what connection that may have with water quality in the pond, particularly relevant given we were hearing applications that reflect a similar scenario.

5.39 On the land based visit we took the opportunity to inspect a number of water takes, particularly those that had ephemeral stretches below the point of take, to understand the nature of the terrain and leaky nature of the stony substrata of much of plains as they emerge from the foothills.

5.40 Our inspection of the Ahuriri Delta was helpful in providing an appreciation of the extensive clear waters and wetlands of the delta, from which we gained a sense of the potential for mahinga kai restoration and better appreciate the cultural association to the area.

5.41 A particularly impressive part of the land based visit was getting out onto the vast plains of Killermont Station and the Pūkaki Flats, which when viewed from the air the degraded state of the landscape was not totally evident. However the land based visit provided graphic evidence of the degraded and unstable nature of the surface soils of these flood plains. We took several core samples by auger on the plains to assess soil moisture holding capabilities and nature of the subsoil characteristics, in every case we were struck by the dry "powder" nature of the soil structure.

5.42 A particular aspect of the land site visit was taking the opportunity to evaluate as best we could the visual effects that the proposed irrigation activities might introduce to the iconic and brown landscape that stretched beyond the various roads we travelled. The effect of variable buffer zones, location of irrigation infrastructure and the greening effect were all topical issues that we evaluated and considered the evidence of the landscape experts.

5.43 We appreciated the open access that the station holders provided to our land based visit and the assistance providing in finding our way around some of the vast stretches of the land site visit. A large number of photos were taken, from the helicopter and the land based visit that provided a useful reference for subsequent use.

6 STATUTORY CONTEXT

6.1 Before discussing some of the catchment-wide issues arising from the applications, it is important to comment on the statutory context under the RMA and the relevant planning documents that must be considered in this context.

Sections 13, 14 and 15 RMA – Duties and Restrictions

6.2 Part 3 of the RMA sets out duties and restrictions on activities, including the following sections that are particularly relevant to these applications:

(a) **Section 13** – restrictions on the use of beds of lakes and rivers. This includes activities such as the disturbance of the bed to install intake structures and irrigation pipelines.

(b) **Section 14** – restrictions on the damming, diverting, taking and using of water. This includes activities such as taking water from rivers and lakes for use in irrigation.

(c) **Section 15** – restrictions on the discharge of contaminants into the environment. This includes activities such as discharging surplus irrigation water back into rivers and lakes.

6.3 The general principle under all of the above sections is that consent is required for these activities unless the activity expressly permitted by a relevant regional plan or valid resource consent[8]. The activities that are the subject of these applications do not meet these exceptions and resource consent is therefore required pursuant to sections 13, 14 and 15 of the RMA.

Sections 104, 104B and 104D RMA – Consideration of Applications

6.4 Section 104(1) of the RMA sets out the matters we must have regard to in our consideration of the applications. The relevant matters are as follows:

"(a) any actual and potential effects on the environment of allowing the activity; and

(b) any relevant provisions of –

(i) a national environmental standard:

(ii) other regulations:

(iii) a national policy statement:

(ii) a New Zealand coastal policy statement:

(iii) a regional policy statement or proposed regional policy statement:

(iv) a plan or proposed plan; and

(c) any other matter the consent authority considers relevant and reasonably necessary to determine the application.

6.5 The balance of s104 contains a range of other matters that may also be relevant to our consideration, including the following (among others). We have discussed these issues in the context of our separate Part B decisions as relevant.

(a) Section 104(2) – Provides us with the discretion to disregard an adverse effect on the environment if the plan permits and activity with that effect (the permitted baseline).

(b) Section 104(2A) – Requires that we must have regard to the values of investment of an existing consent holder when considering an application affected by s124.

(c) Sections 104(6) and (7) – Provides that we may decline a consent on the grounds of inadequate information, taking into account any requests for further information that have been made.

[8] There are some exceptions to this, such as taking water for stock water and domestic use under s14(3)(b). The issue of stockwater is discussed later in this decision under the heading "Issues for Part B decisions".

6.6 We note section 104(1) of the RMA provides that the matters therein listed are subject to Part 2 RMA, which includes sections 5 through to 8 inclusive. We consider Part 2 RMA matters subsequently.

6.7 For non-complying activities, the same requirements of s104(1) apply. In addition, section 104D of the RMA contains particular restrictions for non-complying activities and provides:

> *"(1) Despite any decision made for the purpose of [section 95A(2)(a) in relation to adverse effects], a consent authority may grant a resource consent for a Non-Complying Activity only if it is satisfied that either –*
>
> *(a) the adverse effects of the activity on the environment (other than any effect to which [section 104(3)(a)(ii)] applies) will be minor; or*
>
> *(b) the application is for an activity that will not be contrary to the objectives and policies of –*
>
> *(i) the relevant plan, if there is a plan but no proposed plan in respect of the activity; or*
>
> *(ii) the relevant proposed plan, if there is a proposed plan but no relevant plan in respect of the activity; or*
>
> *(iii) both the relevant plan and the relevant proposed plan, if there is both a plan and proposed plan in respect of the activity.*
>
> *(2) To avoid doubt, section 104(2) applies to the determination of an application for a Non-Complying Activity."*

6.8 In considering whether an effect on the environment is "minor", minor means lesser or comparatively small in size or importance and the judgment is to be made considering the adverse effects as a whole. In relation to the second jurisdictional hurdle, the word contrary is given a meaning of more than just non-complying, but opposed to in nature, different to, or opposite, We are required to consider whether the proposed activity would be contrary (in that sense) to the objectives and policies of the plan in an overall consideration of the purpose and scheme of the plan.

6.9 Based on the above, the process we will follow when considering a non-complying activity is to:

(a) identify the relevant section 104 matters;

(b) consider whether the jurisdictional hurdles in section 104D are met having regard to the relevant and rejecting irrelevant matters under section 104; and

(c) if either one of the jurisdictional hurdles is passed, weigh the relevant matters under section 104 and Part 2 as part of the overall discretion whether or not to grant consent under section 104B.

6.10 All of the applications before us are either discretionary or non-complying activities. In accordance with s104B, after considering such applications, we may grant or decline consent. We must exercise that discretion having proper regard to the purpose of the RMA, which requires a balancing exercise of the various elements identified in the course of the hearing – particularly under section 104 and Part 2 of the RMA. If we grant the application, we may impose conditions under section 108.

6.11 It is clear from the above that all relevant issues must be considered when deciding whether or not grant consent. This includes all potential effects on the environment and consideration of the relevant provisions of the various planning instruments discussed further below. Our consideration is not limited by the reason why consent is required (i.e.

the particular rule which triggers consent). However, this may be of some relevance in evaluating the significance of the different issues arising from a particular proposal.

Section 105 – Discharges

6.12 In addition to the matters specified in s104, for applications for a discharge permit (of which there are several before us) we must also have regard to the following matters under s105(1):

(a) The nature of the discharge and the sensitivity of the receiving environment to adverse effects;

(b) The applicant's reasons for the proposed choice; and

(c) Any possible alternative methods of discharge, including discharge into any other receiving environments.

6.13 We have had regard to these matters in our separate Part B decisions on any applications for discharge permits.

Part 2 matters RMA

6.14 Section 104(1) states that our consideration of the applications is subject to Part 2 of the RMA, which covers section 5 through section 8 inclusive. We record that our approach is that sections 6, 7 and 8 RMA contribute to and will inform our evaluation under section 5 RMA.

6.15 To avoid setting out the Part 2 provisions in full in every Part B decision, we have set them out below and will discuss and apply them as relevant in the context of the decisions on individual applications and proposals.

6.16 Sections 6 identifies the following matters of national importance that we must "recognise and provide for" when making our decision::

> *"(a) The preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use and development.*
>
> *(b) The protection of outstanding natural features and landscapes from inappropriate subdivision, use and development;*
>
> *(c) The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna;*
>
> *(d) The maintenance and enhancement of public access to and along the coastal marine area, lakes and rivers;*
>
> *(e) The relationship of Māori and their culture and traditions with their ancestral lands, water, sites, wāhi tapu, and other taonga;*
>
> *(f) The protection of historic heritage from inappropriate subdivision, use and development.*

6.17 Section 7 list the following other matters that we shall "have particular regard to":

> *(a) Kaitiakitanga:*
>
> *(aa) The ethic of stewardship:*
>
> *(b) The efficient use and development of natural and physical resources:*

(ba) The efficiency of the end use of energy:

(c) The maintenance and enhancement of amenity values:

(d) Intrinsic values of ecosystems:

(e) Repealed.

(f) Maintenance and enhancement of the quality of the environment:

(g) Any finite characteristics of natural and physical resources:

(h) The protection of the habitat of trout and salmon:

(i) The effects of climate change:

(j) The benefits to be derived from the use and development of renewable energy.

6.18 Finally, section 8 requires that we shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).

6.19 Turning now to the overall purpose of the RMA, that is, "to promote the sustainable management of natural and physical resources". In turn, "sustainable management" means:

> *"... managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while –*
>
> *(a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
>
> *(b) Safeguarding the life-supporting capacity of air, water, soil and ecosystems; and*
>
> *(c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment".*

Section 217 RMA – Water Conservation Orders

6.20 Section 217 of the RMA relates to water conservation orders and states that where an order is operative, the relevant consent authority:

> *(a) Shall not grant a water permit … or discharge permit if the grant of that permit would be contrary to any restriction or prohibition or any other provision of the order:*
>
> *(b) Shall not grant a water permit … or a discharge permit to discharge water or contaminants into water, unless the grant of any such permit or the combined effect of the grant of any such permit and of existing water permits and discharge permits and existing lawful discharges into the water or taking, use, damming, or diversion of the water is such that the provisions of the water conservation order can remain without change or variation:*
>
> *(c) Shall, in granting any water permit …or discharge permit to discharge water or contaminants into water, impose such conditions as are necessary to ensure that the provisions of the water conservation order are maintained.*

6.21 This is confirmed by s104(3)(c), which states that a consent authority must not grant a consent that is contrary to s217. The effect of these provisions is that we are prohibited

from granting consent to an application that would cause the provisions of a water conservation order to be breached, taking into account other existing activities and any conditions of consent that may be imposed.

6.22 There is one order that is relevant to some of these applications, being the National Water Conservation (Ahuriri River) Order ("the Order"). The Order was made operative in July 1990 and declares that the Ahuriri River and its tributaries include and provide for outstanding wildlife habitat, outstanding fisheries, and outstanding angling features.

6.23 The Order sets out various restrictions designed to protect the outstanding characteristics and features of those water bodies. This includes controls on both the quality and quantity of water, as provided by the following clauses:

(a) Clause 4 – requires that the level and quantity of water in all water bodies forming part of the "protected waters"[9] must be retained in their natural state.

(b) Clause 5 – specifies minimum flows for different sections of the Ahuriri River depending on the gorge flow and time of year.

(c) Clause 6 – specifies minimum flows for different sections of Omārama Stream

(d) Clause 7 – restrictions on damming in the "protected waters" and tributaries to the Ahuriri River.

(e) Clause 8 – restrictions on discharges into the "protected waters"

6.24 As noted above, we may not grant a consent for an activity that would be contrary to these provisions. This applies not only to activities in the above water bodies, but to any activity that could lead to an outcome that is contrary to the Order. On this point, we agree with the legal submissions on behalf of the Director General of Conservation.

6.25 For example, the Order is relevant to applications to take, divert and dam water from tributaries that flow into the Ahuriri River or Omārama Stream and which may influence the flows in those water bodies. The tributaries themselves do not need to meet the minimum flows in the Order. However we must be satisfied that if consent is granted, there is sufficient water remaining in those tributaries to sustain the minimum flows for the Ahuriri River and Omārama Stream as required by the Order.

6.26 Another example relates to applications to use water for the irrigation of land within the Ahuriri catchment where that water may re-enter the "protected waters" through ground water. We must be satisfied that granting consent would not negatively impact on the quality of the "protected waters" such as to fundamentally alter their natural state. Such an outcome would be contrary to the provisions of the Order and could not be approved.

6.27 Based on the above, we consider that the Order may be relevant to the following applications and have considered the provisions of the Order in relation to these activities within our Part B decisions.

(a) Killermont Station Limited:

(i) Water takes from and discharge to the "protected waters" of the Ahuriri River (CRC041331, CRC041777, CRC041332);

(ii) Activities in tributaries to the Omārama Stream, including taking water from Mānuka Creek (CRC052798) and taking from and damming Frosty Gully (CRC040180, CRC040181)

[9] This defined in the Order and includes the Ahuriri River mainstem, all tributaries within 400m of the Ahuriri River banks, and the Omārama Stream downstream from the bridge (at map reference NZMS 260 H39:6094-2343)

(b) **Southdown Holdings Limited** - water take from the "protected waters" of the Ahuriri River (CRC041788, CRC073115)

(c) **M Horo** - Water take from the east branch of the Ahuriri River (CRC042020)

(d) **Twin Peaks Station Ltd** – water take from Mānuka Creek, being a tributary to the Omārama Stream (CRC063564)

(e) **Dunstan Peaks Ltd** – water take from the upper Tributaries of the Omārama Stream (CRC011361)

6.28 All parties accepted the general requirement for a proposal to comply with the minimum flows specified in the Order. However a common issue that arose was what method should be used to actually ensure that the minimum flows are maintained in the Ahuriri River.

6.29 The approach adopted by the reporting officer (Ms Penman) was to convert the minimum flow requirements in clause 5 of the Order into maximum abstraction rates for the different flow bands as follows:

(a) Up to 0.6 cubic metres per second when flows are between 10 and 15 cubic metres per second;

(b) Up to 2 cubic metres per second when flows are between 15 and 25 cubic metres per second; and

(c) Up to 3 cubic metres per second when flows are greater than 25 cubic metres per second.

6.30 The proposed abstraction for individual applications was then combined with other existing and higher priority takes to determine whether these limits, and hence the minimum flows of the Order, would be complied with if a particular proposal was granted.

6.31 This approach was supported by Mr Frank Scarf on behalf of Fish & Game New Zealand as a submitter. However it was opposed by some of the applicants, notably Mr Whata, Mr McIndoe and Mr Kyle on behalf of Southdown Holdings Ltd and Killermont Station Ltd.

6.32 Mr Whata provided submissions on this issue and emphasised that the Order establishes minimum flows to be retained in the river and does not refer to maximum takes. Provided that the flow in the river meets the minimum threshold, he submitted, water may be taken. Conversely if the water in the river falls below the threshold water may not be taken. Priority applies when the cumulative take causes the threshold to be breached. But there is no such thing as a fixed maximum take.

6.33 Mr Whata added that calculating the flow in the river at any point can be undertaken by a number of methods. He concluded by noting that the applicant will not take water in contravention of these limits and the proposed monitoring will ensure this outcome. Mr Whata stated that Dr Ryder has confirmed that this interpretation gives effect to the objective to protect the instream environment and is preferable to a simplistic maximum abstraction approach, as that does not in fact guarantee that the minimum flows are being maintained. Conditions were proposed by Mr Kyle to achieve this outcome.

6.34 In her addendum report, Ms Penman reviewed the conditions proposed by Mr Kyle and noted that it simply set out the flows required to be maintained in the Ahuriri River under the Order. In her view it did not set out how the minimum flow will be maintained, taking into consideration existing abstractors.

6.35 Ms Penman noted that given the existing allocation of water from the Ahuriri River (close to 2 m3/s), there would be no way of identifying when water might be available at Gorge flows of less than 25 m3/s without any water users group or flow sharing (which existing users are not subject to). She emphasised that the AWCO requires the minimum flow in the river to be sustained along its whole length not at a discrete point on the river.

6.36 Mr McIndoe responded to Mr Penman's view and considered that should the existing consents not be fully exercised, there is opportunity for the proposed consent holders to take water at lower minimum flows. In order for that to happen, Mr McIndoe noted that applicant would have to reach an agreement with existing consent holders, most likely through a water users group, to be able to manage the takes to ensure that the AWCO is not violated. He noted that a simple approach initially is to form a water users group and through telemetry, monitor actual water abstraction and determine water availability. The group would then allocate that water on a priority or agreed basis to abstractors.

6.37 He added that also available to the applicant is the option to monitor river flows at various points, and take into account locations of diversions and takes, tributary inflows and other factors that impact on Ahuriri River flows to determine flow availability. Consequently, Mr McIndoe disagreed with Ms Penman's statement that there is no way of identifying when water is available at Gorge flows of less than 25 m^3/s.

6.38 After considering all of the above, we agree with the applicant that the focus of the Order is on achieving minimum flows, not maximum extraction rates. However we also agree with the reporting officers that setting a limit on total abstraction is the most pragmatic way of achieving the desired minimum flows.

6.39 We agree with Mr McIndoe that forming a water users group, coming to agreements about how much water can be abstracted and when, complemented by telemetered flow monitoring is feasible to achieve the minimum flow provisions of the AWCO. However we consider that such measures a quite sophisticated, require the agreement of all parties, and need to be well documented in order that Council could have some assurance that the minimum flow provisions are being met at all times. We have not seen any evidence of agreement with other users, or, documentation on how it would work in practice. Without such evidence, our view is that a system based on abstraction limits within flow bands is the best method for ensuring that AWCO minimum flows will not be breached.

6.40 Finally, section 217(1) of the RMA provides that the Order shall not affect or restrict any consent granted or any lawful use established before the Order was made. We acknowledge that several applications are to "replace" expiring consents for activities that have been occurring for some time. However this does avoid the need to comply with the provisions of the Order. All applications are for new consents that must be considered under the RMA and are subject to the requirements of the Order.

Resource Management (Waitaki Catchment) Amendment Act 2004

6.41 The Resource Management (Waitaki Catchment) Amendment Act 2004 ("the Waitaki Act") established the Waitaki Catchment Water Allocation Board with the function of developing a regional plan for the allocation of water in the Waitaki catchment. This is the now operative Waitaki Catchment Water Allocation Regional Plan (WCWARP).

6.42 The Waitaki Act includes a schedule of applications that the Waitaki Act affects (Schedule 2). It includes details of what must occur when WCWARP becomes operative, including details regarding the processing of applications, including hearing and deciding applications.

6.43 We have considered and applied the provisions of the Waitaki Act when making our decisions. Further discussion on the Waitaki Act is provided later in this decision in respect of the relationship between the WCWARP and other regional plans, and determining the status of activities for applications listed in Schedule 2.

7 RELEVANT PLANNING INSTRUMENTS

7.1 There is a wide range of relevant planning instruments that are relevant to consideration of the applications under the RMA. This includes national and regional policy documents, along with regional and district plans, as listed below:

(a) National documents:

(i) National Policy Statement on Freshwater Management;

(ii) National Policy Statement on Electricity Transmission; and

(iii) National Environment Standard for Sources of Human Drinking Water.

(b) Regional documents:

(i) Transitional Regional Plan (TRP);

(ii) Waitaki Catchment Water Allocation Plan (WCWARP);

(iii) Proposed Natural Resources Regional Plan (PNRRP);

(iv) Operative Natural Resources Regional Plan (NRRP);

(v) Operative Canterbury Regional Policy Statement (CRPS); and

(vi) Proposed Canterbury Regional Policy Statement (Proposed CRPS).

(c) District documents (depending on location of application):

(i) Waitaki District Plan;

(ii) Waimate District Plan; or

(iii) Mackenzie District Plan.

7.2 The provisions of these documents are relevant to two important parts of our decision making on the applications. The first is determining the status of the activities, which is discussed further under the heading "Issues for Part B decisions". The second is in relation to s 104(1)(b) of the RMA, which requires that we have regard to the relevant provisions of the above planning instruments when considering whether or not to grant consent.

7.3 We record that we have read and considered the relevant provisions all of the above planning instruments. Although each one is important, many of these documents contain similar provisions that are intended to achieve the same or similar environmental outcomes. In addition, when considering the large number of applications before us, common issues arise that require consideration of the same key provisions and themes from these planning instruments.

7.4 For these reasons, the following sections of our decision provide an overview of the various planning instruments and address issues that are common to multiple applications. The approach we have endeavoured to apply involves an overall consideration of the purpose and scheme of the relevant planning documents, rather than a detailed assessment of every provision within each document.

National Policy

National Policy Statement on Freshwater Management

7.5 At a national level, the key relevant document is the National Policy Statement on Freshwater Management 2011 ("the Freshwater NPS"). The Freshwater NPS took effect on 1 July 2011. Even though this document was not operative at the time when the applications were made or the hearing was held, we are nonetheless required to have regard to it as part of our consideration of the applications.

7.6 The Freshwater NPS is a high level document that sets broad goals for the management of freshwater in New Zealand. The objectives within the Freshwater NPS reflect this high level nature and can be summarised as follows:

(a) Safeguard the life-supporting capacity of freshwater ecosystems;

(b) Maintain or improve water quality;

(c) Avoid over allocation of freshwater;

(d) Improve and maximise the efficient allocation and use of water;

(e) Protect outstanding freshwater bodies and significant values of wetlands;

(f) Improve integrated management of freshwater and land use; and

(g) Ensure tangata whenua interests and values are reflected in the management of fresh water.

7.7 The policies in the Freshwater NPS direct that regional councils take specific actions to give effect to the objectives. This includes the requirement to set minimum flow levels and quality limits through regional plans. However the details of these measures and the other methods to achieve the objectives of the Freshwater NPS are left for the regional councils to determine.

7.8 The objectives of the Freshwater NPS are consistent with the relevant objectives and policies of the WCWARP and the NRRP, both of which we discuss further below and in our Part B decisions. Where we conclude that a particular application is consistent, inconsistent or contrary to those regional plan provisions, it follows that the same conclusion generally applies to assessment of the proposal against the Freshwater NPS.

Other national documents

7.9 In addition to the Freshwater NPS, two other national documents that are relevant to some of the applications are the National Policy Statement on Electricity Transmission ("the Electricity NPS") and the National Environment Standard for Sources of Human Drinking Water ("the Drinking Water Standards"). We confirm that we do not consider that the New Zealand Coastal Policy Statement to be relevant, as the Upper Waitaki Catchment does not comprise part of the coastal environment.

7.10 In relation to the Electricity NPS, Policy 10 of that document requires that we, to the extent reasonably possible, manage activities to avoid reverse sensitivity effects on the electricity transmission network. However, we do not consider that this is a significant issue in the relation to the current applications and have not considered it further. We do observe in the Rosehip Orchards NZ Limited Decision (CRC072118) a high tension power line crosses the property. However, appropriate mitigation measures were proposed to address any reverse sensitivity issues.

7.11 The Drinking Water Standards are intended to reduce the risk of activities contaminating sources of drinking water sources. In particular, water permits or discharge permits should not be granted if those activities would likely result in the breaching of the Standards for community water supplies that serve 501 people or more. The only water supply to which the Standards apply is the Twizel water supply with a reported population of 1,300. We have taken this into account where relevant in the context of our Part B decisions.

Regional Policy

7.12 There are two regional policy statements that we are required to consider, being the operative Canterbury Regional Policy Statement 1998 and the Proposed Canterbury Regional Policy Statement 2011. These documents provide an overview of the resource management issues for the region and set out how natural and physical resources are to be managed. Relevant chapters are summarised in Table 1 below:

Issue	Relevant Provisions	
	RPS 1998	Proposed RPS 2011
Tangata Whenua	Chapter 5 and 6	Chapter 4
Soils and land use	Chapter 7	Chapters 5 and 15
Landscape	Chapter 8	Chapter 12
Ecosystems and biodiversity	Chapter 8	Chapter 9
Water	Chapter 9	Chapter 7
Beds and margins of rivers and lakes	Chapter 10	Chapter 10

Table 1: Relevant provisions on the RPS and Proposed RPS

7.13 As for national policy, we consider that the provisions of the RPS and Proposed RPS are consistent with and support the more detailed provisions of the WCWARP and the NRRP. To avoid repetition we generally do not discuss regional policy provisions in detail in our Part B decisions. We simply apply the same approach as for national policy documents and note that our conclusions on the relevant district and regional plans apply equally to the corresponding provisions in the regional policy statements.

7.14 The only exception to this is the objectives and policies relating to landscape matters, which are not addressed in detail in the regional plans. The approach of the CRPS in relation to landscape is to recognise that there is the potential for adverse effects on recreational values, landscape, visual amenity and natural character when water is abstracted from a waterbody. The objectives and policies of Chapters 8 and 9 of the RPS recognise this potential and seek to provide for it.

7.15 In particular, Chapter 9, Objective 1 refers to preserving the natural character of lakes and rivers (e); protecting outstanding natural features and landscapes (f); and maintaining and, where appropriate, enhancing values in the region's waterbodies (h). Chapter 9, Policy 9 refers to setting and managing water flow, levels and allocation regimes to achieve those objectives.

7.16 Chapter 8, Objective 2 refers to protecting or enhancing natural features and landscape that contribute to Canterbury's distinctive character and sense of identity, including their associated ecological, cultural, recreational, and amenity values.

7.17 In terms of discharge permit activities dealing with discharges directly into water, Chapter 9 RPS, Objective 3 deals with discharges of contaminants into water and seeks to ensure the preservation of natural character (e) and the protection of outstanding natural features and landscape (f).

7.18 Turning to the Proposed CRPS, Chapter 12 recognises broad landscape patterns distinctive in a regional context and recognises that greater detail is mapped at district and regional plan levels with site specific landscape assessment occurring as a result of management methods implemented through those plans where appropriate.

7.19 The objectives and policies within Chapter 12 are primarily concerned with landscape values and their protection and/or maintenance. Chapter 12 also is to do with identification and protection of outstanding natural features and landscapes and consistency of assessment in terms of management of the same. The plan, in terms of methods and making provision for identification of outstanding natural features and landscapes and management of them, devolves responsibility between the council and territorial authorities.

7.20 The policy framework also provides for protection of other important landscapes, principally via Policy 12.3.3. This policy seeks to recognise that other important landscapes that do not meet the threshold of outstanding, may warrant protection and management for natural character, amenity, historic cultural or historic heritage values, or other purposes. The methods referred to are that local authorities may within their plans set out objectives, policies and methods that provide for the protection and management

of these other important landscapes, including for their natural character, amenity, historic cultural or historic heritage values or for other purposes.

7.21 The Proposed CRPS recognises the linkage with Sections 6 and 7 RMA in terms of landscape and amenity issues, which we will discuss later.

Waitaki Catchment Water Allocation Regional Plan

7.22 For most of the applications (particularly those to divert, take and use water), the key planning document is the WCWARP, which is a regional plan containing specific objectives and policies to provide for the allocation of water in the Waitaki Catchment. The provisions of this plan are of critical importance to our consideration.

7.23 The WCWARP is a water allocation plan. "Water allocation" is defined as addressing the taking, using, damming and diverting of water in relation to the following matters:

(a) A whole-catchment approach;

(b) Environmental flow and level regimes;

(c) The mixing of waters;

(d) The allocation to activities;

(e) Efficient and effective use;

(f) Water metering;

(g) Transfer of resource consents;

(h) Restrictions during times of low water availability; and

(i) Replacement of existing consents.

7.24 Based on the above, the rules of the WCWARP focus on allocation limits and flow regimes for various water bodies within the catchment. It is these rules which primarily trigger the need for resource consent to divert, take and use water.

7.25 Notwithstanding this focus on water allocation, the WCWARP clearly identifies the relationship between water allocation and other aspects of resource management, including water quality, landscape, cultural values, and a range of other matters. The WCWARP does not itself comprehensively provide for such matters; rather, it approaches these other aspects of resource management on the assumption and expectation they will be dealt with via "*parallel management provisions*" in other plans that address these issues.

7.26 In other words, even though the WCWARP rules do not have specific controls on matters such as water quality or landscape, these wider issues associated with the use of water must still be carefully evaluated when considering applications to take and use water. This is consistent with the requirements under s104 of the RMA, and is reflected in the objectives and policies of the WCWARP, as discussed further below.

7.27 The WCWARP contains five objectives. We consider that Objective 1 is the critical objective, which seeks the following outcome:

> *"To sustain the qualities of the environment of the Waitaki river and associated beds, banks, tributaries, islands, lakes, wetlands and aquifers by:*
>
> *(a) recognising the importance of maintaining the integrity of the mauri in meeting the specific spiritual and cultural needs of the tangata whenua, and by recognising the interconnected nature of the river*

(b) safeguarding the life supporting capacity of the river and its ecosystems

(c) managing the water bodies in a way that maintains natural landscape and amenity characteristics and qualities that people appreciate and enjoy

(d) safeguarding the integrity, form, functioning and resilience of the braided river system

(e) providing for individuals' reasonable domestic water needs

(f) providing for individuals' reasonable needs for their animals' drinking-water

(g) providing for fire-fighting water needs."

7.28 The objective directly recognises the need to sustain the potential of the Waitaki Catchment to meet reasonably foreseeable needs by safeguarding the life supporting capacity, form and functioning of the river system and maintaining natural landscapes and amenity characteristics and qualities of the river that people appreciate and enjoy. In addition, the objective responds to the specific cultural and spiritual needs of Ngāi Tahu by recognising the interconnected nature of the catchments water resources and the importance of maintaining the integrity of the associated mauri.

7.29 Objective 2 seeks to enable people in communities to provide for their social, economic and cultural well-being and their health and safety by providing for agricultural and horticultural activities, among other uses. However Objective 2 makes it clear that the provision of water for this purpose is available only to the extent that to do so is consistent with Objective 1. As we read and interpret the plan, Objective 1 sits as a higher order objective and Objective 2 in terms of allocating water sits as an objective which is available only to the extent that the provision of water is consistent with the outcome that Objective 1 seeks.

7.30 Objective 3 of the WCWARP requires recognition of beneficial and adverse effects on the environment in both national and local costs (environmental, social, cultural, and economic). Objective 4 seeks to promote the achievement of a high level of technical efficiency in the use of allocated water. Objective 5 seeks to provide for a practical and fair sharing of allocated water during times of low water availability.

7.31 The policies of the WCWARP give effect to these objectives cover a number of key issues, including in particular a whole-catchment approach, water quality, efficient use and replacement consents, each of which is discussed further below.

Whole-catchment approach

7.32 Policy 1 of the WCWARP recognises the importance of the connectedness between all parts of the catchment from the mountains to the sea. The explanation to that Policy provides that the Waitaki catchment is large and complex and requires a whole catchment approach that recognises the physical, ecological, cultural and social connection throughout the catchment.

7.33 We have endeavoured to apply this catchment wide approach when considering the issues arising from the applications. This is one of the reasons why this Part A decision considers some of the key issues on a catchment wide basis, rather than simply considering them in isolation for each separate application.

Water quality

7.34 We think the WCWARP has an important focus on water quality issues in respect of allocating water for agricultural and horticultural activities. This is reflected in Policy 13, which requires that we have regard to the extent to which exercising a consent could result in the water quality objectives of the PNRRP not being met.

7.35 The relevant water quality provisions from the PNRRP are incorporated by reference into the WCWARP in accordance with clause 30 of the First Schedule to the RMA. The following is a brief summary of the key objectives incorporated into the WCWARP:

(a) **Objective 1.1** – Seeks to maintain or enhance the quality of water in rivers, depending on whether the river is in a "natural state". This is linked to Table WQL5, which contains specific numerical outcomes for nutrient indicators and riverbed sedimentation in rivers.

(b) **Objective 1.2** – Seeks to maintain or enhance the quality of water in lakes. It distinguishes between high country lakes (natural and modified state), coastal lakes or lagoons, and artificial lakes, but has no associated table of numerical outcomes.

(c) **Objective 2** – Seeks to maintain the quality of groundwater not affected by human activities and ensure that all other groundwater meets specified values.

(d) **Objective 3 –** Seeks to ensure that the source water for a community drinking water supply is suitable for that purpose, with reference to the above objectives and other relevant considerations for drinking water.

7.36 We read Policy 13 and the associated PNRRP provisions as being of significant importance in the context of the WCWARP. We are fortified in this view because of the strong linkage between Policy 13 and Objectives 1-4 of the WCWARP. We note that there are only five objectives set out in the WCWARP and all but one of them are linked with Policy 13.

7.37 Policy 13 is directed at recognising the importance of water quality considerations when allocating water to agricultural and horticultural activities, particularly irrigation. The explanation to the Policy notes that intensification of land use, including that arising from irrigation, increases the potential for adverse effects on water quality. The Waitaki catchment has some sensitive and pristine waterbodies that have not to date had intensive land uses in their catchments. The Policy therefore expressly incorporates the PNRRP provisions to ensure that the issue of water quality is carefully considered when deciding consent applications.

7.38 In relation to the PNRRP objectives, we note that Mr Whata and Mr Kyle on behalf of MWRL was critical of these objectives, including the reference to "natural state" water bodies and the numerical values in Table 5. They considered that many, if not all, of the water bodies in the Upper Waitaki were already significantly modified by surrounding land use practices and exceeded the values in Table 5.

7.39 We provide a detailed discussion on the shortcomings of the water quality study later in this decision. However we note at this point that many of the concerns about the PNRRP objectives have been addressed in the revised objectives that now form part of the operative NRRP. We discuss this issue further below under the heading of the NRRP, including the approach we have applied to consideration of the two sets of operative water quality objectives in the two regional plans.

Efficient use

7.40 We consider that the WCWARP has a clear emphasis on the efficient and effective use of the water resource. There are a suite of policies directed at seeking to obtain that outcome (Policy 15-20).

7.41 These policies seek to achieve efficiencies in a number of different ways. The first is by ensuring that rates and volumes of abstraction are reasonable for the intended end use and reflect the actual quantity of water needed to undertake the activity. This is achieved by requiring consent applications for irrigation to meet a "reasonable use test" under Policy 16. The policies also encourage multiple uses of water and the piping of water distribution systems to minimise water loss.

7.42 These efficiency considerations apply equally to new and existing activities, with the WCWARP recognising that is desirable to enhance the efficiency of water wherever practicable. There are no rules specifically associated with these policies, which simply provide for matters of discretion when considering a consent application.

Replacement consents

7.43 Policy 28 of the WCWARP applies in a circumstance where an application is made to replace an existing consent. In this circumstance, we must consider whether all reasonable attempts have been made to meet the efficiency expectations of the WCWARP (as discussed above) and recognise the value of the investment of the existing consent holder (as required under s104(6) of the RMA). Considering the efficiency of existing water uses is described as "critical" to ensure that the expectations of the WCWARP are met.

7.44 As noted in the explanation to Policy 28, there is no right of renewal for a resource consent. The issue of replacement consents and the approach we have adopted to consideration of this issue is discussed further under the part of this decision titled "Issues for Part B decisions".

Other issues

7.45 In addition to the above matters, the objectives and policies of the WCWARP also address a range of other matters and require that they be taken into account when considering applications to take and use water. This includes landscape and amenity values of water bodies (Objective 1(c)) and the importance of maintaining the integrity of the mauri in meeting the specific spiritual and cultural needs of the tangata whenua (Objective 1(a)).

7.46 The WCWARP also identifies a number of specific water bodies that are worthy of a high level of protection due to their natural character. This includes water bodies that are in largely unmodified parts of the catchment or which contain rare of important species and habitat. These water bodies are covered by Policies 2 and 29-34 of the WCWARP and are discussed further in our Part B decisions as relevant.

WCWARP Rules

7.47 The key rules in the WCWARP that regulate the taking of water in the Waitaki catchment are Rules 2, 3, and 6. These rules set standards that govern the activity status of the water takes and can be summarised as follows:

(a) **Rule 2** and the accompanying **Table 3** set out minimum standards for specified water bodies in the Waitaki catchment in relation to:

(i) minimum flows and levels for rivers and lakes respectively;

(ii) allocation limits for the amount of water taken or diverted; and

(iii) flow sharing regimes.

(b) **Rule 3** provides that water from Lakes Tekapo, Pūkaki, and Ōhau and the canals leading from those lakes cannot be taken, used, dammed, or diverted unless specified minimum lake levels are complied with.

(c) **Rule 6** specifies annual allocations for various activities set out in **Table 5**. This includes a limit of 275Mm^3/year for agricultural and horticultural activities upstream of the Waitaki Dam, except that:

(i) No more than 8Mm^3/year can be taken upstream of Lake Tekapo outlet;

(ii) No more than 8Mm^3/year can be taken upstream of Lake Pūkaki outlet; and

(iii) No more than 12Mm^3/year can be taken upstream of Lake Ōhau outlet.

7.48 Compliance with the rules will determine whether a resource consent for a discretionary or non-complying activity is required. In summary:

(a) If compliance is achieved with Rules 2, 3, and 6 (as relevant) then a consent for **discretionary** activity is required;

(b) If compliance is not achieved with the standards and limits in Rule 2 and/or Rule 6, then a consent for a **non-complying** activity is required; and

(c) If the take cannot comply with the minimum lake levels in Rule 3, it is a **prohibited** activity.

7.49 Further comment on the status of activities under the WCWARP and other relevant plans is provided later in this decision under the heading "Issues for Part B decisions"

Natural Resources Regional Plan

7.50 In addition to the WCWARP, the other relevant regional plan is the NRRP. The NRRP was made operative in July 2011, after the conclusion of the hearings. Notwithstanding this timing, we are still required to have regard to it as an operative regional plan under s104(1)(b) of the RMA.

7.51 The NRRP contains a range of objectives and policies across multiple chapters relating to matters such as water quality, water quantity, landscape, ecosystems, the beds of lakes and rivers, and tangata whenua issues. This raises the issue of which parts of the NRRP are relevant to the current applications in light of the existence of the WCWARP.

7.52 The starting point for this issue is s104(1)(b) of the RMA which requires that we must have regard to the provisions of any relevant regional plan. On this basis both the WCWARP and the NRRP are operative regional plans that we must have regard to.

7.53 However this starting point is modified by the provisions of the Resource Management (Waitaki Catchment) Amendment Act 2004 ("the Waitaki Act"), which is the statute under which the WCWARP was developed. The Waitaki Act includes the following provisions that are of particular importance to this issue.

(a) Section 14 – The WCWARP is deemed to be the Canterbury Regional Plan for the allocation of water in the Waitaki catchment; and

(b) Section 28 – If the provisions of a regional policy statement or regional plan are inconsistent with the WCWARP, the WCWARP prevails.

7.54 In addition to the above, there is also some comment in the WCWARP and the NRRP about the relationships between the two plans. The WCWARP states that the objectives, policies and methods of the Canterbury regional planning instruments that address the following matters apply in the Waitaki catchment, with any necessary modifications to give effect to the WCWARP:

(a) Landscape;

(b) Water quality;

(c) Soil and bank erosion;

(d) Operational management of beds and rivers;

(e) Passage of fish past structures;

(f) Fish screening of intakes; and

(g) Various other matters (not generally relevant to the current applications)

7.55 In relation to the NRRP, each chapter has a section describing the relationship of that chapter with other relevant plans, including the WCWARP. The details of these provisions are discussed below, along with our overall conclusion on the relevant provisions of the NRRP taking all of the above matters into account.

Water allocation – Chapter 5

7.56 Chapter 5 of the NRRP relates to the issue of water quantity. Its primary focus is on managing the competition for water between different needs and demands. Due to the nature of the subject matter, there is an obvious overlap with the provisions of the WCWARP.

7.57 Table WQN3 of the NRRP addresses the relationship of the NRRP with the WCWARP and states the following:

> *"The Waitaki Catchment Water Allocation Regional Plan primarily deals with the allocation of water within the Waitaki catchment. The Plan includes objectives, policies and rules that apply to the taking, use, damming and diverting of surface water and hydraulically-connected groundwater, and the transfer of water permits. Policies and rules in the NRRP Chapter 5 addressing the same activities* ***do not*** *apply in this catchment …"* (emphasis added)

7.58 The final sentence of the above clearly states that the policies and rules of Chapter 5 relating to the taking, use, damming and diverting of surface water do not apply in the Waitaki Catchment. We have therefore not considered those provisions. However it does not state how the objectives of Chapter 5 should be treated.

7.59 The approach we have adopted in relation to the objectives of Chapter 5 is to only consider objectives that do not relate to "water allocation" as defined in the WCWARP. This is principally Objective 1, which contains reference to range of other issues such as landscape, amenity values, ecosystems, and cultural values. Objective 1 is quite a broad statement about enabling the use of water while still protecting these associated values. This is consistent with the provisions of the higher order planning instruments discussed above and the provisions of the WCWARP.

Water quality – Chapter 4

7.60 Chapter 4 of the NRRP relates to the issue of water quality. In contrast to the issue of water quantity, the NRRP states that the policies and rules of Chapter 4 **do** apply in the Waitaki Catchment. It also notes that the objectives of the PNRRP as notified are incorporated into the WCWARP and have legal effect as part of that plan.

7.61 On this basis, it is clear that the policies and rules of Chapter 4 are relevant to our consideration of the applications. Key relevant policies include Policies WQL 1, 2, 4, 5.1, 9 and 10. In relation to the rules, WQL48 is relevant to the proposed discharges of surplus irrigation water that are associated with several proposals. These policies and rules are discussed further in our Part B decisions as applicable.

7.62 Notwithstanding the above, there remains some uncertainty as to the relevance of the objectives in Chapter 4. As discussed above, the earlier versions of these objectives are incorporated into the WCWARP in the form that they were notified. However there have been changes to those objectives throughout the hearing process, resulting in slightly different objectives now residing in the NRRP.

7.63 We note the requirement under s28 of the Waitaki Act that the WCWARP take precedence over inconsistent provisions in other regional plans. However we do not consider this applies in this case on the basis that the NRRP objectives are not inconsistent with those incorporated into the WCWARP.

7.64 Comparing the two sets of objectives, our observation is that although there are some differences, the general intent of the provisions remains unchanged. Both sets of objectives have a clear focus on maintaining and enhancing the quality of water in rivers,

lakes and groundwater throughout the Canterbury Region. The main difference is that some objectives have been modified to provide a clearer picture of the intended water quality outcomes by simplified wording and additional detail on the numerical indicators for water quality.

7.65 We consider that the key differences that are relevant to these applications relate to Objective 1 and the associated Tables, which can be summarised as follows:

(a) Rivers and lakes within land administered by the Department of Conservation are to be maintained in a natural state.

(b) For all other rivers and lakes, water quality is to be managed in accordance with the updated numerical indicators and classifications in **Table WQL5** for rivers and a new **Table WQL6** for lakes.

(i) Where these outcomes are being achieved, the quality of the water and the bed should be managed so as to continue to achieve that outcome.

(ii) Where the outcome is not being achieved, the objective seeks that the water quality be progressively improved.

7.66 Although we have considered both sets of objectives, we have generally given greater weight to the NRRP provisions. The key reason for this is that these provisions are based on the best available information and represent the latest approach for achieving the common goal of protecting water quality. It was also generally accepted during the hearing that there were some interpretation and application issues associated with the objectives incorporated into the WCWARP. Reference was therefore made to amended objectives proposed by reporting officers through the PNRRP hearing process. These changes are now largely reflected in the final NRRP objectives, which provide a greater level of assistance to our consideration of the water quality issues arising from the applications.

Bed of Lakes and Rivers - Chapter 6

7.67 A further chapter of the NRRP that is relevant to the applications is Chapter 6, which relates to activities within the beds of lakes and rivers. It is clearly stated in the NRRP that the provisions Chapter 6 applies to all works, structures, and activities in the bed of rivers and lakes in the Waitaki catchment.

7.68 The provisions of this chapter are particularly important in relation to applications to disturb the bed for the purpose of installing intake structures and pipelines in or under various water bodies. Rules BLR 2, 4, 6 and 7 impose conditions and consent requirements for these activities.

7.69 In relation to objectives and policies, there is only one objective in Chapter 6 (Objective BLR1) and two associated policies (Policies BLR1 and BLR2). These provisions generally cover the same types of issues as addressed by the WCWARP, along with specific mention of the risk of flooding, erosion and bank stability. The relevant rules, objectives and policies are discussed further in our Part B decisions as appropriate.

Other issues

7.70 In addition to the above, Chapters 2 and 7 contain provisions relating to Ngāi Tahu and Wetlands respectively which have been considered and referred to as necessary.

7.71 Chapter 2 does not contain objectives, policies or rules and is intended to help inform interpretation of the other chapters of the NRRP. Chapter 7 is a relatively short chapter that contains one objective, two policies and four rules that seek to protect the quality and quantity of wetlands within the Canterbury region.

Transitional Regional Plan

7.72 The TRP is relevant for determining the status of some activities, as discussed in detail under the part of our decision titled "Issues for Part B decisions". However given its age and content it is of little assistance is considering whether or not to grant the applications and has now been largely superseded by the NRRP. We have therefore not discussed the TRP is detail in our decisions.

District Plans

7.73 In addition to the regional plans, there is also the Waitaki, Waimate and Mackenzie District Plans to consider. Although consents are not being sought under these plans, they nonetheless remain as relevant plans that we are required to have regard to under s104(1)(b).

7.74 The main relevance of these plans is in relation to landscape issues that arise in the context of several applications. The district plans provide the context that helps to define the relative importance of the landscape in which the activity is proposed. For example, if an activity is located within an Outstanding Natural Landscape identified in a District Plan, this signals that we should carefully consider the potential landscape effects that would result from granting consent.

7.75 The issue of landscape and its relevance to these applications is discussed in more detail under the part of this decision headed "Landscape effects". We also provide specific comment on the relevant provisions from the district plans within our Part B decisions as appropriate.

Opportunity for further input

7.76 As is evident from the other discussion, there have been several changes to the planning instruments since the close of the hearing. In particular, the Proposed CRPS has been released and the Freshwater NPS and NRRP have been made operative. We therefore considered whether it was appropriate to provide applicants and submitters with an opportunity for further comment on these provisions.

7.77 Our conclusion was that further comment from the parties was not necessary in the circumstances. The key reason for this is that none of the new documents fundamentally alter our decisions whether or not to grant consent to particular applications. Furthermore, the new documents do not introduce any new considerations or issues that are not already covered by other planning instruments and /or were foreshadowed at the hearing.

7.78 The most significant new document is the NRRP, however the potential for changes to this document were discussed at length during the hearing, including the amendments proposed by the reporting officers for the PNRRP. As such all parties were aware that this document was likely to change and had the opportunity to comment on the likely changes, many of which are now reflected in the operative NRRP. The similarities and differences between the PNRRP and the NRRP are discussed further above.

7.79 In relation to the Freshwater NPS and the Proposed CRPS, these documents are consistent with and emphasise the key themes from other regional planning instruments. We therefore consider that nothing would have been gained by providing an opportunity for further comment on these documents. It would simply have created further delay in the release of decisions for no meaningful benefit.

Key conclusions from planning instruments

7.80 Based on all of the above, there are some key conclusions we can draw from the range of planning instruments that we are required to consider.

7.81 Overall we consider that the WCWARP is the key planning instrument, particularly for applications to take and use water. Some of the core considerations under this plan are the

amount of water being taken, the efficiency of the use of water, and the implications of the use on water quality, including the associated ecological and cultural values.

7.82 The WCWARP must be read in combination with the other relevant planning documents, particularly the NRRP. The NRRP contains rules that apply to discharge permits and applications for structures in the beds of lakes and rivers. It also contains a range of objectives and policies covering a wide range of relevant issues. The general approach we have adopted is to only consider those provisions where they are consistent with the WCWARP and add something new that is helpful to our consideration. Examples of such issues are in relation to landscape, erosion and flooding, and the updated water quality objectives.

7.83 The above regional plans are consistent with the applicable higher order documents including the proposed and operative regional policy statements and various national policy documents on discrete issues. As above, our Part B decisions only refer to these documents where they provide guidance and assistance over and above that provided by the relevant regional plans. In addition, the district plans provide some helpful context for consideration of landscape issues.

7.84 With this context in mind, we now turn to our consideration of the key catchment-wide issues arising from the applications, including cumulative water quality effects, landscape effects and effects on cultural values.

8 HYDROLOGY AND GEOHYDROLOGY

Introduction

8.1 The main potential for adverse environmental effects resulting from the granting of the applications before us is the enrichment of surface waters due to leaching of nutrients (nitrogen and phosphorus) from the irrigated pasture surface through to groundwater, and thence to streams, rivers, and lakes. Nutrient losses from irrigated pasture will be greater than those of dryland pasture principally because of the increase in stocking rate brought about by the increase in fertility (organic matter, soil nutrient status,, pasture composition) associated with irrigated pasture, together with greater potential for transport of nutrients beyond the rooting zone.

8.2 As water is the means by which nutrients are transported from the farm to waterways and lakes, understanding the hydrology and geohydrology of the upper catchment is an essential prerequisite to making reasonable predictions of the nitrogen and phosphorus concentrations and loads to various receiving waters.

8.3 MWRL have outlined their understanding of hydrological processes in the Upper Waitaki catchment in various parts of the WQS; particularly the 'Rivers and Lakes Report, and the 'Groundwater Report'. Indeed the model that underpins the WQS incorporates MWRL's understanding of sources of water, the partitioning of that water into surface water and groundwaters, and the routing of water down through the catchment to Lake Benmore and the Lower Waitaki.

8.4 A suite of reports were prepared by GHD for Russell McVeagh on behalf of MWRL relating to the "*Cumulative Water Quality Effects of Nutrients from Agricultural Intensification in the Upper Waitaki Catchment*". Mr Whata submitted the suite to the hearing panel, as Mackenzie Water Research Limited was not an applicant. The "Rivers and Lakes Report" and the "*Groundwater Report*" which contain information on surface water hydrology and groundwater were part of that suite.

8.5 The information presented in these two reports was complemented by evidence from MWRL experts.

8.6 The purpose of this section is to critique the surface water and groundwater hydrological evidence as it relates to the assessment of cumulative water quality effects. Thus we focus on:

(a) The surface water hydrology of streams and rivers in the Basin; particularly in relation to water quality monitoring to validate the WQS model,

(b) The assessment of the existing groundwater environment and the groundwater data that MWRL used in their assessment of cumulative effects,

(c) The prediction of groundwater flows, direction, lag times, and groundwater quality should the consents be granted

(d) The overall adequacy of the WQS from a hydrological and hydrogeological standpoint, as a foundation for prediction of existing and future nutrient loading to streams and lakes in the Upper Waitaki catchment.

8.7 We build on our analysis of this evidence in later sections on lakes, streams and rivers, and predicting nutrient loss from pastures.

8.8 We record here that a significant amount of surface water hydrology and groundwater hydrology relates to individual applications (or suites of applications) and is covered in full in decisions relating to those applications within the relevant Part B decisions.

Background – Upper Waitaki Hydrology and the Waitaki Power Scheme

8.9 The Waitaki River has the fourth largest flow of all New Zealand rivers. The ice and snow fed upper catchment has a strong seasonal inflow regime with summer peaks produced by heavy rain and snow/glacial melt, and lowest flows in the winter. That seasonal pattern of inflows is significantly modified by the storage capacities of Lakes Tekapo and Pūkaki as the discharges from those lakes are manipulated to meet the electricity demand of New Zealand.

8.10 For Lake Tekapo 65% of the inflows occur in the 6 months between October and March and only 35% between April and September. For Lake Pūkaki 71% of the inflows occur in the six months between November and April and only 29% between May and October.

8.11 The commissioning of Waitaki Power Scheme took place between 1935 and 1985 (50 years), although the most significant period of commissioning was 1965 to 1985 (20 years). A significant factor of the scheme is the control of Lake Tekapo (1951) and the raising of Lake Pūkaki in 1979 by the Pūkaki High Dam. These two features allow for the reduction of flood peaks in the lower catchment and the storage of inflows for redistribution over time. Because storage contained in Lakes Pūkaki and Tekapo is 57% of the national hydro-electricity storage it is a key element in New Zealand's power resource.

8.12 In addition, the three large glacial lakes (Lake Ōhau, Lake Pūkaki, and Lake Tekapo) dammed for water storage are hydraulically interconnected by a canal system for hydropower generation. There are also five other significant lakes namely Alexandrina, Ruataniwha, Benmore, Aviemore and Waitaki. The latter three are storage reservoirs created by the construction of dams to generate hydro electricity. Also the Tekapo River, Pūkaki River, Upper Ōhau River and Lower Ōhau River are the four sub-catchments of Lake Benmore that are hydrologically controlled by Meridian's consents for the operation of the Waitaki Power Scheme.

8.13 Flows in rivers are the result of complex natural processes, which operate on a catchment scale. Recharge to the whole system is largely dependent on climate. However, storage and discharge are controlled by a combination of catchment processes and human intervention. Discharge from Lake Benmore, which in itself has little storage, is carefully controlled to match the seasonal New Zealand electricity demand profile with its high winter and low summer demand.

8.14 Four major braided river systems (the Tekapo, Pūkaki, Ōhau and Ahuriri) cross the basin and feed into Lake Benmore. Of these only the Ahuriri follows its natural course. The other three rivers have been largely diverted into canals for the purpose of power generation.

8.15 The consents held by Meridian Energy for the operation of the power scheme do not require them to maintain a minimum flow in the Tekapo, Pūkaki, or Lower Ōhau rivers, or to provide flushing flows.

8.16 The Upper Waitaki Catchment covers an area of about 842,691 ha upstream of the Benmore Dam. Lake Benmore covers an area of 7,585 ha and is about 90 m deep. Lake Aviemore is located downstream of Lake Benmore and upstream of Lake Waitaki. Lake Waitaki is located downstream of Lake Aviemore. Lake Waitaki is the smallest, oldest and furthest downstream of the three manmade lakes of the Waitaki Valley Hydroelectric Scheme. The Upper Waitaki Catchment annual rainfall ranges from about 400 mm/yr to 10,000 mm/yr from south to north of the catchment. For the catchment as a whole the mean annual rainfall is 1,730 mm/yr.

8.17 With the current hydro electricity development, the Upper Waitaki Catchment can hydrologically be divided into two parts of approximately equal area, one part directly draining to Lake Benmore, while the other part drains to the glacial lakes, which then drain to Lake Benmore via the canals.

8.18 Surface runoff from the upper catchment enters Lake Benmore through two major waterways the Ahuriri Arm and the Haldon (Northern) Arm. The Ahuriri Arm of Lake Benmore directly drains a catchment area of approximately 20% of the total catchment area. The Haldon Arm of Lake Benmore directly drains approximately a further 30% of the catchment area. In addition, the Haldon Arm of the lake drains the remaining 50% of the catchment through an artificially made hydropower canal system.

8.19 The large variation in rainfall in the catchment results in the Ahuriri Arm receiving approximately 11% of the total inflow to Lake Benmore, whereas the Haldon Arm receives approximately 15% of the total inflow from the direct draining area and 74% of the lake's total inflow from the canal system.

8.20 The upper catchment hydrology is dominated by very high rainfall on the main divide, which falls off very rapidly with distance to the East. However the rivers and streams in the area are in the main separated from their headwaters by the glacial lakes. The flow in the canals feeding Lake Benmore is controlled to meet electricity demand. The other streams and rivers can have low flow variability with long periods of stable flow similar to spring fed streams. The only undammed river feeding Lake Benmore is the Ahuriri, which is approximately 11% of the Benmore inflow.

Is the understanding of surface water hydrology in the WQS adequate – particularly in relation to calibrating and validating the WQS?

8.21 The MWRL Rivers and Lakes Report presented material on rainfall distribution and potential evapotranspiration within the Upper Waitaki Catchment, a mass balance for the catchment, mean flows for key tributaries, FRE3 (average number of flood events per year greater than 3 times the median flow) and gains and losses within streams and rivers. The report adopts a node system to partition the Upper Waitaki Catchment for hydrological analysis.

Applicants View

8.22 Dr Bright said that inflows from Lake Tekapo, Pūkaki and Ōhau were the measured average annual canal flows over the period 1996-2007, plus measured spill flows from Lake Ōhau. Data on other spill flows was not available and had to be estimated. The unavailability of data on all measured water inputs from the Lakes, and the lack of data at sub-catchment level that was suitable for validating the flow models meant that no direct model validation was possible. He believed however the model of the system as a whole was able to be calibrated successfully to measured average annual flow past Benmore Dam over the period 1996-2007. Consequently he believed the data provided by the model was robust.

8.23 Dr Bright has a PhD in agricultural engineering from University of Canterbury and is the Managing Director of Aqualinc Ltd, a respected consultancy company based in Christchurch and Hamilton. Dr Bright led the Canterbury Groundwater model, which has been used by

ECAN and resource consent applicants to obtain a better understanding of Canterbury's groundwater system. Dr Bright's CV indicates that his principal expertise is in the area of groundwater allocation and irrigation efficiency; and we give his evidence significant weight in this area but somewhat less weight in the area of surface water hydrology.

8.24 Dr Mzila told us that mean flows and low flows for the nodes were derived from NIWA database using TIDEDA. However, the NIWA database did not contain all current flow data. GHD updated flow data to include current flow data from ECan and also spot gauged data. He said that at locations or nodes with no adequate information, GHD applied single and multiple regression analysis to estimate mean and mean annual low flows (MALF). However, stream correlations are generally poor within the basin. In areas with no data or inadequate information, stream gains and losses including mean and base flows where estimated using the model Visual MODFLOW, with stream functions and ZONE budget modules.

8.25 Dr Mzila has a BSc. MSc in Environmental Engineering from South Africa, an MSc in Engineering Hydrology from the Russian State Hydrometerological University, and a PhD in Civil and Environmental Engineering from Nanyang Technological University in Singapore. He has a very good mathematical background and the topic of his PhD thesis concerned irrigating treated wastewater on reclaimed land. According to his evidence he has published over 40 conference and journal papers on in the fields of environmental engineering, ground water flow and contaminant transport. However we were only able to locate 5 of relevance to this project (from his PhD project), with only one as senior author. His work since being in New Zealand has concentrated on irrigation of treated wastewater and he has also completed a couple of projects on surface/groundwater interactions using Visual MODFLOW. From his background and experience we conclude that he is a competent hydraulic modeller but we can find nothing in his background to suggest that he has particular expertise in surface water hydrology, water quality modelling or of managing and analysing water quality data.

8.26 Dr Mzila said a dynamic model was applied to route the flows from the foot of the highlands through the sub-catchments to Lake Benmore by considering gains and losses within the sub catchments. The routed flows were then compared to the calculated values. The derived mean and low flows were compared to catchment specific yield for the basin to verify consistency, as this was the most plausible technique when data was inadequate.

Submitters' View

8.27 Dr Griffiths commented on the nodal network proposed by MWRL (Figure 2, Rivers and Lakes Report) saying that while conceptually it was fine, it partitioned the catchment differently from that used in previous work by Mr Freestone and Mr Henderson during the Waitaki Allocation Board (WAB) hearings. This meant that the ability to compare flow values at various locations with those estimated previously is severely limited. Dr Griffiths made the point that Mr Freestone's and Mr Henderson's hydrological analyses were robust and based on many years of data and that by changing the locations of analysis points made it extremely difficult to verify whether a mass balance had been achieved.

8.28 Dr Griffiths has a PhD in Civil Engineering from Canterbury University. He is vastly experienced having worked as an engineer and/or scientist for Ministry of Works and Development, North Canterbury Catchment Board, ECAN (11 years) and now NIWA. He has been a reviewer for a number of international journals including, the Journal of Hydrology (Amsterdam), Journal of Hydraulic Engineering and Water Resources Research for nearly 35 years. A search of Google Scholar showed that Dr Griffith has published extensively on hydrology and sediment transport in peer-reviewed international scientific journals from the 1980's through to the present day. Where his research had a geographical focus, it was mainly on rivers in the Canterbury Region. We therefore place a lot of weight on Dr Griffith's evidence related to hydrology and sediment transport.

8.29 Dr Griffiths said it was implied in Section 5.3 (p. 34 et seq.), from the description of the nutrient sampling programme and no mention of flows other than the mean flows, that nutrient loads at a site for both nitrogen and phosphorus were calculated by simply multiplying mean flow by mean concentration. He said this was a rudimentary and unreliable approach and was a fundamental error with potentially large consequences for

the reliability of nutrient loads. He pointed out that the relationships between nitrogen concentration and flow, and phosphorus concentration and flow, are non-linear so that simply multiplying mean values together gives biased estimates of loads. To avoid the introduction of significant error as a consequence of this rudimentary approach, an attempt should have been made to establish a rating between nitrogen and phosphorus concentrations and flow at key sites; and to integrate that rating over the flow record in order to compute the load for the period of flow record. The ratings are also needed to predict concentrations at values other than the mean flows.

8.30 In addition, Dr Griffiths criticised the absence of error reporting in any of the GHD hydrological analyses. He said because estimates are given, it was essential to have a measure of how reliable they are likely to be through the provision of standard errors.

8.31 Dr Griffiths also said that because of the lack of information on data and methodology he was unable to confirm whether the entire mass balance for Lake Benmore has been computed correctly. A number of estimates provided in the Report vary, in places markedly, from earlier work. He said that more detail needed to be provided about how values of mean annual flows and volumes were arrived at together with estimates of errors and the reference period for the mass balance before those values can be accepted with confidence.

8.32 He said that the method used to calculate total nutrient loads of nitrogen and phosphorus delivered to Lake Benmore is flawed. The unreliability of the load estimates is further increased by uncertainty about mean annual flows and volumes. Further sampling of nitrogen and phosphorus concentrations at key sites was required to allow robust estimation of both concentrations in rivers and canals and nutrient loads. Consequently, conclusions based on load values given in the report should be regarded as speculative.

Section 42A Officers View

8.33 Mr Heller considered that an accurate assessment of cumulative water quality impact of irrigation development on specific surface water nodes should have been undertaken at mean annual low flow (MALF) to better represent critical stream flows.

8.34 Mr Heller is Director of Environmental Associates Limited, a private environmental consultancy based in Dunedin. He holds the qualifications of New Zealand Certificate in Engineering (Civil), a National Diploma of Science majoring in surface water and groundwater resources, a Certificate in Management from the New Zealand Institute of Management and a Masters Degree in Environmental Science completed with first class honours from the University of Otago. Mr Heller has over 25 years' experience working in surface water and groundwater resource evaluation, both as a consultant (Environmental Associates, Beca, SKM) and as a council officer (Otago Regional Council). He has been involved with groundwater and surface water policy development for the Regional Plan: Water for Otago, the Proposed Regional Freshwater Plan for Southland and the Proposed Natural Resources Regional Plan for Canterbury, and he has served as an Independent commissioner on consent applications relating to groundwater and surface water takes for Environment Canterbury

8.35 Furthermore, an appropriate proportion of the N load from groundwater inputs should also have been considered, to provide for critical comparison to resultant N concentrations in rivers and streams. At MALF it is also expected that surface waters will become more reflective of groundwater quality, which is likely to provide for increased concentrations of N in waterways.

8.36 Mr Heller said that on the basis of providing an assessment of water quality effects of irrigation development in the upper Waitaki catchment, the overall methodology employed by the applicants' consultants in respect of a regional mass balance assessment appears in general terms of water flow, to be reasonably reflective of an average catchment outflow condition. He was not satisfied that individual sub-catchment water balance components are accurately reflected and he was unable to identify (based on information provided within GHD reports) critical groundwater inputs, imports and outputs within each sub-catchment.

8.37 No assessment had been made to determine cumulative effects upon surface water quality at river nodes or specific stream reaches (or Lake Benmore) for low flow conditions. This is due to the current assessment being based upon mean flow and thus not being representative of a low flow condition e.g. MALF. However, on the basis of mean flow, the current sub-catchment mass balances are unable to be accurately quantified due to inconsistencies in some sub-catchment definitions and that insufficient data reporting does not enable a useful audit of the results to be undertaken.

8.38 He said that by considering just the mean flow condition, the applicants' consultants have not assessed any variability in groundwater N inputs, surface water N and P variation, and the effects of resultant stream nutrient concentrations during low flow periods.

Applicant's rebuttal

8.39 Dr Mzila in reply said that the procedures for load estimation were discussed at the caucusing meetings on 16th and 28th October 2009 and it was agreed that the procedures were appropriate considering that there is not a strong relationship between flow and nitrate-N concentration. Data and analysis of nutrient concentrations versus flows were circulated on 28th October 2009. However, there were several more data on measured concentrations but without concurrent flow data. An understanding of flow versus stream concentrations was derived through the use of monthly rainfall values as discussed in his evidence.

Our consideration of the issue

8.40 The hydrology of the Upper Waitaki Catchment is unusual in that much of the catchment has been modified to take advantage of the large volume of natural storage. The seasonal flow regimes of the canals carrying water used for hydro electricity generation is very different to the flow regimes of streams and rivers that drain directly to Lake Benmore. There will also be more extended periods of stable flow in streams modified for hydro generation than direct draining rivers and streams.

8.41 We agree that the nodal network proposed to monitor nutrient movement in the catchment has merit, but concur with Dr Griffiths that it is handicapped by the partitioning of the Upper Waitaki Catchment based on the location of the nodes at sites which have not previously used for hydrological recording. This is not an insurmountable handicap but the applicants have not provided sufficient information whereby an auditor of the hydrological analyses carried out (Dr Griffiths in this case) can readily confirm that the analyses are robust. The absence of long-term continuous records at the nodal sites precludes the generation of hydrological statistics, which makes it difficult to check the flows calculated at those sites with existing long term records from other sites in the catchment.

8.42 The lack of site data was acknowledged by Dr Mzila #42-49. For an unspecified number of catchments where there was no flow data single or multiple regression techniques were used to get correlations with other streams where there was data. However as the other hydrologists reporting on individual applications also found, stream correlations are generally poor within the basin. Of greater concern is that no standard errors were attributed to the data obtained from the use of those techniques so it is not possible to assess what confidence can be placed on such data.

8.43 The choice of the parameters used in some correlations is a matter of some concern. The use of the mean flow for defining nutrient concentrations and loads appears to be based on a poorly defined relationship between monthly rainfall values and stream nitrate concentrations. Dr Mzila said at Wairepo there were only two concurrently measured flows and nutrient concentrations so they then used mean monthly rainfall to understand the flow/concentration relationship. However no evidence was presented that supported an acceptable relationship between flow and monthly mean rainfall.

8.44 We agree that using mean flow as the hydrological statistic from which to estimate load may be adequate for rivers and canals controlled by Meridian Energy, but we concur with Dr Griffiths that such an approach may also lead to large errors; especially in uncontrolled tributaries or major rivers such as the Ahuriri. In any case we are of the view that a sampling programme to establish loads with a prescribed degree of confidence needs to be

'designed' rather than simply using all available data collected by multiple agencies for different purposes. Using the latter approach is flawed because it is not possible to verify the integrity of the concentration data in all cases, and it is not possible to ensure that the samples were collected at the river stage that approximates the flow statistic being used in the computation of load. There are simple techniques available to estimate load with a prescribed level of confidence using grab sampling, but there is no evidence of such techniques being applied in this case.

8.45 Determining the location and quantum of gaining and losing reaches of streams requires a significant commitment of experienced hydrological fieldwork. There is no evidence that such work was undertaken for this report. At best it locates a number of reaches where flow gains or losses were recorded at times during limited field investigations. As was pointed out by Mr Callander, the gains and losses are not well defined.

What is the state of the existing groundwater environment and what is the data quality supporting that assessment?

8.46 Dr Bright, as part of the joint statement of evidence with Dr Melissa Robson, gave the initial evidence on the groundwater aspects of the study. Dr Robson's portion of that statement of evidence centred on Farm Environmental Management Plans. Dr Bright undertook a peer review role in terms of the preparation of the WQS.

Applicants View

8.47 Dr Bright's overview evidence included the following insights relevant to groundwater issues:

(a) The study suggested that convenient access to a potable water source is the sole groundwater use that may be degraded by an increase in N concentration due to land-use change.

(b) However, because of the interchange between the groundwater resource and surface water bodies over gaining and losing reaches the visual appearance of the surface water bodies could be adversely affected if periphyton biomass increases significantly, due to the groundwater increasing N and P concentrations within the surface water body.

(c) The contributing areas for the 11 groundwater node points were primarily defined by surface water sub-catchments. The contributing areas for groundwater and surface water node points therefore generally coincided. The node points typically represent the outlet from a sub-catchment.

(d) The nitrate-N concentration in groundwater in this area, under extensive pastoral farming, typically ranges up to 1 mg/L. The concentration threshold proposed by the WQS is 1 mg/L nitrate-N. The report says this threshold was proposed by the WQS because it was seen to correspond with the qualitative standard for groundwater described in the proposed NRRP.

(e) Dr Bright was not aware of any valued attribute that is intrinsic to the groundwater system in the Mackenzie basin that otherwise justified the use of this concentration limit.

8.48 For the purpose of the study Dr Mzila said that the Upper Waitaki Basin was divided into 10 sub-catchments. Within the study area there were 69 wells with recorded depth to groundwater, 52 with stratigraphy data and 37 with groundwater quality data. A relatively sparse distribution of wells with the greatest coverage being in the Chain Hills and Omārama sub-catchments with approximately 1 well per 3.5 km^2 and the lowest density 1 well per 119 km^2 in the Wairepo sub-catchment and two sub-catchments with no bores. The greatest coverage for wells with groundwater quality data is the Omārama subcatchment with 1 well in 8 km^2.

8.49 Dr Mzila also said that although the distribution of wells was sparse this database did allow development of an appropriate level of understanding of the flow directions and groundwater levels within the basin.

8.50 Dr Mzila presented a summary of groundwater quality availability (ECan data base) within the basin used in the groundwater report. His opinion was that the data was sufficient to provide a general understanding of groundwater quality in the basin. Wells with groundwater quality information are generally located in areas of intensive land use and would provide an indication of nutrient loads to groundwater within those areas.

8.51 Dr Bright told us that groundwater appears to be impacted by human influence in some areas, although the quality remains high.

8.52 The measured nitrate concentrations in 90 bores show that 98 % of bores monitored had groundwater nitrate N concentrations of below 1 mg/l. Below this concentration is categorised as 'unaffected' by Burden (1980), and also has been estimated to represent the top end of the range naturally occurring under extensive grazing of unimproved pastures (as stated in Policy WQL9 in the Proposed Canterbury Natural Resources Regional Plan). Two bores had groundwater concentrations above the national median of 1.3 mg/l nitrate-N.

8.53 Dr Bright said that in summary, model estimates of N concentration in groundwater are acceptably close to measured values. Where the model estimates differ significantly from measured values they tend to be over estimates and thus apply a degree of conservatism to this aspect of the WQS.

8.54 Dr Mzila (# 12-15) said that data on hydrogeological characteristics (aquifer transmissivity and hydraulic conductivity) were mainly derived through installation and aquifer tests of wells or piezometers contained in a Canterbury Regional Council database.

8.55 Bore/well logs were also studied to derive the hydrogeological parameters and groundwater flow directions estimated from information of depth to groundwater table. Dr Mzila said that this information was collected data on bores that had previously been installed in sub-catchments.

Submitters' View

8.56 Mr Callander (groundwater consultant to Meridian) said that in his view the critical issues for the groundwater assessment were the concentrations of nutrients in the groundwater, their effect on groundwater users and the contribution that groundwater flow makes to the nutrient content in the surface waterways. It is also relevant he said to consider the time it might take for nutrient migration through the groundwater resource as this information is important if a cap on nutrient loads is proposed as the ability to allocate nutrients loads amongst contributors requires an understanding of the existing nutrient loads coming into the system via surface or ground water flows.

8.57 Mr Callander holds a BSc in Geology from the University of Auckland and MSc (Earth Sciences) from the University of Waterloo (Canada). He is a member of the New Zealand Hydrological Society, Water NZ (formerly the New Zealand Water and Waste Association) and the USA based National Ground Water Association. He is a Director of Pattle Delamore Partners Limited, an environmental consulting firm specialising in groundwater resources. Previously Mr Callander had been employed for seven years by the Canterbury Regional Council (ECan) and its predecessor the North Canterbury Catchment Board. During this time, he was involved with the Regional Council's groundwater resource investigations and field trials. Between 1989 and 1991, he was in charge of ECAN's groundwater section. Mr Callander has been involved with the assessment of groundwater effects and aquifer management in alluvial gravel aquifers for most of his career. This has involved work for Regional Councils in their regulatory capacity and for consent applicants seeking to abstract and use water. He has been involved in the assessment of irrigation schemes and their impact on groundwater for a large number of schemes in Canterbury, which has included Environment Court hearings, and mediation for individual consent applications and Regional Plans involving groundwater issues related to irrigation activities. Mr

Callander is a very experienced and well-qualified practitioner and we have placed considerable weight on his evidence.

8.58 Mr Callander expressed concern about the assessment of the existing groundwater quality. He pointed out that on ECan's database the most frequently sampled wells have only three samples for nutrients, and there are only three wells with that number of samples. Therefore, there is very little information to reliably characterise the current groundwater situation. Having said that, he concurred that the measurements that have been made indicate the current nutrient concentrations are low.

8.59 Mr Callander noted that even the most efficient irrigation schemes would cause some increase in drainage and nutrients into the underlying groundwater. He also said that the relatively low nitrogen values in the groundwater was due to the small proportion of irrigated land that has impacted on groundwater to date and the dilution of soil drainage water that is achieved from the inflows of stream seepage and highland seepage. He also pointed out that the existing sample results (Appendix C of the MWRL Summary Report) indicated that dissolved reactive phosphorus is able to migrate into the groundwater system and is not fully absorbed by soils, which is a mechanism for phosphorus retention that is often assumed to prevent phosphorus entering groundwater. Therefore, many soils in the area are of such a stony nature that phosphorus is leached into the groundwater along with nitrogen.

8.60 Mr Callander pointed out that the accuracy of any groundwater assessment is typically judged by its ability to explain, and be consistent with, existing groundwater data. In the case of the Upper Waitaki Catchment, Mr Callander said there was unfortunately an absence of groundwater data and long term monitoring records. This was primarily because the strata does not represent a widespread highly permeable productive groundwater resource due to the relatively poor sorting of the sedimentary particles and as such there have not been a large number of groundwater abstraction bores completed.

8.61 Furthermore, he said there appears to be no significant records of pumping tests to accurately determine aquifer parameters or long-term trends in groundwater levels and groundwater quality.

8.62 Mr Callander emphasised that there are relatively few wells within the study area and Appendix DD of the MWRL Summary Report shows an irregular distribution pattern, which results in a poor characterisation of the existing groundwater system. Mr Callander pointed out that this is acknowledged in the Groundwater Report, where at page 17 it states: *"… generally, borehole stratigraphy data is sparse in the catchment. No borehole data could be found for large areas in the Quail Burn, Hen Burn, Wairepo Creek or Willow Burn sub-catchments or northern parts of the Pūkaki sub-catchment"*. Furthermore, there appears to be no significant records of pumping tests to accurately determine aquifer parameters or long-term trends in groundwater levels and groundwater quality.

8.63 Mr Callander presented a table (his Table 7) on mass flows of phosphorus that could be attributed to groundwater sources (using MWRL's own data). This showed that for the Ahuriri Arm and for directly connected Haldon Arm catchments as much as a third of the phosphorus could enter Lake Benmore via groundwater sources. However despite recognising groundwater as a potential significant pathway for phosphorus there was no discussion or quantification of the pathway in the Groundwater Report. Similarly, the MWRL Summary Report does not account for any phosphorus migration in groundwater.

<u>S42A Officers' Views</u>

8.64 Mr Heller said that it appears that the majority of available climate, soils and environmental information has been utilised where possible within the assessments. However, it should be noted that there is little groundwater data and relatively recent surface water flow data for many individual waterways. Some further targeted monitoring data has been collected as part of the study.

8.65 Mr Hansen was unclear of the origin of the data reported by MWRL, however he said that is was consistent with ECAN's own data, which he said was based on 35 wells in the Upper Waitaki catchment.

8.66 Mr Carl Hansen is employed by the Canterbury Regional Council as a Groundwater Quality Scientist, a position he has held since 2001. Prior to that he was employed as a consulting groundwater scientist in Dunedin and in the USA. He holds a Bachelor of Science degree in geology from Syracuse University in New York, USA, and a Master of Science degree in geology from Dartmouth College in New Hampshire, USA. His work with the Canterbury Regional Council includes the design and management of projects to investigate, monitor, and report on the chemical and microbiological quality of groundwater in the region.

8.67 Mr Hansen was critical about the lack of information in the groundwater assessment to support the conclusions made. In particular, he said, the conclusions cannot be traced back to the raw data. Calculations are described only in general terms, and it was not possible to evaluate the details of the methods used to calculate critical parameters including groundwater flow rates and nutrient loadings to groundwater.

Our consideration of the issue

8.68 The study was hampered by the shortage of good quality groundwater data and long term monitoring records. This was primarily because the strata does not represent a widespread highly permeable productive groundwater resource due to the relatively poor sorting of the sedimentary particles and as such there have not been a large number of groundwater abstraction bores completed. Nor are there significant records of pumping tests to accurately determine aquifer parameters or long-term trends in groundwater levels and groundwater quality.

8.69 The use of parameters derived from data on the Canterbury Regional Council's wells database without checking the quality of that data (Dr Mzila confirmed with the hearing panel that the quality of the data had not been scrutinized) is a concern. Using data collected for a different purpose and from an external source without scrutinizing it is certain to lead to misinterpretation and errors.

8.70 There are few production bores in the basin, the great majority of the wells are domestic or stock drinking bores which generally are 150mm or less in diameter and drilled to the shallowest available water. Development of these bores is quite often limited because the proposed abstraction rates are generally low. The bore diameter and the method of drilling will also influence the quality of the stratigraphy data supplied by the driller.

8.71 We accept the MWRL evidence that the existing quality of groundwater in the Mackenzie Basin is very high, with recorded nitrate-nitrogen concentrations being mainly < 1 mg/L. However we say this with the following caveats:

(a) The database upon which the assessment has been made (mainly ECAN data) is very patchy, with most observations around the Twizel-Omārama region. Some subcatchments in which irrigation is proposed have no representative wells, and there have been few samples taken from those wells adjacent to existing irrigation areas from which to establish concentrations are increasing with time,

(b) There have been no systematic measurements or modelling of dissolved phosphorus despite there being some evidence that phosphorus is relatively mobile through these shallow stony soils,

(c) The location of groundwater wells has not been 'designed' with monitoring of groundwater nutrient concentrations in mind. Hence there is a significant risk that monitoring sites are not capturing effects of existing irrigation, and/or that elevated N levels have yet to be detected through lag effects. Indeed Dr Bright alluded to this possibility in his discussion of why the WQS predicted higher N concentrations at the Wairepo node than are currently detected.

8.72 We agree with Mr Callander that the geohydrological data needed to have confidence in groundwater flow directions and flow rates has not been collected to any substantive degree. In the absence of this information, the data necessary for the WQS to give confident predictions at a subcatchment level has been interpolated to a significant extent.

What is the predicted future groundwater quality if all consents are granted and how will it interact with surface waters?

8.73 Dr Bright submitted that the effects of granting the consents on groundwater per se were unlikely to be significant as potable water is the sole groundwater use that may be degraded by an increase in N concentration due to land-use change. However the interaction of nutrient-enriched groundwater (relative to the existing state) with surface waters could cause significant environmental effects. On that point Mr Callendar, Mr Heller and Mr Hansen largely agreed with Dr Bright and for the remainder of the hearing groundwater effects were clearly focussed on interaction with surface waters.

8.74 MWRL assessed the likely effects of granting the consents on lakes and rivers through the WQS model. The groundwater component of that model was embedded within the WQS, which is described in the reports tabled by Mr Whata and also briefly in Dr Bright's evidence. We do not intend to repeat that description in detail here, but rather focus on aspects of validation, assumptions, and data interpretation highlighted by submitters and s42A officers.

8.75 The WQS's overall approach to modelling nutrient concentration in groundwater, streams, rivers and lakes was to model the generation of stream flow, groundwater flow and nutrient loading on a sub-catchment basis and, starting with the most upstream sub-catchments, route the water and nutrients down through a sequence of sub-catchments to Lake Benmore.

8.76 The system was modelled as being in steady state and conveying the average annual water flow and nutrient load from the headwaters down to Lake Benmore.

8.77 Surface and groundwater flow was attributed to three distinct sources:

(a) Rain on the highlands of the sub-catchment – areas that are, and are expected to remain, essentially unaffected by land-use in terms of nutrients mobilised.

(b) Rain on the part of the sub-catchment that is subject to land-use change

(c) Inflows from other sub-catchments, such as canal, river, stream or groundwater flow.

8.78 Rain on the highlands was partitioned into water lost through evapotranspiration, water draining to regional groundwater, and stream flow. The methods used are the most practical option to use when there is a limited amount of measured flow data, as is the case here.

8.79 Rain on the Basins was partitioned into water lost through evapotranspiration and water draining below the root zone by using water balance modelling methods.

8.80 Inflows from Lake Tekapo, Pūkaki and Ōhau were the measured average annual canal flows over the period 1996-2007, plus measured spill flows from Lake Ōhau. Data on other spill flows was not available and had to be estimated. The unavailability of data on all measured water inputs from the Lakes, and the lack of data at sub-catchment level that was suitable for validating the flow models meant that no direct model validation was possible.

Applicant's View

8.81 The ability of the WQS to predict observed nitrate-N concentrations at nodes was viewed by the applicants as an indicator the model was producing sensible results. Dr Bright told us that model estimates were similar to the measurements obtained for the Greys River, Mary Burn and Hen Burn nodes. Observed N concentrations were higher than estimated for Stony River and Omārama Stream nodes, however, the estimated N concentrations were within the range of observed concentrations. Estimated N concentrations were approximately twice observed concentrations for the Wairepo Creek, Chain Hill and Twizel nodes, but within the observed range for the Twizel node. Where irrigation has only

recently started, such as the Wairepo Creek sub-catchment, the full impacts may not have yet been manifested in the measured groundwater quality. Dr Bright said that the modelling approach assumed that the full impacts were immediately apparent. Hence the modelling may be indicating the N concentration that will eventually be reached as a result of recent irrigation.

8.82 Dr Bright said that in summary, model estimates of N concentration in groundwater are acceptably close to measured values. Where the model estimates differ significantly from measured values they tend to be over estimates and thus apply a degree of conservatism to this aspect of the WQS.

8.83 The model was calibrated to the measured average annual flow past Benmore Dam over the period 1996-2007. Consequently Dr Bright believed the data provided by the model is robust.

8.84 Dr Mzila told us that a groundwater flow direction was determined using a numerical model Visual MODFLOW with an understanding of drainage and water surface features of the catchment. Groundwater flow directions were confirmed through groundwater level measurements and groundwater level model calibrations. Model simulated groundwater levels were calibrated against measured groundwater levels. A comparison between modelled and measured showed sufficient correlation to confirm their understanding of the groundwater flow directions.

8.85 Dr Mzila told us that groundwater within the basins is derived from three main sources:

(a) Highland flows;

(b) Infiltration of rainwater and irrigation water through the soils of the basin floor that directly overlie the unconsolidated sediments; and

(c) Seepage through drainage systems such as creeks, streams, rivers and lakes of the basin.

8.86 In the WQS, highland flows were partitioned to runoff and deep groundwater seepage based on measured streamflow at the bottom of the highlands. Where stream flow data was inadequate, flows were estimated using similarity analysis between highland catchments by way of specific discharge based on catchment yield.

8.87 Dr Mzila (#31-33) said that the interaction between stream flow and groundwater as the streams traverse the basins is based on a quasi-dynamic model that incorporates some statistical analysis.

8.88 The stream flow was initiated at the foot of the highlands and, where stream flow data was inadequate, flows were estimated using similarity analysis between highland catchments by way of specific discharge based on catchment yield.

8.89 Concurrently measured flow in different sections along the streams or creeks quantifies the amount of stream gain or loss.

Submitters' View

8.90 Mr Callander said that the groundwater flow calibration plot that compared measured water level values with the model output of estimated water level values showed a general pattern that looks reasonable at the scale of the plot which is very large. However many of the modelled water levels have errors of the order of 5 to 10 metres compared to the measured data set and therefore at a localised level it was not a very precise representation of the groundwater situation. Furthermore, the existing dataset is very sparse in many areas, which prevents any calibration match at all. This situation adds to the uncertainty of the groundwater assessment.

8.91 Mr Callander said that despite the simplifications of the steady state model, in reality the drainage of nutrients down to the underlying groundwater will vary throughout the year

and as a result there will be times when groundwater levels (and nutrient concentrations) are higher than what is predicted by a steady state model, and other times of the year when the concentrations are lower.

8.92 In Mr Callander's opinion the groundwater model should be viewed as providing a general indication of potential flow patterns within this area, however the quantification of these flows has a large degree of uncertainty associated with it. He said that this was a matter of concern particularly with regard to the partitioning of groundwater flow between shallow and deep pathways and quantification of the interaction of groundwater and surface water as it crosses the basins. In his opinion a large part of this uncertainty was due to the small number of bores, lack of monitoring data and aquifer tests to reliably represent the groundwater system and provide good calibration of the model.

8.93 Furthermore Mr Callander considered the MWRL groundwater assessment should have presented more discussion on the potential uncertainties that exist within their calculations of groundwater flows. He believed that the detailed reporting of a single set of groundwater flow components might create an unrealistic impression that the groundwater system is well defined and accurately quantified. In his opinion, that was not the case and the authors had presented only a broad-brush generalised concept of the groundwater flow system in this area. Therefore the conclusions that are drawn from the groundwater report cannot be confidently relied on.

8.94 Mr Callander said that highland runoff was calculated from empirical relationships that have been developed for the Canterbury Region. This runoff was apportioned between runoff into surface waterways and infiltration to groundwater based on calibration with infiltration and runoff generated from the stream flow at the base of the highland areas. The remainder of highland runoff and infiltration is assumed to enter the groundwater. That seemed to be a reasonable approach for dealing with highland flows, although it is a fairly broad-brush assessment.

8.95 Having said that, Mr Callander noted that the numbers presented in the Groundwater Report were not consistent with the explanation provided in the text. During caucusing Mr Callander was provided with a spreadsheet that matched the partitioning of the Highland precipitation by Dr Mzila who commented that the difference between the two sets of numbers is less than 6%. Mr Callander said that whilst that might be the case, his view, was that due to the absence of detailed field data this component of the water balance evaluation should be subject to a sensitivity analysis to indicate the potential range of groundwater recharge effects from the Highland areas. That level of more detailed assessment has not been carried out.

8.96 Mr Callander said that the interaction between stream flow and groundwater as the streams flow across the basins was poorly defined - in many instances simply due to a lack of detailed data. However, in broad terms, the general pattern that is presented, at a conceptual level, does not seem unreasonable. There is some uncertainty as to the exact pattern of this interaction due to a lack of detailed information. However in general terms, streams will gain water from groundwater in areas where the gravels become thinner and narrower due to rising basement rock. However, the quantification of the gains and losses are not well defined. Both the stream seepage losses to groundwater and the total groundwater flow estimate are unlikely to be well defined given the lack of available data and the apparent inconsistencies in soil infiltration estimates and highland recharge. As a result it is difficult to determine the accuracy of the total groundwater flow and the relativity of the different recharge sources.

8.97 Mr Callander said that the MWRL groundwater flow calibration plot compares measured water level values with the model output of estimated water level values. Whilst it shows a general pattern that looks reasonable the scale on the plot is very large. Because of the relatively large average errors in modelled water levels noted earlier, at a localised level it is not a very precise representation of the groundwater situation. Furthermore, the existing dataset is very sparse in many areas, which prevents any calibration match at all. This situation adds to the uncertainty of the groundwater assessment.

8.98 He also considered that it was also important to recognise that the groundwater flow model is a steady state model dealing with long-term average inflows and outflows. It

provides no information on seasonal or longer-term variations or the groundwater flow pattern. In reality the drainage of nutrients down to the underlying groundwater will vary throughout the year. As a result there will be times when groundwater levels (and nutrient concentrations) are higher than what is predicted by a steady state model, and other times of the year when the concentrations are lower.

8.99 Mr Callander tabled (his Table 4) calculations of replacement storage volume using MWRL's own data, which showed that in some catchments (e.g. Quail Burn, Willow Burn) it could take of the order of 15-24 years for groundwater throughflow to replace storage volume. Consequently it could be many years before the real effects of irrigation were detected in groundwater, and subsequently in surface waters. In reality, he said, there will be a wide range of travel times for drainage water to pass through the groundwater system and enter the surface waterways.

8.100 Consequently, in Mr Callander's opinion the groundwater model should be viewed as providing a general indication of potential flow patterns within this area, however the quantification of these flows has a large degree of uncertainty associated with it, particularly with regard to the partitioning of groundwater flow between shallow and deep pathways and quantification of the interaction of groundwater and surface water as it crosses the basins. A large part of this uncertainty is due to the absence of enough bores, monitoring data and aquifer tests to reliably represent the groundwater system and provide good calibration of the model. There is little discussion on the potential uncertainties that exist within their calculations of groundwater flows. The detailed reporting of a single set of groundwater flow components creates an unrealistic impression that the groundwater system is well defined and accurately quantified. In Mr Callander's opinion, that is not the case and we only have a broad-brush generalised concept of the groundwater flow system in this area. Therefore the conclusions that are drawn from the groundwater report cannot be confidently relied on.

8.101 Mr Potts said that the drainage rates look reasonable however the technical experts assisting Meridian considered the nitrogen leaching rates to be underestimated and the groundwater modelling lacked detail, culminating in the overall conclusion that they do not consider it has been robustly demonstrated that the predicted effects are accurate. He added that if further detailed information or clarification of assumptions could be provided, that conclusion may change.

8.102 Both Mr Potts and Mr Callander were critical of MWRL adopting a constant factor for denitrification of leached nitrogen where it passes through gley soils. Whilst this factor was applied after the prediction of leached N mass (OVERSEER) and is part of the GHD toolkit, we think it is more appropriately discussed in the section on predicting nutrient loss from soils below.

Section 42 A Officers' Views

8.103 Mr Heller said that the cumulative water quality assessment provided by the applicants' consultants are essentially the spreadsheet balances giving estimated N and P loads in surface waters (at nodes) and into Lake Benmore. This has been undertaken for a mean flow condition, albeit, recognising the limitations on the results as given within this and other evidence provided by the ECan auditing officers.

8.104 Mr Heller said that there appeared to be consistency with the Lake Benmore outflows for the total water balance. However as the majority of the inflow is contained within the Ōhau canal (about 75% of flow to the lake) there may be significant errors contained within individual sub-catchment flows whilst maintaining a reasonable overall water balance for the lake.

8.105 He also said that in general, there is an apparent lack of hydraulic parameter detail for model generation and output processes. This, he said, makes it inherently difficult to assess the adequacy of the model and to be able to assess individual sub-catchments with respect to groundwater flows and N fluxes. This was also apparent for model calibration and verification, whereby only a single set of observation data has been given to validate the model. The correlation, whilst showing that the model does behave similar to the piezometric data, the variation of modelled to measured levels is quite large at some

elevations (up to a 20 m difference). However, as stated previously, Mr Heller could not provide any further detailed audit of the models because of the inadequacy of reported model data.

8.106 Overall, the results given by the applicants' consultants for mass water and nutrient balances may provide for a broad assessment of regional water quality effects of irrigation development. However, Mr Heller was uncertain that the results are useful on a sub-catchment scale due to the deficiencies identified with respect to groundwater and surface water mixing, and that the relative nutrient inputs determined and reported are unable to be audited.

Applicant's rebuttal

8.107 Dr Mzila defended the inadequacies in groundwater information to reliably characterise groundwater flow conditions in the Mackenzie basin identified by Mr Callander. He told us that topographical and drainage features of the Mackenzie basin allows for the groundwater flow patterns to be well defined and that GHD established that isophreatic maps would reflect in an approximate way the general groundwater flow directions. He submitted that such investigations have great value in characterising hydrogeological conditions when there was little or no other information available to characterise the aquifer in sub catchments.

8.108 He discussed other criticisms made by Mr Callander commenting that many of these had been discussed and agreed in caucusing or other communications. We have noted Dr Mzila's rebuttal of these points. Similarly we have noted his rebuttal of points made by Dr Griffiths and Mr Heller.

Our consideration of the issue

8.109 We accept that that WQS will provide estimates of the likely rise in N concentrations due to at a large catchment. However largely because of the above shortcomings in data collection, our view is that its predictive ability at a subcatchment level is limited. We do not believe the data has been collected that will allow the WQS to predict the N concentration at any particular node with any certainty.

8.110 Whilst we accept that the catchment is large and it would be both expensive and time consuming to collect geohydrological data throughout the catchment. However we are of the view that there are certain critical areas where it is important to have more detail on the direction and partitioning of groundwater flow, where, for example there is a groundwater divide between a nutrient-sensitive catchment and one with a higher tolerance to nutrient leaching. Data that gave more certainty over groundwater travel times would have also been useful.

Key Conclusions on Hydrology and Geohydrology

8.111 The hydrological and groundwater assessment provides a useful conceptual understanding, but it does not provide a reliable verification of the distribution of nutrient concentrations in groundwater throughout the catchment and the pattern of emergence in surface waterways, other than a broad-brush average assessment of nutrients entering the waterways and Lake Benmore.

8.112 In our opinion the study in many respects merely presents a broad-brush assessment one would expect from a scoping study. It lacks the data, precision and clearly defined error limits on predictions, which would have provided a solid foundation for predictions of the effects of increased nutrient load on the sensitive streams, rivers and lakes that characterise the Mackenzie Basin.

9 EFFECTS ON LAKES

9.1 The 'outlet' of the Upper Waitaki catchment is the Benmore dam. Lake Benmore is therefore the ultimate receptacle for nutrients lost from dryland or irrigated pasture in the upper catchment before it passes to the Lower Waitaki River, and finally to the sea.

Significant increases in the nutrient concentration of lake waters will usually result in increased growth of phytoplankton, which affects both ecological and recreational values. Lake water quality is commonly classified by their trophic (degree of enrichment by phytoplankton) status.

9.2 The potential for Lake Benmore to be become more enriched should the consents be granted (due to the cumulative effects of irrigating pasture) was a major focus of the hearing. The principal issues arising were:

(a) what is an appropriate threshold of trophic state that should not be exceeded in the lake?

(b) how should it be measured?

(c) what is the current trophic state and does it vary in different parts of the lake; what is the current nutrient load entering the lake? And,

(d) what future load (if consents are granted) can the lake assimilate without causing the threshold to be breached?

9.3 The travel time (lag) from irrigated pasture to the lake also has a bearing on estimates of future load. Secondary issues related to localised effects near the Tekapo-Pūkaki and Ōhau River mouths (extent of mixing) with inflows from the Ōhau C Canal) and the extent of mixing and incursion between the waters of the Ahuriri and Haldon Arms of the lake.

What is a suitable threshold and how should it be measured?

9.4 The applicants recognized the current very low degree of enrichment in Lake Benmore and proposed that the oligotrophic state was a suitable threshold for the lake (Bright and Robson #6.33) based on the trophic level index (TLI) advanced by Burns et al. (1999). MWRL proposed that that the threshold should be set at 20% below the boundary for total nitrogen and 15 % below the boundary for total phosphorus.

9.5 Dr Coffey tabulated (Coffey, Table 3) how the trophic level of lakes affects ecosystem characteristics and usage values. This table is reproduced below as **Table 2** with the oligotrophic state characteristic highlighted.

9.6 Dr Coffey is the Director of Brian T. Coffey and Associates Limited, and its chief scientist. Dr Coffey was retained by GHD principally to assess the aquatic ecological implications of modelling work being undertaken by GHD to assess the current trophic status of surface and groundwaters in the Upper Waitaki catchment and to predict what the cumulative effect of changed nutrient loads to receiving waters would be as a result of changed land use if the proposed consents were granted. The main thrust of Dr Coffey's evidence related to periphyton in streams (Chapter 7) but he also introduced the work on the biological response of Lake Benmore.

9.7 Dr Coffey has a PhD in Botany from University of Auckland. He spent 18 years as a research scientist, mainly in MAF's Aquatic Weeds Division. A Google scholar search shows he has numerous publications (>20) on macrophytes (higher plants) in lakes, particularly lagorosiphon, egeria (oxygen weeds affecting hydro dam operations). However he has no publications on stream ecology and none on periphyton. Since becoming a consultant in 1988 (22 years experience) he has carried out numerous stream ecological assessments (Appendix 1 to his primary evidence), but (judging from the titles in his Appendix 1) only one previous assignment that dealt specifically with periphyton issues.

9.8 In terms of his 'expertise' we gave a lot of weight to his evidence on macrophytes in lakes, but rather less weight (in relation to other experts) on periphyton in streams, particularly their growth dynamics in relation to nutrient additions, and hydrological response. Our view was that Dr Coffey is a competent field biologist and that we should be able to accept his reports on what he has found in streams, but rather less on the reasons why, or quantitative analysis on distribution and the reasons for that distribution. Similarly we gave less weight (relative to other experts) on nutrient dynamics in lakes and the variables

leading to phytoplankton response. This is not to say that we do consider him expert in this field, but just as a matter of degree, other experts were more current and credible in this area.

9.9 It can be seen that using the above criteria, provided Lake Benmore stays in an oligotrophic state it will tick all the boxes in terms of 'low risk', 'healthy ecosystems' and 'high values'. However once trophic state exceeds the oligotrophic threshold (i.e. strays into the mesotrophic state) there is a moderate risk of visual phytoplankton, a green tint in the water being detectable, some risk of toxic algal blooms (from none), and the various biodiversity, recreation and amenity values dropping from high to simply good. As we proceed to still higher trophic states these characteristics and values decline further and once the lake reaches a eutrophic state it loses considerable value in terms of ecosystem, biodiversity, recreation and amenity.

Table 2. *Trophic Characteristics of Lake Types proposed by Burns et. al (1999) – reproduced from Coffey – Table 3.*

Parameter	Trophic Status of Lake						
	Ultramicrotrophic	Microtrophic	Oligotrophic	Mesotrophic	Eutrophic	Supertrophic	Hypertrophic
Water Clarity	Clear Visually appealing	Clear Visually appealing	Clear Visually appealing	Clear tending green (variable appeal	Turbid green visually unappealing	Turbid green visually unappealing	Turbid green visually unappealing
Visual Phyto-plankton	No risk of green colour	No risk of green colour	Very low risk of green colour	Moderate risk	High risk of sustained phytoplankton blooms	Sustained phytoplankton blooms	Sustained phytoplankton blooms
Periphyton on bed & margins	Low	Low moderate	Low moderate	Moderate	Low moderate	Low	Low
Macrophyte beds	Healthy	Healthy	Healthy	Increased Stress. Potential shift to phytoplankton dominated system	High risk of collapse. Likely phytoplankton dominated system	High risk of collapse. Likely phytoplankton dominated system	High risk of collapse. Likely phytoplankton dominated system
Toxic algal blooms	No risk	No risk	No risk	Some risk	High risk	High risk	High risk
Invertebrate & fish communities	Healthy	Healthy	Healthy	Increased productivity	Shifts in composition	Shifts in composition	Shifts in composition
Biodiversity Value	Moderate	High	High	Good	Compromised	Compromised	Compromised
Contact Recreation Value	Very High	Very High	High	Good	Poor	Poor	Poor
Amenity Value	Very High	Very High	High	Good	Poor	Poor	Poor
Nuisance growths to Hydro-generation	Very low risk	Very low risk	Low risk	Moderate risk	High risk	High risk	High risk

9.10 Scientists determine a lakes' trophic status by reference to a range of chemical, biological and physical parameters. For the TLI index used by the applicants, Burns et al. (1999) set out the range in these parameters that define a particular trophic state. This table is reproduced as **Table 3** below with the oligotrophic range highlighted. The TLI for a particular lake is calculated as the average of individual indices averaged over a year.

9.11 All parties to the hearing agreed that the threshold (if there was to be a threshold – see Dr Schallenbergs's evidence) TLI for Lake Benmore (both Haldon and Ahuriri Arms) should be set below the oligotrophic-mesotrophic boundary.

Applicants' View

9.12 Dr Gamage (GHD for MWRL) described the modifications he made to the Burns et al. (1999) method for estimating lake TLI (#16-25). The main modifications were simply using TN and TP rather than including secchi depth (water clarity) and chlorophyll a (index of plankton concentration. Gamage justified his methodology by including an analysis of North Island Lake TLI and showing that determining TLI using TN and TP alone gave just as good an estimate of TLI as using all four variables. In addition Gamage described how he believed the TLI estimate derived from summer-autumn analysis of TP and TN lake samples gave a robust estimate of annual TLI, whereas if he had included chlorophyll a, summer and autumn samples would have skewed the estimate of annual TLI upwards (because of higher productivity in the summer-autumn period). He also justified MWRL's sampling strategy (grab surface water samples) citing Burns et al.'s avoidance of "the thin turbid layer of detritus often present near the thermocline" (#23).

9.13 Dr Gamage has a PhD in Biological and Environmental Sciences from the Saitama University in Japan. This followed an MSc (1st Class honours) in Engineering Hydrology form the National University of Ireland in Galway, and a BE in Civil Engineering from Sri Lanka. The PhD in Biological and Environmental Sciences) implies that he is a biologist, and yet he had no previous (to his PhD) biological training. He appears to have published little in this field (only one referenced in his evidence on decomposition of water hyacinth) that would support him having limnological expertise. His background and publications lead us to conclude that he is an engineer/hydrologist who has done a PhD with a biological flavour. In addition his work on lakes (prior to the Benmore work) appears to have been restricted to shallow tropical lakes, which are totally different limnologically to deep temperate lakes. We have, therefore, placed some weight on his evidence relating to modelling, but little where it relates to biological response.

Table 3. *Indicators of lake trophic level using the TLI method (Burns et al., 1999)*

Lake type	Trophic level	Chlorophyll a (mg/m^3)	Secchi depth (m)	Total phosphorus (mg/m^3)	Total nitrogen (mg N /m^3)
Microtrophic	< 2.0	< 0.82	> 15	< 4.1	< 73
Oligotrophic	2.0 – 3.0	0.82 – 2.0	15 – 7.0	4.1 – 9.0	73 – 157
Mesotrophic	3.0 – 4.0	2.0 – 5.0	7.0 – 2.8	9.0 – 20	157-357
Eutrophic	4.0 – 5.0	5.0 – 12	2.8 -1.1	20 – 43	337-725
Supertrophic	5.0 – 6.0	12 – 31	1.1 – 0.4	43 – 96	725 – 1558
Hypertrophic	6.0 – 7.0	> 31	< 0.4	> 96	>1558

Submitters' views

9.14 Ms Sutherland for MEL (addendum #17) rejected Dr Gamage's method of using only TP and TN for TLI estimates, saying that only chlorophyll a provided an index of biological response to increased nutrients. Sutherland also said that while dropping secchi depth from the TLI estimates was acceptable in this case (because the glacial flour component in the Haldon Arm would mask any decline in water clarity due to algae), there was no precedent in New Zealand for not using chlorophyll a.

9.15 Ms Sutherland was also critical of the surface grab sample methods employed by Dr Gamage saying that in large oligotrophic lakes phytoplankton often aggregate into a layer known as the deep chlorophyll maximum. Ms Sutherland pointed out (#12) that the protocols developed for determining TLI specify sampling strategies which include

integrated depth sampling through the water column and that grab sampling (by failing to include the deep chlorophyll maximum) would underestimate TLI.

9.16 Ms Sutherland has a BSc, MSc (Hons) from the University of Canterbury specialising in plant and algal science. She has worked on NZ lake ecosystems for the past 11 years focusing on algal and macrophyte response to anthropogenic impacts and has worked on over 150 lake systems in New Zealand and Antarctica. A Google Scholar search substantiated her evidence that she had published 11 papers on the above topics as well as papers on the taxonomy and ecology of algae and freshwater macrophytes. Ms Sutherland has also authored or co-authored numerous client reports for NIWA on projects relating to lakes, water quality, and, macrophyte and algal growth in the Canterbury Region, including the Upper Waitaki catchment. We conclude that she is a competent mid-career scientist and well qualified to give expert evidence in the area outlined in her scope of evidence.

S42A officer's view

9.17 Dr Schallenberg (s42A officer addendum #11.12) stated that Dr Burns included four separate indicators in his TLI because none of them alone are sufficiently reliable. Schallenberg reported that the TLI protocol (Burns et al. 2000) shows that one can expect around ±1.0 TLI error when estimating TLI_{Chla} from measured TLI_{TN} or TLI_{TP}. In other words, while there is a good correlation between the components, there is substantial variation about the means. In addition Dr Schallenberg stated that Burns et al 2000 acknowledges the importance of variation in TLI (monthly variation, inter-annual variation, depth variation, variation among TLI components) whereas the applicant seems to argue that these types of variation are not relevant to establishing the current and predicted TLI of Lake Benmore.

9.18 Dr Schallenberg stated that while there appeared to be consensus amongst the parties that Lake Benmore should not be allowed to progress to a mesotrophic state as a result of the proposed irrigation, he had some concerns about the implications of arbitrarily setting the oligotrophic-mesotrophic boundary as a planning threshold.

9.19 Dr Schallenberg has spent the last 16 years at the University of Otago as a limnology research fellow in the Department of Zoology. In that time he studied around 70 lakes, from Northland to Campbell Island, but with the majority being in Otago. He has worked on Lake Dunstan, a hydroelectric reservoir in Otago that has some similarities to the Lake Benmore. A Google Scholar search showed that Dr Schallenberg has published more than 20 papers in peer-reviewed journals on South Island lakes with particularly emphasis on food webs, response to nutrients, eutrophication, and climate change. We have given Dr Schallenberg's evidence considerable weight. However we found his evidence on lake modelling to be more academic/less pragmatic than the other witnesses and for this reason we preferred the views of Dr Spigel and Dr Romero on this topic.

Applicants' Right of Reply

9.20 Dr Romero presented new TLI data collected by GHD in February 2010 in his right of reply evidence. This included TLI_{ChlorA} which, he concurred with Ms Sutherland, was necessary to represent the biological response within the TLI index.

9.21 Dr Romero also concurred with Ms Sutherland that the summer period was the most critical for determining TLI and provided recommendations for future monitoring frequency and timing.

9.22 Dr Romero is currently a Principal Marine and Aquatic Scientist for GHD Pty Ltd (GHD) in Perth, Australia. Dr Romero has a PhD in Biological Sciences from the University of California at Santa Barbara specialising in stratification, mixing and nutrient dynamics of a hypersaline lake. This followed an MSc in Environmental Engineering and a BSc in Civil Engineering from Stanford University. He has worked on a large number of lake projects specialising in the hydrodynamics, nutrient dynamics and water quality of lakes and reservoirs. He worked on the development of CAEDYM at the University of Western Australia (the water quality model used by NIWA for Benmore) and has worked with Bob Spigel (NIWA) and Professor David Hamilton (University of Waikato) whilst at UWA. He is

very well qualified in lake nutrient dynamics both as a consultant and a researcher. He has numerous publications on lakes and reservoirs including some in prestigious journals such as Limnology and Oceanography, and Ecological Modelling. In addition he has undertaken consultancy projects on lakes and coastal waters in many countries and on diverse aspects. We found Dr Romero to be a highly credible witness and we have given a lot of consideration to his evidence.

Our consideration of the issue

9.23 A central tenet of MWRL's case is that granting the consents will not result in a more than minor effect on the water quality and ecology of Lake Benmore. For the purposes of providing a definition of 'more than minor' MWRL have proposed that the average total phosphorus and total nitrogen concentration of the lake should be 15% and 20%, respectively below the oligotrophic-mesotrophic boundary (TLI < 2) as measured using the method published by Burns et al. (1999). Apart from some discussion about the appropriate period over which to measure an average TLI there was no disagreement from submitters or s42A officers as to the threshold itself. We note that in proposing this threshold it is implicit that there may be some deterioration in water quality down to that threshold.

9.24 The pNRRP had as objective WQL1.2 for high country lakes:

> "*(a) where the water quality is in a natural state, it is to be maintained in that state; and*
>
> *(b) where the water quality is not in a natural state, the water quality is to be maintained or improved so that:*
>
> *(i) it is suitable for contact recreation;*
>
> *(ii) it is suitable as a habitat for indigenous species and salmonids;*
>
> *(iii) it provides for Ngāi Tahu cultural values, including mahinga kai;*
>
> *(iv) the average annual phytoplankton biomass does not exceed five milligrams of chlorophyll a per cubic metre; and,*
>
> *(v) there is no conspicuous change to the visual clarity of the lake.* "

9.25 If this clause were adopted in the final NRRP then whether there was a case for allowing any degradation in existing water quality would centre on whether the lake was in a 'natural state'. We note that Mr Kyle argued that Lake Benmore (or any of the other hydro lakes could not be considered to be in such a state; which (if accepted) could lead to a more than minor environmental effect (all except subclause iv above being calling for a subjective assessment).

9.26 However the operative NRRP changed WQL1.2 by abandoning the distinction between high country lakes and other lakes, and rather distinguished between lakes within land administered for conservation purposes by the Department of Conservation (which should be maintained in a natural state), and lakes where the outcomes in Table WQL6 are being achieved (where the existing water quality should be maintained). In lakes where one or more of the outcomes in Table WQL6 are not being achieved the objective is to progressively improve the existing water quality. The outcomes listed in Table WQL6 would place Lake Benmore into the category of an artificial lake (on-river) with a TLI index <3 which means that it should be maintained in at least that state (i.e. no deterioration). This is consistent with the MWRL-selected threshold, which we accept as appropriate and, if not breached, will constitute a no more than minor effect relative to the current state.

9.27 Similarly MWRL have proposed the mesotrophic-eutrophic boundary as the threshold not to be exceeded for the Wairepo Arm of Lake Ruataniwha. Submitters or s42A officers have not contested the selection of this threshold and the same arguments apply with respect to the pNRRP. In addition, the final NRRP would categorise (Table WQL6 as 'Artificial lakes -

other' with a TLI <4, which is consistent with the MWRL-selected threshold. We therefore accept that this as an appropriate threshold that if not breached will constitute a no more than minor effect relative to the current state.

9.28 Dr Gamage (GHD) proposed to use a modification to the Burns et al (1999) method whereby only TP and TN would be measured rather than also including secchi depth and chlorophyll a. We agree with Ms Sutherland and Dr Schallenberg that chlorophyll a needs to be included in the TLI because it is the only indice that measures the biological effect that is being targeted. Total nitrogen and total phosphorus in lake water do not by themselves constitute an effect. It is only when that nitrogen and/or phosphorus is utilised by phytoplankton that the effect is manifest. Ms Sutherland and Dr Schallenberg convinced us that the correlations between nitrogen, phosphorus and chlorophyll a were not sufficiently strong that chlorophyll a could be removed from the indice without unacceptable errors, and it would constitute a major violation of the protocol proposed by Burns et al (1999). We note that Dr Romero (MWRL right of reply) agreed that chlorophyll a should be measured and included in the TLI. We accept that it is not appropriate to include secchi depth in the TLI for Lake Benmore because of the confounding (non-biological) effects caused by glacial flour.

9.29 During the course of the hearing the period over which average TLI should be defined and measured was modified from annual (but measured predominantly over the summer months) to 'summer TLI". We accept Ms Sutherland's argument that summer is when the lake is most used and also the period when 'breaches' of the oligotrophic boundary would be most likely. We do not accept Dr Romero's argument that January 1 through April 1 is the most appropriate period to define summer TLI for Lake Benmore because it is more likely to be hydrologically stable than a December 1-March 1 period. As will be discussed later, floods do provide a significant load of nutrients to lakes and the effect of that nutrient load needs to be taken into account. We also note that because of residence time considerations, nutrients delivered in December floods should not be manifest in the TLI until January in any case.

9.30 We accept Ms Sutherland's argument that the presence of a deep chlorophyll maximum (whereby algae can congregate below the epilimnion) is a real phenomenon in deep oligotrophic lakes and failure to sample this zone could underestimate the true biological effect of increased nutrient loading. We also accept Ms Sutherlands and Dr Schallenberg's argument that depth integrated sampling was specified in the TLI protocols because grab sampling is less reproducible and may underestimate TLI.

9.31 We conclude that an appropriate trophic threshold for Lake Benmore is 20% below the oligotrophic-mesotrophic boundary as assessed using the TLI method proposed by Burns et al (1999) excluding the secchi disk component of the index. The threshold should be the summer TLI (1 December-1 March) as measured using depth integrated sampling down to the deep chlorophyll maximum.

9.32 We conclude that the mesotrophic-eutrophic boundary as assessed using the TLI method proposed by Burns et al (1999) is an appropriate trophic threshold for the Wairepo Arm of Lake Ruataniwha. For consistency with Lake Benmore the same temporal and sampling protocols should apply.

What is the current trophic state of, and nutrient load to, Lake Benmore?

Applicants' view

9.33 Dr Gamage noted that the two arms of Lake Benmore (Ahuriri arm and Haldon arm) have markedly different characteristics and water quality and that therefore these two arms were treated as separate entities throughout the WQS.

9.34 Dr Gamage tabled GHD's assessment of TLI in the Ahuriri and Haldon Arms of Lake Benmore (Gamage, Table 5 and 6) and compared these estimates with those made by NIWA. He noted that GHD's assessment of TLI from sampling lake waters was much lower than NIWAs estimates (e.g. 2.0 (GHD) vs. 2.9 (NIWA) for the Ahuriri Arm) but that there was much closer agreement with the NIWA estimate when the GHD estimate was made using catchment loads (2.8 vs. 2.9).

9.35 Dr Gamage hypothesized that the lower GHD (lake) estimate may be due to their assumption of using half of the detection limit for the calculation of averages.

9.36 In answer to our questions Dr Gamage agreed that the data used to calculate TLI by GHD was that tabled in Appendices J and L of the Rivers and Lakes report. He also agreed that 10 of the 12 Lake Benmore samples taken in January 2008 (Appendix J) were less than the detection limit for TN stated by Hills laboratories to be 0.11 g/m^3, and 6 of the 12 were samples were below the TP detection limit of 0.004 g/m^3. Dr Gamage also confirmed that TN was not analysed on any of the twelve samples taken in April 2008 (Appendix L) and that a similar percentage (50%) of the samples analysed for TP were below detection limits.

9.37 Dr Gamage explained (#29) that he had examined the NIWA lake water quality data for 2009 and determined that 2 points in the dataset were outliers because they did not represent the average water quality of the lake isothermal layer. By removing these points the calculated TLI from NIWA data would be lower and much closer to the GHD estimates.

9.38 Dr Gamage attempted an assessment of GHDs proposed nutrient load (where scenario 1 is current load) with proposed nutrient load caps proposed by both GHD and NIWA. However as pointed out by Ms Sutherland (#84-85), the 'NIWA threshold' reported by Drs Bright and Robson of 173,000 kg of TN and 24,000 kg for TP, was in fact their estimate of current load. As it appears likely that Dr Gamage has perpetuated this assumption we have not considered his analysis further.

9.39 Dr Gamage dismissed the importance of including floods in an assessment of nutrient loads (#48) saying that "flooding can bring organic matter into the lake but these organic nutrients are not readily available for consumption".

Submitters' views

9.40 Ms Sutherland considered that the TLI estimates tabled by her were the most robust measures of TLI available to the panel because they are the only estimates that follow the protocols published by Burns et al (1999) when establishing the method. Ms Sutherland did not have the opportunity to comment on the 2009/10 TLI estimates presented by Dr Romero because his evidence was given as 'right of reply'.

9.41 Ms Sutherland (addendum #12-16, and Figure 2) defended the inclusion of data points considered 'outliers' by Dr Gamage for several reasons: (i) while they are departures from the median, 'spikes' in inflow loads are not such an uncommon event. Ms Sutherlands Figure 2 demonstrated the rainfall distribution by month (1984-2008) which showed high variability in rainfall; particularly in December-January, (ii) the NIWA sampling point in the Haldon Arm of Benmore was in the deepest part of the lake, some 35 days travel time from the inflow. Therefore one should not expect a direct correspondence between a runoff event and lake water quality in any case, (iii) the results were real data and were self-consistent, i.e. elevated P was accompanied by elevated N, therefore the results were unlikely to be analytical error.

9.42 Ms Sutherland highlighted the large discrepancy between the NIWA and GHD estimates of existing nutrient load both for the Ahuriri and Haldon Arms (#55 and Table 3). In percentage terms this difference was most acute for total phosphorus in the Ahuriri Arm where NIWA estimated more than double the annual load of the GHD estimate.

9.43 Ms Sutherland pointed out (#56-58) that one reason for the difference may be GHD's choice of sampling site (the nodes). Whereas the NIWA sampling site for the Ahuriri catchment was close to the lake, the GHD 'node' was some 5 km upstream. Samples taken from the GHD site would not include groundwater recharge of the Ahuriri River in the delta area. In addition there is a large amount of irrigation presently occurring downstream of the Ahuriri River sampling node which could also contribute to the P load. On 2 occasions when NIWA and GHD sampling occurred concurrently, the TP concentration at the river mouth (NIWA site) was 2-3 times higher than at the GHD site.

Section 42A Officer's Views

9.44 Dr Schallenberg (addendum #13) noted that the NIWA data reflect a summer TLI for the lake during 2008/2009, not an annual average as used in the Burns et al. (2000) protocol, but that nevertheless this was an appropriate season in which to determine a TLI.

9.45 Dr Schallenberg was critical of the GHD TLI estimates as presented by Dr Gamage because of methodological reasons outlined earlier. He noted NIWA's calculated TLI for the Ahuriri Arm was 2.9, which is almost at the oligotrophic - mesotrophic boundary (boundary = 3.0) ,which demonstrated there is no surplus nutrient assimilative capacity if the arm is to be maintained in an oligotrophic state with the applicant's stated aim of a 20% TN and 15% TP buffer. Ms Sutherland was also of the view that summer-time nutrient concentrations are already above the proposed WQS threshold, without accounting for lag effect from recent development (#77).

9.46 Dr Schallenberg documented changes in the dominant phytoplankton species in the Ahuriri Arm (addendum #14) from diatom-dominated in 1976-1979) to the green and cyanobacterial dominance reported by Ms Sutherland. In Dr Schallenberg's view this change in phytoplankton community structure is consistent with the type of response one would expect as a result of increased nutrient loading, which together with TLI estimate indicates the Ahuriri Arm is already exhibiting symptoms of increased nutrient loading and appears to be the verge of exceeding the oligo-mesotrophic threshold.

9.47 Dr Schallenberg was particularly critical of the lack of flood flow sampling by GHD (#9-14) because higher flows are known to deliver a much greater proportion of the total nutrient load (per unit of time) than occurs at baseflow. This is especially important in uncontrolled rivers systems such as the Ahuriri. As noted earlier, Dr Gamage was of the view that flood flows weren't significant because the organic nutrient entrained in floods was not biologically available to phytoplankton.

9.48 Dr Schallenberg was also concerned whether nutrient taken up by periphyton in streams (including the 25% allowable increase mooted by GHD) was accounted for in estimates of nutrient loading to the lake, stating (#10) that nutrient taken up by periphyton will eventually be dislodged during flood events, and though present in organic form would eventually be recycled in the lake environment. Dr Gamage argued (#45) that because this periphyton-absorbed nutrient had not been subtracted from the projected loads generated in the WQS they are therefore included.

9.49 Dr Schallenberg noted (addendum #21) that the NIWA estimate of existing nutrient load also has limitations including: 1) assuming nutrient concentrations are independent of flow, 2) assuming constant ratios of organic to inorganic nutrients at different loading scenarios, and 3) using a dataset consisting of only 6 samplings of the inflows between December 2008 and Feb. 2009. He concluded (addendum #22) that "As neither the GHD nor the NWA approaches accounted for variation in nutrient concentrations with discharge, neither of the estimates of the present nutrient loads to Lake Benmore (or the modelled loading scenarios) are convincing."

9.50 Dr Schallenberg was of the view that it is important to have robust estimates of the threshold loads that are deemed to define the lake's assimilative capacity, and that more data of the kind collected by NIWA are required so that nutrient loads can be more accurately modelled and accounted for.

Applicants' Right of Reply

9.51 Dr Romero in the MWRL right of reply, reviewed Dr Gamage's evidence and the points of disagreement with Ms Sutherland and Dr Schallenberg. He audited the TLI calculations of all parties and rather than exclude 'outliers' from the NIWA dataset as had been done by Dr Gamage, he analysed the data using a lognormal transformation. He explained that the advantage of estimating a mean using a lognormal transformation is that a few outliers do not unduly compromise a much larger frequency of similar measurements. Using this analysis he reported that the TLI on the Ahuriri arm was 2.8 compared to 2.9 reported by

Ms Sutherland. There was no change in Ms Sutherlands TLI estimate for the Haldon (Northern) Arm of 2.4.

9.52 Dr Romero also reported the TLI estimates obtained from their December 2009 and February 2010 samplings of Lake Benmore. These samples were analysed for TN, TP, and chlorophyll a using detection limits appropriate for an oligotrophic lake. The TLI estimates for the Ahuriri Arm were 2.4, and 2.3-2.5 for December and February, respectively, while those for the Haldon (Northern) Arm were 2.0 (December) and 2.6-2.7 (February). Dr Romero commented that few samples were taken from the Haldon Arm in February and hence this estimate has less certainty.

9.53 Dr Romero provided his analysis of the discrepancy between the NIWA and the GHD (2009/10) TLI estimates for the Ahuriri Arm (2.8 vs. 2.4) in particular. He noted that the calibrated NIWA model also produced a summer TLI of 2.4 for the Ahuriri Arm and hypothesized that the higher data-derived TLI estimate was due to high December flood flows in 2008. Dr Romero also told us that TP component of TLI in the December 2008 was much higher than in December 2009 when GHD sampled, which is consistent with a higher flood flow contribution from the uncontrolled Ahuriri River. As a result of this analysis Dr Romero recommended that future estimates of summer epilimnetic TLI be derived from data collected from January 1 – April 1 in order to minimise the effect of hydrologically-induced variability.

9.54 In the MWRL Right of Reply, Dr Romero overviewed the available river water quality datasets and established 'characteristic' annual river concentrations for TN and TP, and assessed the veracity of the nutrient load estimates from NIWA and MWRL.

9.55 He concluded that neither the GHD or NIWA estimates gave a robust estimate of loads from the Ahuriri and Tekapo Rivers during high flows and that a 'refinement' was necessary to provide such an estimate.

9.56 Dr Romero clearly does not agree with Dr Gamage's conclusion on the importance of floods as he recommended not including the month of December in compliance monitoring of summer TLI because of the risk of flood flows delivering elevated levels of phosphorus (particularly) which could also be reflected in chlorophyll a levels.

9.57 For the purposes of the audit Dr Romero assigned GHD-collected water quality samples with values less than the limit of detection (LOD) a value equal to the LOD. This contrasts with previous GHD witnesses (Gamage, Mzila, Bright and Robson) who assigned a value = 50% of the LOD. Romero thus took a more conservative approach with respect to estimating baseline load. He then 'pooled' all available data and using lognormal statistics he derived a 'characteristic N and P concentration' for all surface water inflows to Lake Benmore. 'Characteristic' in the sense used by Romero has no scientific or statistical meaning (in the way that mean annual concentration, or median concentration does): it simply means it is characteristic of the data collected. It is noteworthy that even combining data from all sources (GHD, NIWA, UWWQT, ECAN) Romero used a maximum 21 data points to produce a 'characteristic' N and P concentration (for the Ahuriri River) and that used data collected over several years.

9.58 Dr Romero then compared the GHD and NIWA water balances, and although he found them to be quite comparable he deferred to the NIWA water balance (2003-04); because this was used in the NIWA lake modelling. By multiplying the appropriate flow component with the characteristic N or P concentration he was able to estimate the annual N and P loads from the pooled dataset and compare this with the various estimates derived by GHD (2009) and NIWA (2009).

9.59 Using this approach Dr Romero concluded that GHD (2009) substantially underestimated the Ōhau C canal load and likely also underestimated loads from the Ahuriri River. By then assuming no losses between inflows and outflows he constructed a simple box model and compared the various inflow estimates (normalised to concentration) with the lognormal average of the three NIWA (2009) lake stations. He then compared the normalised inflow concentration estimates with that lake data using the criteria for the box model that inflow concentrations had to be a least at large as that of the lake. He concluded that the GHD (2009) dataset did not meet this criterion nor did the lognormal pooled dataset. However

the average pooled dataset (not logged) and NIWA (2009) estimates did meet the criteria and hence were the most trustworthy.

Our consideration of the issue

9.60 We agree with Ms Sutherland that the current trophic state of Lake Benmore determined by GHD in the Rivers and Lakes report, and presented by Dr Gamage is not valid. This is primarily because GHD chose an analytical method that had detection limits within the range of concentrations expected in the lake and they also did not analyse total N on half of the sampling occasions.

9.61 GHD used the accepted convention of ascribing a value 50% of detection limit for those samples that were below the detection limit. This convention is designed for datasets in which relatively few of the data are below the detection limit, not the majority of the data as in this case. When the majority of the data is less than detection limit, using that data to generate a metric that is subsequently used as the baseline from which permissible nutrient loads are calculated, is in our view, meaningless.

9.62 The violation of other protocols designed to ensure the integrity of the TLI (only taking surface grab samples, not including chlorophyll a, declaring an annual average TLI when samples did not reflect this time scale) are additional reasons for rejecting the MWRL assessment of TLI.

9.63 We agree with Ms Sutherland that her assessment of summer TLI is the most robust measure available to us because it largely follows the Burns et al (1999) protocols, and that departures from it (summer only, and minus secchi depth) are scientifically defensible. We accept Dr Schallenberg's observation that a summer TLI does not follow the protocol but that nevertheless is an appropriate period in which to determine TLI. We also agree with Ms Sutherland that the 'outliers' rejected by Dr Gamage are real data and should be incorporated within the TLI she calculated.

9.64 We agree with Ms Sutherland and Dr Schallenberg that her estimate of current TLI in the Ahuriri Arm (2.9) indicates there is no surplus nutrient assimilative capacity if the arm is to be maintained in an oligotrophic state with the applicant's aim of a 20% buffer (TLI < 2.75). We note that Dr Romero agrees with the substance of this conclusion (that there should be no additional nutrient loading to the Ahuriri Arm) even if he doesn't agree with the specific TLI measure.

9.65 We appreciated Dr Romero's thoughtful audit of TLI measurements to date. We accept his analysis using log transformed data to deal with 'outliers' that the TLI of the Ahuriri Arm estimated by Ms Sutherland might be as low as 2.8 (c.f. 2.9) and that the TLI for the Haldon Arm is unchanged at 2.4.

9.66 We accept the 2009/10 TLI estimates presented by Dr Romero in the MWRL right of reply though we record that the submitters and s42A officers have not had an opportunity to audit these estimates. That aside, the 2009/10 TLI estimates appear to be the only valid TLI estimates presented by MWRL on the current trophic state of Lake Benmore. If we also accept Ms Sutherlands premise that the ECAN estimates are also suspect (due to only taking grab samples) then we left with only two years of data.

9.67 We accept that there will be year to year variation in TLI due to natural variability and because of this it is necessary to have a long-term record from which to establish trends. The situation we face in assessing the current TLI in Lake Benmore may be contrasted with that of Lake Taupo (highlighted by Mr Whata), where there is more than thirty years of data from which to establish trends.

9.68 We agree with Dr Schallenberg that it is important to have robust estimates of the threshold loads that are deemed to define the lake's assimilative capacity. We are of the view that the MWRL load estimates presented by GHD fall well short of the standard that could be described as robust,

9.69 Fundamental reasons for our arriving at this conclusion are:

(a) A complete absence of sampling design to estimate a load with a prescribed confidence (answers to commissioners' questions – John Bright);

(b) Failure to acknowledge the importance of flood events in delivering a significant nutrient load to the lake and ensure representative sampling of such events (Gamage #48);

(c) inappropriate choice of detection limits for the environment resulting in a dataset containing an excessive number of results below the limit of detection and subsequent assignment of 50% of detection limit (table supplied by Brian Coffey in answer to Commissioners'' questions); and

(d) acceptance and use of data from a variety of sources without any apparent quality control checks (evidence of Bright and Robson and answers to questions from Commissioners).

9.70 We also agree with Ms Sutherland that the choice of sampling sites particularly on the Ahuriri River probably resulted in significant underestimation of the contribution from groundwater sources and also failed to include any contribution from existing irrigation downstream of the sampling point.

9.71 We agree with Dr Schallenberg that the estimate of existing nutrient load carried out by NIWA also has its limitations. The most serious of these, in our view, is that the dataset consisted of only 6 samplings of inflows between December 2008 and February 2009. We acknowledge that NIWA's purpose in taking these samples was not to provide a robust estimate of annual nutrient load but rather to calibrate the Lake Benmore model over the summer period. The load estimate was simply a by-product of this endeavour.

9.72 Despite the limited sampling regime, we have more confidence that the NIWA estimate of nutrient load is closer to the true estimate than the GHD estimate. It is a good illustration of what can be achieved with a relatively modest but well-designed sampling programme. However we agree with Dr Schallenberg's conclusion that for the purposes of providing a robust estimate of annual nutrient load, neither the GHD nor NIWA estimates are convincing.

9.73 We acknowledge Dr Romero's careful audit of current nutrient load estimates and the conclusions that he arrives at that support our own.

What are the predicted nutrient loads should consents be granted?

9.74 The prediction of future nutrient loads from irrigated pasture is at the heart of the MWRL case and is considered in detail elsewhere in this Decision. However, it is relevant at this stage to consider the gross nutrient loads predicted to occur should the consents be granted, and their impacts on the Lake Benmore ecosystem.

Applicants' views

9.75 Drs Bright and Robson tabulated a summary of results from the WQS (Table 10) which showed that for the Ahuriri Arm of Lake Benmore to remain Oligotrophic, nutrient losses must be reduced by 10.7 kg N and 1.1 kg P for every hectare of proposed or renewed irrigation in the catchments that drains to the Ahuriri Arm.

9.76 Dr Gamage did not explain in detail how the load threshold was arrived at but from his response to Dr Schallenberg's concerns (#48) on an "*oversimplified pressure-response approach and using annual means to predict lake responses*" together with his 'Comparison of proposed loads with NIWA and our estimates' (#37-43), it may be inferred that it is simply the estimated load delivered to the lake divided by the flow to give an in-lake concentration compared with oligotrophic-mesotrophic boundary concentration (see Table 2 above) times 0.8 (20% below) for N or 0.85 (15% below) for P.

Submitter's views

9.77 Ms Sutherland did not have confidence in the GHD approach to assessing critical nutrient loads, because, in her view, it is based on the misinterpretation of the TLI and its application. Ms Sutherland's view was that the simplistic approach of selecting a TLI then calculating the loads to achieve the in-lake nutrient concentrations is fundamentally flawed because it does not consider biological and geochemical processes that occur in the lake that influence nutrient levels.

9.78 Ms Sutherland introduced the NIWA Lake Benmore model (Norton et al., 2009) which was commissioned by Environment Canterbury to assist with assessments of nutrient loading. Ms Sutherland stated (#35) that the Lake Benmore model predicted phytoplankton blooms would develop in the Ahuriri Arm during summer with any increase in nutrient load, with the duration and extent of the bloom intensifying as nutrient concentrations increased. The model predicted that at 1.6 times the existing measured nutrient concentrations, chlorophyll a concentrations would reach mesotrophic levels in the Ahuriri Arm.

Independent report on Lake Benmore model - Section 41C report

9.79 Counsel for MEL alerted us to the potential importance of the NIWA Lake Benmore model in our deliberations. We read the report on the model prepared for Environment Canterbury (Norton et al, 2009) and agreed that it appeared to offer a more robust approach to assessing the effects of future nutrient loads on the lake, than had hitherto been presented to us. However because the report was not presented in evidence (other than the single paragraph referred to by Ms Sutherland above) we issued a minute (no 7) stating our intention to seek answers to a number of questions about the model from the chief modeller in the NIWA team, Dr Bob Spigel. The applicants raised no objection to us seeking this information and Dr Spigel duly reported to us and presented evidence on his report on 11 December 2009.

9.80 Dr Spigel is a senior scientist in the hydrodynamic group at NIWA Christchurch. His main area of expertise is hydrodynamics of lakes and lake modelling and he was the principal modeller for the Lake Benmore model. Dr Spigel has a PhD degree in Civil Engineering from the University of California, Berkeley, and an MSc degree in Civil Engineering from the University of Pennsylvania, Philadelphia, and an AB degree in history from Princeton University, New Jersey. Dr Spigel is a very experienced scientist having worked at NIWA for 11 years, and prior to that was a lecturer in Civil Engineering for 21 years where he taught courses and supervised post-graduate research in fluid mechanics, hydrology and hydraulic engineering. He has worked (sabbatical) at University of Western Australia where he helped develop CAEDYM (one of the models used in the Benmore study). A Google Scholar search showed Dr Spigel has published >20 papers on lake hydrodynamics including several in Limnology and Oceanography. He was the principal modeller in the coupled hydrodynamic-ecosystem study of Lake Taupo, used in the Environment Court decision on the nitrogen cap for that lake. Dr Spigel's section 41C report was very thorough, analytical, and transparent. We gave considerable weight to his evidence.

9.81 Dr Spigel informed us of the spectrum of models available for predicting trophic state from simple regression models (as with the TLI) to complex process process-oriented models that simulate the cycles of carbon, nitrogen, phosphorus, silicon and dissolved oxygen; phytoplankton and zooplankton dynamics. He noted that to his knowledge there have been no regression equations published that relate nutrient load in inflows to in-lake nutrient concentrations for New Zealand lakes. Further disadvantages of regression models is that their standard errors only relate to the lakes for which they were developed, not the lake to which they are being applied. In Dr Spigel's view they are of questionable value when used in situations that are outside the range of conditions from which their relations were derived.

9.82 Dr Spigel told us that monitoring data made it evident that a three-dimensional process modelling approach was necessary in order to take account of the complex shape of Lake Benmore, the distinctive character of its three main basins (Ahuriri Arm, Haldon Arm, Lower Benmore basin), and the possible interactions between these basins. The coupled models chosen by NIWA were ELCOM-CAEDYM, which were developed by the Centre of

Water Research, University of Western Australia, and have a long history of use and acceptance in similar applications.

9.83 Dr Spigel informed us that ELCOM was a three-dimensional hydrodynamic model and that because it is physically based on the conservation of mass, momentum and energy, it is generally free of calibration requirements. However CAEDYM is a biogeochemical model and has several parameters that must be adjusted in order to calibrate the model. Optimal calibration is dependent on the expertise and experience of the modeller with the calibration being done by trial and error until there was minimal improvement in the agreement between simulated variables and measurements. This trial and error approach by an expert modeller is commonly used to calibrate complex biogeochemical simulation models. In the Benmore case, Dr Spigel told us, the NIWA team were assisted by Professor David Hamilton; one of the original developers of CAEDYM.

9.84 Dr Spigel told us that NIWA's choice of the three-dimensional ELCOM model was justified by its ability to simulate the exchange of water between the Haldon and Ahuriri arms of the lake, caused mainly by differences in inflow temperatures, and their attendant density variations. Such exchange is important, Dr Spigel told us, because of the different apparent residence times of the arms as well as differences in nutrient concentrations. He showed us video animations of the water exchange under summer and winter conditions and noted that the simulated temperature and dissolved oxygen profiles agreed well with field observations.

9.85 In our 7th Minute we specifically asked Dr Spigel to address us on the errors in the modelling approach, and how this might affect our confidence in the predictions made by the model at different nutrient loading rates. We also asked for Dr Spigel's view on the adequacy of the input data used to calibrate and validate the model.

9.86 Dr Spigel's fulsome reply on the issue of errors (#77-96) considered errors from: (i) input data, (ii) model structure, and (iii) parameter estimation. Dr Spigel made the point that the model is well-accepted internationally and the structure of the model reflects contemporary scientific understanding of processes occurring in lakes. He conceded that the duration of the input dataset is short, and it would be better if a longer dataset were available. However, he did not think the data duration was so short as to invalidate the model results, and stated that the concentrations and variations predicted by model for summer conditions were realistic. Dr Spigel also said that one of the strengths of the model (the ability to simulate a number of interacting processes) was also one of its weaknesses in that the model required values for more than 100 parameters to be specified and not all of these can be assigned a priori.

9.87 Because of the complexity of the model, Dr Spigel's view was that the only realistic way to quantify errors is to compare modelled results with those measured in the lake. Because the model is three dimensional, modelled results are best compared with profiles.

9.88 Dr Spigel showed graphs which showed excellent agreement between modelled and measured temperature at all three sampling sites in Lake Benmore. The predicted profiles of dissolved oxygen were similarly good but the match between the measured chlorophyll-a and predicted profiles was not as close. Dr Spigel said this was not unexpected given similar findings in other model applications and the complexity of the processes involved. There were no measured profiles for TP and TN and only time series plots were available for comparison.

9.89 Dr Spigel expressed the differences between the modelled and measured values in terms of the root mean square (square root of the mean of the squared differences between modelled and measured values) or the normalised root mean square (normalised by the sample mean to give a percentage). The normalised root mean square differences for all except the deepest part of lake were in the range 1.4-4.7%, 3-7%, 28-30%, 28-67%, and 59-152% for temperature, dissolved oxygen, chlorophyll-a, total nitrogen and total phosphorus, respectively. This variation, Dr Spigel explained, is similar to that obtained in other lakes with much simpler bathymetries, and is also similar to the naturally observed variability in measured values.

9.90 NIWA used the Lake Benmore model to predict the likely response (in the Ahuriri Arm, Haldon Arm, and Lower Benmore basin) to increased nutrient loading. The averages of the TP and TN inflow values were multiplied by factors from 2 to 12, intended to span the range of possible increases from irrigation. Dr Spigel explained that variability, as predicted by the model, increases with increasing scenario load, both in absolute and relative terms. In answers to questions from the panel, Dr Spigel explained that the level of confidence we should place on the model decreases with increasing nutrient load. Thus while his confidence in model predictions is high in the area of interest to our deliberations (where it results in a change from the oligotrophic to mesotrophic state) this confidence decreases above a loading factor of about 6 times. This is more critical in the Ahuriri Arm than the Haldon Arm.

9.91 Ms Sutherland had previously told us that the Lake Benmore model showed that the Ahuriri Arm would reach mesotrophic conditions (as indicated by chlorophyll a) at 1.6 times the existing measured nutrient concentrations (not including nutrient run-off from current development yet to arrive at the lake).

9.92 Dr Spigel concluded: "I think the model performance is sufficiently good that, if I had to make decisions on issues relating to the possible responses of water quality in Lake Benmore to changes in nutrient loading, I would unhesitatingly base them on the results of our hydrodynamic-ecosystem modelling, rather than on predictions from any of the simpler models described at the start of this report (paragraphs 35-37)".

Section 42A Officer's view

9.93 Dr Schallenberg provided an independent review of the NIWA model and noted that the complexity of the model contrasts starkly with the simplified approach used by GHD to determine the responses of Lake Benmore to the nutrient loading. Many of his concerns (about the GHD approach) were addressed by the NIWA modelling; particularly as it included temporal resolution, hydraulic residence time, chlorophyll a and dissolved oxygen as response variables and a number of in-lake nutrient processes in the model.

9.94 However, Dr Schallenberg noted that the usefulness of model predictions were limited by the paucity of data used for its calibration and validation. He concluded that while temperature and dissolved oxygen were generally accurately modelled, the key response variables related to TLI (chlorophyll a, TP and TN) were rather poorly predicted by the model, with high normalised root mean square errors. This limited the usefulness of the model to extrapolate the effects of increasing nutrient load too far beyond the range for which it was calibrated. Nevertheless he agreed with the statement in Norton et al. (2009) that "…*the scenario results are…the best that could be expected given the available data*."

9.95 Dr Schallenberg's overall conclusions were that the NIWA model is an improvement over the GHD model in terms of incorporating realism into predictions of lake responses. He viewed it as a working hypothesis of how Lake Benmore functions ecologically, and a useful tool that may in future be useful for predicting lake responses to changes in nutrient loading if sufficient data are collected to support the model.

Applicants' Right of Reply

9.96 Dr Romero also reviewed the NIWA model and Dr Spigel's s41C report. He also commented on the extent to which one could apply the model outside of the calibration range saying that in his view, because of the limitations imposed by the limited calibration/validation data, he only considered the highest Nutrient Load Multiplier that first yields a mesotrophic state as reliable. For the Ahuriri Arm this multiplier was 2.0 whereas for the Haldon Arm it was 8-10.

9.97 Dr Romero agreed with both Dr Schallenberg and Dr Spigel that confidence in the model will be improved with further improvements in the nutrient load estimates; particularly if they better account for seasonal influences, floods, and groundwater concentrations. However based on his own analysis he believed that for TP at least the current nutrient load estimates (and model predictions) appeared reasonable.

9.98 Dr Romero disagreed with Dr Schallenberg's analysis that while the model can be utilised as a 'working hypothesis' of the ecological functioning of the reservoir but by implication not as a management tool at present. In Dr Romero's view the hydrodynamic aspects of NIWA model results clearly show that Lake Benmore is to a large degree controlled by physical processes such as the inflow characteristics, temperature, glacial flour, interactions between arms, and residence time. Dr Romero therefore has confidence that the hydrodynamic component (i.e. ELCOM) is substantially correct and that therefore the ability of the model to be a useful guide to the reservoir's response to changes in nutrient loads is substantive.

9.99 In the final significant section of his evidence Dr Romero stepped through a series of calculations to estimate the predicted lake condition arising from various load multipliers, the state of soil development, irrigation, and the proposed level of mitigation. Having previously come to the conclusion that the GHD load estimates were underestimated, in #7.6 he states:

> *"In Step 2 the increase in nutrient loading estimated by GHD (2009) to the lake in each of the arms is calculated as the difference between Scenarios 2 to 4 less the Baseline Scenario (Scenario 1). Since these differences were derived from modelling of nutrient applications on farms and subsequent fate and transport through groundwater pathways to the rivers, I have assumed these differences are reasonable. In short, the accuracy of the differences between scenarios is considered reasonable and independent of the accuracy of the absolute GHD (2009) load estimates."*

9.100 By accepting the predicted difference in nutrient loading from the status quo to the irrigated 'consented condition' it is therefore logical in Dr Romero's view (#9.2) that the proposed 'nutrient discharge allowances' remain valid for both the Ahuriri Arm and the Northern (Haldon) Arm.

9.101 Dr Romero's overall conclusion is that for the Ahuriri Arm the proposed TLI threshold of 2.75 is likely to be exceeded in some years and therefore no further nutrient export is appropriate. However by accepting the predicted differences (between the status quo and the 'consented condition' as reasonable this is not a problem, since the GHD modelling predicts there will be no increase in nutrient loading in the Ahuriri Arm when all mitigation measures are implemented. What Dr Romero is saying effectively is: (i) Maintenance of an oligotrophic state in the Ahuriri Arm is dependent on no additional nutrient losses, (ii) Scenario 2 with mitigation will lead to no additional nutrient loss, (iii) Therefore, Scenario 2 with mitigation will maintain an oligotrophic state in the Ahuriri Arm.

9.102 In the case of the Northern (Haldon) Arm, Dr Romero concluded that oligotrophic conditions would be maintained with the proposed increase in nutrient loads with mitigation arising from granting the consents.

Our consideration of the issue

9.103 As noted in #6.44, this section considers the predicted gross nutrient loads should consents be granted and their effects of Lake Benmore ecosystem. A detailed assessment of the evidence on modelling losses from irrigated pasture to the aquatic environment is given later in this Decision.

9.104 We cannot discern any robust methodology whereby GHD have related what is predicted to leach/runoff the land to lake response.

9.105 We agree with Ms Sutherland that the approach of selecting a TLI then calculating loads to achieve a corresponding in-lake nutrient concentration is flawed and a misuse of the TLI concept, We also accept Dr Spigel's evidence that to his knowledge there are no published regression equations that relate nutrient load to in-lake nutrient concentrations in New Zealand lakes. We also note his word of caution that the standard error of regression models relate only to the lakes for which they were developed.

9.106 We accept the NIWA Lake Benmore model as a scientifically robust piece of work that materially assists the assessing the effects of increased nutrient load on lake response. We

acknowledge the limitations of the calibration dataset and the resulting errors where the load multipliers predict eutrophic conditions, but we agree with Dr Spigel and Dr Romero that in the range of interest to this hearing (the oligotrophic-mesotrophic range) the model is by far the most robust tool we have available to us.

9.107 We accept the conclusion derived from the modelling that the Ahuriri Arm and Haldon Arms will become mesotrophic at approximately 1.6 times the present load (as estimated by the limited sampling programme) as the most robust estimate we have available to us.

9.108 We agree with Dr Romero's analysis that the Lake Benmore model results show that physical processes dominate the lakes response to nutrient load and that because the hydrodynamic component is substantially correct the ability of the model to be a useful guide to the lakes changes in nutrient load is substantive. We think that Dr Schallenberg's analysis that the model is a good working hypothesis that may in the future be useful to predict lake responses is unduly pessimistic. Nevertheless we agree with his recommendation that further data collection will improve the predictive power of the model.

9.109 We do not accept Dr Romero's final step in his audit of future nutrient loads (#6.68) which is predicated on the assumption that the difference between future scenarios and the baseline scenario is reasonable and independent of the accuracy of the absolute GHD load estimates (which he found to be underestimates). While they may be independent of the load estimates it is a leap of faith in our view to consider them reasonable. In all other aspects of his analysis Dr Romero had undoubted expertise in the subject and was well-qualified to make a judgement call. However in his step, which involves the modelling of fate and transport of nutrients through groundwater paths to rivers he is not qualified to audit the science and appears to have accepted the call of others in the GHD team.

9.110 Nevertheless we accept Dr Romero's overall conclusion that no further nutrient export to the Ahuriri Arm is appropriate and that oligotrophic conditions should be maintained in the Haldon Arm with the proposed increase in nutrient loads with mitigation arising from granting the consents.

9.111 In essence the issue in the Ahuriri Arm becomes accepting the MWRL proposition that granting all the consents (with mitigation) will result in no net increase in current nutrient load.

Will lack of mixing lead to localised problems in embayments of the Haldon Arm?

9.112 During the course of the hearing submitters raised a number of issues not addressed by MWRL witnesses in their primary evidence. These issues were addressed by MWRL in rebuttal evidence.

9.113 Ms Sutherland for MEL submitted that while the Haldon Arm is less sensitive to increased nutrient loads than the Ahuriri Arm, due to the flushing effect of the Ōhau C Canal water, localised effects at the river mouths might occur. Ms Sutherland observed that an area of approximately 1km^2 at the Tekapo-Pūkaki and Ōhau River mouths does not mix with inflows received from the Ōhau C Canal, and as the Tekapo-Pūkaki Rivers are anticipated to receive the majority of increased nutrient loading from the Haldon Arm catchment she submitted it was possible that algal blooms could occur within this 1km^2 region.

9.114 Dr Coffey rebutted Ms Sutherland's concerns saying that in his view algal bloom formation in this 1 km^2 area would be unlikely because: (i) it is a high-energy environment because it is the mixing zone for three different inflows, (ii) there is likely to be significant underflow beneath the apparently unmixed layer due to temperature/density differences, (iii) phytoplankton are likely to be light limited from the turbid Tekapo/Pūkaki Rivers, and (iv) the area is sufficiently windy to generate currents, which combined with the dominant discharge from the Ōhau C tailrace would set up counter rotating currents at the head of the lake, even if the discharge did by-pass a pocket of water on the other side of the bay.

9.115 In her addendum evidence Ms Sutherland countered Dr Coffey's rebuttal saying Dr Coffey had assumed that the turbid waters seen during spill events (shown in Plate 2 of here primary evidence) are typical of inflows from the Tekapo / Pūkaki River and that this would

limit growth. Ms Sutherland tabled evidence based on horizontal black disk measurements (measurement of water clarity) which showed that for periods outside of spill events, water in the Tekapo / Pūkaki inflows is considerably clearer than is the case typical of spill events. Moreover, she stated, the area of concern in the upper Haldon Arm is very shallow (< 2.5m) so light is not a limiting factor for growth of algae, and that because of its shallowness it would be unlikely that underflows of waters of different temperatures and densities mix into this area.

9.116 Dr Horn (GHD) in the MWRL right of reply told us that based on temperature differences between the Ōhau C canal, Tekapo/Pūkaki rivers and the lake waters , he calculated that indeed the inflows would not initially mix in the 1 km^2 region where they enter the Haldon Arm but intrude into the lake where they are subsequently mixed. However, he stated, this does not necessary mean the near-field (1 km2) zone would not be flushed. Based on assumed inflow rates Dr Horn calculated that a flushing time for the region in question is of the order of 1.9 days, which is considerably shorter than the time required to trigger a phytoplankton bloom.

9.117 Dr Horn is a Chartered Professional Engineer with a PhD in Environmental Engineering. He is currently the Manager of GHD's Perth Environment Business Group, which includes Dr Romero. He has 20 years of professional experience in environmental and civil engineering and environmental engineering research. He has particular technical knowledge and experience related to the water and wastewater industry, the management of water quality in lakes, rivers and reservoirs, hydrodynamics and catchment management. Dr Horn has a number of publications relating to lake hydrodynamics and we conclude that he is well-qualified to give evidence relating to the specific issues in his scope of evidence. We did note, however, that Dr Horn had not visited Lake Benmore or the Northern (Haldon) Arm site in question about which he was giving evidence.

9.118 The Commissioners pointed out to Dr Horn that the figure he had used in his calculation for the mean annual inflow from the Tekapo-Pūkaki River (15 m^3/s) included lake spills, and that a more typical inflow was the figure used by NIWA in their Lake Benmore modelling report of 3.69 m^3/s. Using the revised inflow figure would result in a flushing time of ~6 days.

9.119 Dr Horn provided an addendum to his evidence in which he recalculated the flushing time. He pointed out that Donna Sutherland's observation that the Tekapo-Pūkaki discharge did not mix over a 1 km^2 area referred to a period of lake spilling. However he pointed out that if one used the discharge typical of the time when no spill occurred, then there would be lower momentum into the lake, which would result in a lower average water depth, the discharge plunging sooner, and the unmixed area being reduced. He calculated the average water depth in the unmixed zone to be ~ 1m and the reduced plume area to be about 0.78m^2 from which he calculated a revised flushing time of ~3 days.

Our consideration of the issue

9.120 We acknowledge Ms Sutherland's arguments that increased nutrient loads in the Haldon Arm could lead to localised enrichment problems at the head of the arm due to a lack of mixing between Tekapo/Pūkaki River and the Ōhau B/C canal waters. Ms Sutherland's arguments are plausible. However the rebuttal provided by Drs Coffey and Horn are also plausible. It appeared to us that the final flushing time of 3 days calculated by Dr Horn was equivocal with respect to whether algal blooms are possible or not. Our view is that neither party has provided sufficient proof to make a call on this matter and that further hydraulic measurement and calculation is necessary.

9.121 We observe that in any case the possible occurrence of transitory algal blooms in this embayment is a minor matter compared to the trophic state of the entire Haldon Arm itself, and if monitoring showed that the algal blooms were likely as Ms Sutherland hypothesized then an engineering solution could be found.

Will increased nutrient loading result in undesirable changes in phytoplankton and macrophyte community structure?

Phytoplankton composition

9.122 Ms Sutherland was concerned about MWRLs emphasis solely on nutrient concentrations. She told us that whereas nutrients concentrations might increase linearly in the lake, the biological response could be exponential. In addition there was increased risk in her view, of changes in species dominance to undesirable nuisance species.

9.123 Ms Sutherland told us that surveys done in the 1970s found that diatom species dominated in the lake. In recent surveys she had carried out, cyanobacteria (blue-green algae) were more dominant in the Ahuriri Arm and Lower Basin of Lake Benmore. There was an increased risk, she contended, of nuisance blooms of these species with further increases in nutrients. Blooms of *Volvox aureus* (a colonial green algae) already occur at low incidences in the Ahuriri Arm she told us. Ms Sutherland's contention was uncontested by MWRL experts.

Didymo

9.124 Mr Turner for MEL told us that his company had particular concerns about the potential for nuisance growths of didymo in the Ōhau B/C canal. Didymo was first recorded in the canal on l April 2007 and it was confirmed present throughout the length of the canal in November 2009. Mt Turner explained that MEL had already experienced generation outages due to nuisance growths of Elodea (a macrophyte) and that Meridian had significant concerns regarding the potential for didymo biomass to similarly effect of their operations. Their advice was this was an increasingly likely possibility, with increases in nutrient inputs into the Wairepo Arm as proposed by MWRL.

9.125 Mr Turner is Meridian Energy Limited's (Meridian) Planning Manager – Natural Resources, responsible for managing Meridian's response to resource consent applications by third parties to take and use water in the Upper Waitaki and Waiau (Manapouri) Catchments. Mr Turner has a Bachelor of Planning (Hons) from the University of Auckland and he is a full member of the New Zealand Planning Institute. He is also a member of the International Association of Impact Assessment (IAIA). Mr Turner is well-qualified to evaluate the environmental evidence from Meridian's perspective.

9.126 Ms Sutherland explained that that there was a scientific basis for this concern as NIWA in-house experiments had shown that didymo was responsive to small increases in nutrient concentration, and because of the stable flows and hard substrate of the canals she expected prolific growth of didymo with only a small increase in nutrient concentration. According to Ms Sutherland, an increase from the current microtrophic state to an oligotrophic state (which could be expected from nutrient additions in the Wairepo catchment) would provide nutrient concentrations that produce the greatest didymo biomass. She noted currently the highest biomass of didymo in the canal was found downstream of the salmon farm and that nutrient release was the probable cause.

9.127 In his rebuttal evidence Dr Ryder presented excerpts from current literature that concluded didymo was not having a significant effect on trout fisheries or aquatic invertebrates. He concluded that MEL was in the best position to manage didymo biomass by manipulating water levels and flows.

Macrophytes

9.128 Ms Sutherland gave us a summary of the current distribution of macrophytes in Lake Benmore. In the Ahuriri Arm Lagorosiphon now occupies a large proportion of the delta with large monospecific surface-reaching stands up to 6 km wide. Diquat is being used for control. In contrast the Haldon Arm is dominated by native characeans, although Elodea is present in sheltered bays. Elodea is also present in the hydro canals and as we heard from Mr Turner, has caused problems for Meridian.

9.129 Ms Sutherland contended that an increase in nutrient concentration would favour aggressively growing plants such as lagorosiphon as it is able to take up nutrients from both sediment and water. She also raised the spectre of dense lagorosiphon beds preventing diffusion and mixing of oxygen through the water column leading to benthic anoxia, and release of nutrients from the sediments.

9.130 In his supplementary evidence Dr Coffey questioned whether lagorosiphon biomass would increase with increased nutrient concentrations. He said that in his experience, other invasive plants such as hornwort and/or Egeria usually replaced lagorosiphon. In her supplementary evidence Ms Sutherland agreed that would be the case if those plants were present in the Waitaki lakes but that is not the case, and that her research on other mesotrophic lakes had found that lagorosiphon thrived in areas where Egeria had not yet established.

9.131 In supplementary evidence Ms Sutherland further explained her concerns over anoxia in lagorosiphon beds saying that in the Ahuriri Arm, the densest beds of lagarosiphon occur on the delta near the mouth of the Ahuriri River. These beds are likely to intercept higher nutrient concentrations from the inflows than they would have if they occurred closer to the main body of the lake. Furthermore, she stated, the lack of clarity around where the groundwater finally re-charges into the lake makes it difficult to assume that the interstitial waters will remain at low nutrient concentrations, thus not affecting the growth of lagarosiphon. If this occurred, she contended, then benthic anoxia was a real possibility that could lead to release of sediment-bound phosphorus into the water column.

9.132 In his rebuttal evidence Dr Coffey agreed with Ms Sutherland's analysis of lagorosiphon growth in mesotrophic lakes where Egeria and hornwort were absent, but he disagreed with her analysis over possible benthic anoxia. Whilst reduced oxygen concentrations and low pH values can occur in the canopy of Lagarosiphon beds at dawn he had never encountered anoxic conditions within Lagarosiphon beds in oligotrophic or mesotrophic lakes.

Our consideration of the issues

9.133 We agree with Ms Sutherland that the focus of this hearing should be about 'effects' and that phytoplankton community composition is an important indicator of the cumulative effects of land development in a way that simply measuring nutrient concentrations alone cannot be.

9.134 Ms Sutherlands historical evidence of a diatom dominated Ahuriri Arm and her observations that green and blue-green algae are now the dominant species is an important indicator that changes have occurred in the this part of the lake. However the power of the evidence is limited because of the small number of recent data.

Didymo

9.135 We acknowledge Meridian's concerns about the potential for the growth of didymo in the Ōhau B/C canal to interfere with electricity generation, and the evidence of Ms Sutherland that contrary to earlier work, didymo will respond to small increases in nutrient concentration in the microtrophic → oligotrophic range.

9.136 It is, however, a secondary issue compared with effects on natural ecosystems such as the Wairepo Arm and, as observed by Dr Ryder, Meridian Energy Ltd is in the best position to manage didymo biomass by manipulating water levels and flows.

9.137 If preventing the growth of didymo were the sole focus of this hearing, we would question whether farmers, who had nothing to do with its introduction, should have their activities curtailed in order to prevent its growth. However this is not the case and there are other more substantive issues to consider.

Macrophytes

9.138 We accept Ms Sutherland's evidence that lagorosiphon infestation of the upper Ahuriri Arm

(delta area) is a real problem. Her hypothesis concerning possible benthic anoxia with increasing nutrient load is plausible. However we note that Dr Coffey's primary expertise is macrophyte ecology and control in lakes and he has extensive experience in diving and surveying such beds. We accept his evidence that he has never encountered anoxic conditions within lagorosiphon beds in oligotrophic or mesotrophic lakes

What will be the effect of increased nutrient loading on the Wairepo arm of Lake Ruataniwha?

9.139 MWRL witnesses (Drs Bright and Robson) told us that measured total N and P concentrations were used to estimate the existing trophic status of Lake Ruataniwha but that total nitrogen concentrations were below detection level and so the trophic level could not be calculated (assumed to be oligotrophic or better). However, the data for Wairepo Arm/Kellands Pond indicated that it is currently in a mesotrophic state. They estimate that to maintain the Wairepo Arm/Kellands Pond in this state, nutrient losses from the proposed irrigated area will have to be 16.4 kg N/ha and 0.7 kg P/ha less than is estimated to occur under Good Agricultural Practice.

9.140 Ms Sutherland for MEL said that she had calculated the TLI from GHD data over the same summer period used for Lake Benmore and that in her view the mean TLI of 3.7 indicates the arm is already close to the mesotrophic/eutrophic boundary. Further the TLI (TP) is 3.95 which indicates there is little buffer for any increase in nutrient load. Ms Sutherland also made the point that since the Wairepo Arm/Kellands Pond is already well into the mesotrophic range, then chlorophyll-a would be expected to be an important component of the TLI. There have, however, been no chlorophyll-a measurements made to date.

9.141 In his addendum evidence Dr Meredith presented graphs showing trends in nitrate-N concentrations in Kellands Pond from 2004-2010. He noted that nitrate-N concentrations in Kellands Pond have remained low since sampling began in 2004, (except for an elevated result in July 2006) but in spring 2009 a series of elevated nitrate results have been seen. He also presented a photograph that showed filamentous algal growths on the bed and margins of Kellands Pond and hypothesized that both their presence and the elevated nitrate-N concentrations are evidence that effects of adjacent intensification are now being seen, and that a 'lag' of four years (since the adjacent dairy farm developments commenced in the lower Wairepo catchment) has been necessary before effects are first seen. We record that we also observed the algal growths in Kellands Pond during our field trip in January 2010 and that these growths were more prolific adjacent to a groundwater 'spring' on the side of the pond closest to the dairy development.

Our consideration of the issue

9.142 We agree with Drs Bright and Robson that it is not possible to determine the TLI of Lake Ruataniwha because the data is below detection limits. We also agree with their evidence that the data indicate that the Wairepo Arm/Kellands Pond is mesotrophic but record that there is little data upon which assess the actual TLI.

9.143 We agree with Ms Sutherland that for consistency with Lake Benmore it is appropriate to calculate the average summer TLI for the Wairepo Arm/Kellands Pond and that her calculations show that it is close to a eutrophic state. We also agree that it is even more important to include chlorophyll a within the TLI in mesotrophic systems.

9.144 We agree with Dr Meredith that the ECAN monitoring data and photographic evidence strongly suggests that an adjacent dairy farm established 4 years ago is starting to have an effect on Kellands Pond. While it is not possible to establish a definitive cause and effect relationship, the visual evidence is compelling and does provide added credence to the argument that we may not be seeing all the effects of current development yet. We agree with Ms Sutherland that based on the current evidence there is little buffer for any increased nutrient load in this catchment if the aim is to prevent Wairepo Arm/Kellands Pond from becoming eutrophic.

Key conclusions on effects on lakes

9.145 Based on the evidence presented to us we conclude that the Ahuriri Arm of Lake Benmore is close to the oligotrophic-mesotrophic boundary and that no significant net increase in

nutrient load should be permitted.

9.146 Similarly we conclude that the Wairepo Arm/Kellands Pond is close to the mesotrophic-eutrophic boundary and no significant net increase in nutrient load should be permitted.

9.147 We conclude that there is sufficient buffering capacity in the Haldon Arm of Lake Benmore to assimilate an increased nutrient load from the granting of consents before us (with mitigation) and remain within an oligotrophic state.

9.148 We acknowledge that MWRL have arrived at substantially the same conclusion and that their case rests on the ability to develop the proposed farming systems without any increase in net nutrient load (in the Ahuriri catchment).

10 EFFECTS ON RIVERS AND STREAMS

10.1 The Upper Waitaki catchment contains a myriad of streams and rivers that drain ultimately to Lake Benmore and thence to the Lower Waitaki. The environmental effects of each application on particular streams and rivers is discussed with varying degrees of thoroughness in Part B, The MWRL case was the Upper Waitaki catchment could be divided into various compartments viz: lakes, streams and rivers, and groundwater, and that each of these compartments had a certain threshold below which they could assimilate nutrients derived from proposed farming activities with no more the minor effects. The approach was to select appropriate thresholds and then use the GHD WQS to determine whether that threshold would be breached. From this MWRL developed the concept of 'limiting systems', i.e. ascertain the compartment; lakes, streams and rivers, groundwater in which the appropriate threshold would be first breached with increasing nutrient load. This then became the limiting system.

10.2 This part of the decision considers the cumulative effects of granting the consents on streams and rivers at a macro-scale. It considers MWRLs description of the existing environment, the appropriateness of the thresholds selected, the prediction of breaches in the thresholds with the granting of consents, and the potential effectiveness of the monitoring proposed to provide early warning of potential breaches.

Is the MWRL node concept appropriate?

Applicants View

10.3 Drs Bright and Robson outlined the MWRL network of nodes, which were selected as points of obligation and compliance (#6.6-6.13). Nodes are intended to represent points through which nutrients leached upstream (or upgradient in case of groundwater) will pass. They are, therefore, based on the assumption that they will reflect the full cumulative impacts of land use in the catchment or subcatchment concerned.

Submitters' views

10.4 Dr Snelder agreed that basing the analysis (of water quality effects) on a series of nodes that are strategically located downstream of irrigated areas is, in principle, an acceptable method. However he was of the view that because there was a lack of detailed information on groundwater direction and where it intersects with surface waters, the surface water nodes chosen by GHD may not reflect the full impact of irrigation. The current network of nodes, therefore in his view, only provides for a high-level summary of effects and may miss local areas where impacts could be more severe. Ms Sutherland's concerns over the siting of the most downstream node in the Ahuriri catchment some 5 km upstream of the lake is an extreme example of a node that fails to capture existing irrigation.

10.5 Dr Snelder is a Principal Scientist at NIWA Christchurch. He has 23 years experience in water resource management including 14 as a Water Resource scientist at NIWA. He has led many projects that have assessed the effects of water takes and discharges on river environments and has written a number of guidelines for the management of water quality and quantity and developed several tools for water management purposes. This includes the highly regarded River Environments Classification which is now used nationally as a

tool to not only classify rivers, but also to abstract various relevant attributes. A Google Scholar search confirmed that Dr Snelder has authored or co-authored 14 scientific publications in the field of river management, including two that specifically address setting nutrient concentration criteria in rivers. While not a biologist himself, Dr Snelder has worked extensively with multi-disciplinary teams that included biologists and all publications relating to setting nutrient concentration criteria included expert biologists as co-authors. We have therefore placed considerable weight on Dr Snelder's evidence on nutrient impacts on streams and rivers.

10.6 Mr Horgan (legal representative for Ngāi Tahu) was also concerned that the siting of Ahuriri node 5 km upstream of the Ahuriri delta, failed to recognise the cultural significance of the delta to Ngāi Tahu.

S42A Officers views

10.7 Dr Meredith was also of the view that planned nodes may not capture leached nutrients, or whether leachate remained in deeper groundwater and arose beyond the river nodes and/or within the lakes themselves (addendum #9). He considered that GHD's own experts acknowledged this citing Dr Mzila's evidence that a discrepancy between measured nitrate-N suggested that over 90% of the nitrate-N generated in the Wairepo creek catchment bypassed the node in groundwater (addendum #15).

10.8 Dr Meredith has a BSc (Hons) and a PhD in Zoology from the University of Canterbury (1985). The Canterbury Regional Council has employed him for over twelve years, most recently as a Christchurch based principal water quality scientist. His areas of responsibility include monitoring, investigations, and technical advice on water quality and ecology of rivers and lakes of the Canterbury Region. Prior to this he was employed for ten years as an environmental scientist by the Waikato Regional Council and its preceding authorities and prior to this for two years as a freshwater fisheries scientist with the Fisheries Research Division of the Ministry of Agriculture and Fisheries. He is a member of the New Zealand Freshwater Sciences Society and the American Fisheries Society. Dr Meredith is familiar with most of Canterbury's rivers and streams having designed, conducted and reported on monitoring and investigation programmes on individual rivers, generically on river types, and on regional trends. He is familiar with the rivers, streams and lakes of the upper Waitaki catchment and Mackenzie Basin, having visited the area on a large number of occasions and has scoped, designed, conducted and supervised monitoring programmes throughout the upper Waitaki catchment to establish baseline information on lakes and rivers for a range of council functions. We conclude that Dr Meredith has a vast experience on water quality management, both in Canterbury and elsewhere and that he is well-qualified to give evidence within his nominated scope.

10.9 Dr Meredith opined that nodes should reflect points where the majority of contaminants will have arisen and had an opportunity to exert their effects. He noted that at the Ahuriri, Tekapo and Wairepo nodes the water discharges into adjacent shallow lake delta zones, which retain high intrinsic and recreational values and uses. He was of the view that in a nodal approach, all three deltas could be accorded particular consideration because of their high value/use and shallow, clear water status. However, he did not provide specifics on how these deltas could be included in the nodal network.

Our consideration of the issue

10.10 We consider that the nodal network put forward by MWRL is a sound and pragmatic concept and if designed correctly should provide an enduring basis for consent monitoring. It is essential, however, that the location of sites does largely detect nutrient leached upstream of that point, and if it does not, then the reasons for its non-inclusion are known and other monitoring is put in place to compensate. We accept the views of submitters and s42A officers that the current node locations are deficient in this respect, particularly near the river deltas. This is largely because groundwater pathways are not understood in sufficient detail to optimise the design. We have also discussed the node design in relation to hydrological considerations.

10.11 In evaluating individual decisions (Part B) we noted several instances where groundwater/surface water interactions confound the assignment of nodes simply on the

basis of apparent surface water catchments. Grays Station is one such example. Complex interaction between ground and surface waters is another reason why it is not easy to determine the effects of existing irrigation on surface waters.

What is the current state of streams and rivers?

Applicants view

10.12 Drs Bright and Robson tabled data that provided an overview of the baseline condition of Mackenzie Basin streams (Table 4.1) which was also used to provide calibration for the WQS model. The data was gathered from a variety of sources including ECAN, the study itself, and the Mackenzie Water Quality Trust. The WQS sampled 17 sites including all the node points from January 2008- January 2009. Only nutrients (nitrogen and phosphorus forms) were analysed and presented. Dr Bright told us (answers to questions from Commissioners) that although other contaminants such as *E coli* could be expected to be lost from irrigated farmed systems, they were of minor concern compared to nutrients in this environment. In addition MWRL considered that mitigation measures taken to minimise nutrient losses would also minimise losses of other contaminants.

10.13 Drs Bright and Robson told us (#6.43) that the frequency and spread of samples over the twelve-month period Jan 08 to Jan 09 is fit for the purpose of providing an average annual snapshot of the current nutrient status of the waterways.

10.14 Dr Coffey presented his assessment of the current state of streams and rivers in the catchment. The evidence for this came from two stream surveys carried in late summer of 2007/08 and 2008/09. The first survey was a qualitative survey of 11 sites whilst the second was a more comprehensive survey of 27 sites in the Lake Benmore catchment, and included quantitative measurement (ash-free dry weight) of periphyton. Both surveys focussed on periphyton though macroinvertebrate species were also assessed. Fish species were not surveyed.

10.15 From the results of his stream surveys Dr Coffey concluded (#3.8-3.10) that existing land use was already having an impact on streams and rivers. Specifically, instream habitat quality was degraded in the lower reaches of the Twizel River, Mary Burn, Stony River, Wairepo Creek, Quailburn and Omārama Creek relative to upstream sites; nuisance growths of periphyton were present in the downstream reaches of the Tekapo River and Grays River, and poor instream habitat quality was present in the downstream reaches of the Willowburn and Henburn sub-catchments.

10.16 From his surveys, Dr Coffey considered that periphyton guidelines promulgated by Ministry for the Environment are generally exceeded in streams and smaller rivers in the Mackenzie Basin.

10.17 Whilst stating that existing land use was having an effect, Dr Coffey was of the view (answer to questions from Commissioners) that there was no obvious relationship between the presence of conspicuous periphyton growths and the presence of existing irrigation upstream of those growths. In his opinion the lack of riparian shading was the main controller of periphyton in these streams.

10.18 Dr Ryder for MWRL reinforced Dr Coffey's view that streams in the Upper Waitaki catchment support benthic and fish communities typical of those flowing through extensively farmed land that have little protection of riparian margins. He considered this lack of protection strongly influences the make-up of stream communities. In his view the restoration of riparian margins and channel habitat is equally important to minimising nutrient loss from irrigation.

10.19 Dr Ryder holds BSc (Hons) and PhD degrees in Zoology from the University of Otago. He is a member of the New Zealand Freshwater Sciences Society; New Zealand Water and Wastes Association; and the Royal Society of New Zealand. Dr Ryder is the Director of Ryder Consulting Ltd an environmental consulting practice with offices in Christchurch, Dunedin and Tauranga. Dr Ryder has more than 24 years experience in freshwater ecology and water quality studies on South Island Rivers, mainly as a consultant. He has an independent commissioner on a number of resource consent hearings associated with

marine farming, water abstraction and wastewater discharges. Dr Ryder has considerable experience with water abstraction for hydroelectric, irrigation and drinking water supply schemes, and has provided ecological assessments on a number of existing and proposed schemes, large and small, throughout New Zealand. Dr Ryder was contracted by MWRL to peer review Dr Coffey's evidence and we agree that he is well qualified to give evidence relating to this peer review.

10.20 One of the only areas of concern raised by Dr Ryder about Dr Coffey's evidence was about survey methodology and specifically the lack of quantitative periphyton data in a form that is directly compatible with the model output predictions of nutrient levels presented in the WQS work (#3.3). He commented on the difficulty of predicting periphyton biomass from nutrient concentrations (#4.4) saying such predictions were subject to error because there are a number of other factors influencing periphyton accrual such as flood frequency, water clarity, temperature, riparian cover, bed material and invertebrate grazing pressure. His view was that these variables are difficult to account for without undertaking site-specific studies over a long period.

10.21 Despite this disquiet, Dr Ryder was of the view that the lack of quantitative information could be remedied with additional targeted pre-irrigation monitoring over the summer/autumn period.

10.22 Dr Ryder stated (#3.10) that fish biodiversity, salmonid rearing habitat, angling and visual aesthetics are probably the key aspects of the McKenzie Basin rivers that should be considered in setting management objectives. This statement was unchallenged by submitters and section 42A officers.

Submitters' views

10.23 Dr Snelder (#31) disputed Dr Coffey's assertion that MfE guidelines were in fact frequently breached, citing measured biomass in late summer of 2007 (after 3 months of stable flow) as evidence that the guideline of 120mg/m^2 was not exceeded at any of the ten sites and the more stringent limit of 50mg/m^2 was not exceeded at most sites. Dr Coffey did not dispute this evidence in rebuttal.

10.24 Dr Snelder (#17.3 and answers to questions) was of the view that there is a link between existing irrigation and stream reaches impacted by periphyton noting that Coffey's own data showed that in seven of the eleven sub-catchments sampled the periphyton biomass was observed to increase, sometimes to nuisance levels, downstream of irrigated areas. Of the remaining four sub-catchments where increased biomass was not observed, two had soft-bottomed streams that do not support periphyton communities, whilst the remaining two sub-catchments had low periphyton biomass at both upstream and downstream sites.

10.25 Dr Snelder (#17.1) also reported the results of nutrient limitation studies carried out by Wilks et al (2009) using nutrient diffusing substrates[10], which showed that all stream reaches were nutrient limited. They concluded that the Upper Waitaki aquatic environment is largely a nutrient deficient environment irrespective of river type or area, and that all rivers may be responsive to increasing soluble nutrient additions, particularly the Omārama Stream and Ahuriri Rivers (which responded the most to phosphorus).

S42A Officer's Views

10.26 Dr Meredith (addendum #57) agreed with Dr Ryder that degradation of streams in the Mackenzie Basin is due mainly to a lack of riparian protection. He also stated that it was physical habitat rather than water quality causing the current degradation of streams in the Mackenzie.

10.27 Dr Meredith (#46) criticised the frequency of sampling to establish the current state arguing that two 'spot' surveys do not adequately describe the environment. He also opined (addendum #30) that it was doubtful that the sampling presented by Coffey

[10] Containers of agar impregnated with P or N or P+N, covered with filter paper and incubated in the stream channel. The biomass accumulating on the filters is measured after 28 days.

provided useful information on periphyton biomass because only one survey (2009) was quantitative and even that did not measure chlorophyll a. He argued that monthly quantitative sampling over 12-18 months was the minimum required to establish an adequate description of periphyton biomass in the catchment. He was also of the view that nutrients, periphyton and invertebrates alone were insufficient to characterise the environment and that microbiological parameters, fine sediment (SS) , BOD, and emerging contaminants such as endocrine disruptors also should have been considered (addendum #49-50).

10.28 Dr Meredith (#47-48) disputed Coffey's conclusions that the stream surveys indicated a poor environment arguing that even if periphyton biomass was high it was due to oligotrophic species rather than 'green' species indicative of excessive nutrient levels. Meredith further argued (#46) that the high biomass was in any case due to an excessively long duration since flood flows, which would have scoured it from the bed.

Rebuttal evidence and Right of Reply

10.29 In his rebuttal evidence Dr Coffey countered Meredith's claims that the observed periphyton were oligotrophic species by producing photos of *stigeoclonium* , *cladophora*, *vaucheria*, and *oedogonium* species taken during his two surveys. All these species are green filamentous algae, which normally only reach conspicuous levels when there is sufficient available nutrient to support their growth.

10.30 In his Right of Reply evidence (#2.09) Dr Coffey conceded that there was lack of consensus between experts on the current ecological condition of waterways in the Mackenzie Basin and that he accepted there was "a case for a further annual round of monthly monitoring to adequately benchmark the current ecological condition of these waterways prior to further land use intensification."

10.31 In Dr Coffey's view (RoR #2.02) the lack of agreement on the current ecological condition of rivers and streams is the principal reason why there is also disagreement on ecological thresholds ("targets" in Dr Coffey's words) appropriate for compliance monitoring should the irrigation consents be granted.

10.32 In his tabled rebuttal evidence rebuttal, Dr Ryder (#2.5, 2.6) analysed ECAN Quantitative Macroinvertebrate Community Index (QMCI) and water quality data to show evidence of existing stream degradation. Dr Meredith (addendum #57) admitted that QMCI aren't all high and are variable – but maintains lower scores due to physical habitat limitations rather than water quality.

Our consideration of the issue

10.33 Our view is that the information presented by MWRL experts is inadequate for a proposal of this scale, particularly with respect to aquatic ecology. We agree with Dr Meredith that more systematic sampling (at least monthly over 12-18 months) is needed to give basic understanding of the biota in streams/rivers within the affected catchment. Furthermore given the proposed scale of development and the investment it would have been prudent to include other parameters such as dissolved oxygen and faecal coliforms. Dissolved oxygen could have provided a connection with periphyton metabolism while microbiological contaminants are a perceived issue associated with intensive pastoral agriculture. We note that Dr Coffey recommended including these parameters in post-consent monitoring, but we would have also expected them to be included in the MWRL assessment of the existing environment.

10.34 Given their importance, and their relationship to invertebrates, we would have expected to be presented some data on native fish distribution to better understand the likely effects of the development. As a bare minimum, we would have expected some analysis and commentary of fish distribution and trends from the NIWA Freshwater fish database. This is all the more noteworthy given Dr Ryder considered fish biodiversity, salmonid rearing, and angling to be key factors to be considered when setting management objectives.

10.35 We were not convinced of the cost-effectiveness of including novel endocrine disruptors as suggested by Dr Meredith. We agree with Dr Coffey (Right of Reply #2.26) that these are

primarily associated with municipal wastewater rather than intensive land use effects.

10.36 Dr Coffey provided factual evidence that conspicuous growths of mesotrophic /eutrophic periphyton were present at the time of his surveys. Dr Meredith's view that the nuisance levels of periphyton were mainly oligotrophic species appears unfounded, at least at the sites where Coffey's photos were taken.

10.37 The occurrence of conspicuous growths of green periphyton indicates a sustained source of nutrients; at least at that point. Dr Coffey's surveys were at single points (upstream and downstream) in large catchments so we have no idea of the spatial extent of the periphyton, and hence the areal extent of the nutrient source. However we surmise, both from Dr Coffey's answers to questions and the groundwater evidence that nutrient inputs to streams are likely to be within confined reaches rather than evenly along the stream length. Dr Snelder's evidence (uncontested) shows there was not a case for nutrient enrichment throughout the lower reaches of the streams when sampled in late summer 2007. The instances where measured periphyton biomass exceeded the most stringent MfE guideline demonstrated that the streams are sensitive to nutrient additions but that in general they remain well beneath this guideline set to manage nuisance periphyton in streams (50 g/m^2 to protect benthic biodiversity).

10.38 Our conclusion is that in general the state of the streams is not indicative of excess nutrient inputs, but that there are stream reaches where this is the case. There does appear to be good evidence that the lower reaches of all streams are stressed by lack of riparian protection/shading as discussed by Dr Ryder.

10.39 We are of the view that Dr Snelder's explanation that there is a relationship between conspicuous growths of green periphyton and the presence of existing irrigation is more likely to be correct than Dr Coffey's view that there is no link and that periphyton growth is due to a lack of riparian shading is the main controller of periphyton in these streams.

10.40 Whilst we accept that the relationship is not perfect (there are cases where conspicuous growths occurred without upstream irrigation) there is likely to be rational explanation for these occurrences, which cannot be adduced from the sampling program, such as a groundwater inflow from outside the surface water catchment. Green algae will not grow to the extent shown in Dr Coffey's plates without an adequate nutrient supply. It is most unlikely, in our view, that a sustainable source of nutrients sufficient to support nuisance growths of green algae could be supplied from extensively farmed unirrigated catchment in this arid environment.

10.41 The relationship to existing irrigation explained by Snelder seems plausible and is reinforced by the Wilks et al (2009) nutrient limiting substrates work (Snelder #17.1) which found the least difference between upstream and downstream periphyton response to nutrients in the Maryburn and Twizel Rivers; both of which have existing irrigation in their catchments. Dr Coffey's non-specific explanation that existing land-use (excluding existing irrigation) is causing the nuisance growths of green periphyton in streams and rivers appears unlikely and is a view we cannot support, particularly as the full effects of existing irrigation may not yet be manifest due to groundwater lag times.

10.42 To use the argument of 'existing nuisance growths' caused by existing land use (rebuttal #2.06) to justify increasing the periphyton burden with the proposed irrigation (albeit by <25%) is in our view, untenable.

10.43 Open channels will not by themselves result in conspicuous growths of green periphyton, they still need sufficient nutrient to grow and be competitive with oligotrophic algae such as diatoms and some blue-green species. In the absence of irrigation to support an increase in pasture productivity, and provide the water to leach nutrients to groundwater, we find it difficult to understand how the very extensive pastoral agriculture (stocking rate < 0.5 su/ha) in an arid climate could produce the nutrient required to sustain conspicuous growths of green periphyton.

10.44 We agree with Dr Snelder that the streams and rivers of the Upper Waitaki Catchment are likely to be very sensitive to nutrient inputs (much more than predicted by MWRL)

because they are characterised by infrequent floods and stable bed sediments, and that small increases in nutrients are likely to bring about proliferations in periphyton biomass.

10.45 We agree with Dr Ryder and Dr Meredith that physical habitat is currently the main limitation to aquatic life in Mackenzie Basin streams rather than water quality. The implication from both Dr Ryder and Dr Coffey was that if the irrigation consents were granted, farmers would have the income to provide the riparian restoration that would enhance physical habitat. While this may be true, there is no guarantee that this would occur, and in any case it misses the point that irrigation would, in some cases, make water quality the main limitation to freshwater invertebrates (through increasing periphyton biomass above levels tolerated by high-grade species). Riparian planting has the potential to provide some mitigation against nutrient increases, but the dominant groundwater pathway and its likely intersection with the stream channel make designing riparian buffers that provide effective nutrient mitigation tenuous.

10.46 Having examined the raw ECAN QMCI[11] and water quality data, we were not convinced by Dr Ryder's argument that the water quality data in particular, showed evidence of stream degradation. Many of the low DO's occurred during winter months when low biological metabolism would be expected to occur and it is likely that a systematic measurement error was responsible for apparently low DO measurements across a number of sites on at least one occasion.

What are suitable thresholds for streams and rivers and how should they be measured?

Applicant's view

10.47 Drs Bright and Robson introduced the thresholds adopted by the WQS for rivers and streams. For nutrients, the ANZECC default thresholds for upland streams (>150m) were adopted. They adopted this guideline " *because of their standing nationally*".

10.48 Drs Bright and Robson also introduced the WQS periphyton threshold, which is based on a permissible 25 percent increase in calculated periphyton biomass above existing conditions at the sub-catchments node point(s).

10.49 Periphyton biomass was calculated by GHD using equations proposed by Biggs (2000) which calculate concentration criteria for N and P in order to meet specific biomass guidelines. The Biggs model relates periphyton biomass in terms of chlorophyll a to the mean concentrations of N and P and the accrual period. The accrual period (days) is measured as FRE3 (average number of flood events per year greater than 3 times the median flow). Drs Bright and Robson explained that MWRL translated maximum periphyton biomass into in-stream nitrogen and phosphorus concentrations.

10.50 Dr Coffey justified the need for the proposed 25% increase periphyton threshold on his assessment of current stream condition and his view that if the NZ Periphyton Guidelines (MfE), or Environment Canterbury Proposed Water Quality Guidelines (Environment Canterbury 2004) were adopted, no further increase in nutrients would be permitted.

10.51 Dr Ryder agreed with Dr Coffey that adopting the NZ Periphyton Guidelines (MfE) would permit no further increase in nutrient concentrations in the McKenzie Basin. He went further saying that in his experience, the nutrient concentration aspects of these guidelines are highly restrictive and are frequently exceeded in stream environments subject to relatively little human influence and containing good quality macroinvertebrate communities and support robust fish populations.

10.52 Dr Coffey submitted repeatedly that he considered a 25% increase in the mean annual maximum periphyton biomass at any nominated stream / river node in the catchment of Lake Benmore could be considered a minor effect relative to current conditions (#7.13, 7.15, 8.4, rebuttal 2.05, 6.08, 7.02, 8.02) and not observable to the casual observer.

[11] Quantitative macroinvertebrate community index

Submitters' views

10.53 Notwithstanding his views that the proposed 25% increase in periphyton guideline was unnecessary because the MfE periphyton guidelines were fit for purpose, Dr Snelder was critical of the methodology used in its development. In particular, no attempt had been made to assess the sensitivity of their estimates of existing maximum biomass or nutrient concentration criteria to the assumptions and uncertainties in the GHD approach. A sensitivity analysis would have at least provided information on which components of the overall model were subject to the most uncertainty and informative about whether the ranges of values calculated by the model were at all plausible.

10.54 Dr Snelder also pointed out that the base equations (Biggs, 2000) used by GHD are based on the mean of monthly samples taken over an entire year because periphyton integrates nutrients over time. Dr Snelder pointed out that MWRL's calculations for many nodes are based on three sampling occasions in December 2008 and January 2009. For some locations such as the Stony Node and the Wairepo Creek Node there were more sampling occasions but these are irregularly distributed through time and cover a long time period often back to the 1990s. In Dr Snelder's view, this irregular and sparse sampling of water chemistry data that MWRL have used cannot be regarded as being representative of the mean of monthly samples taken for an entire year and this may result in large errors. The water chemistry data used by GHD to calculate the existing periphyton biomass was, in his view, inadequate because it did not meet the criteria given in Biggs (2000).

10.55 Dr Snelder (#26,29.5) questioned Coffey's adherence to the Biggs (2000) algorithms centred around accrual period since last flood pointing out that the Biggs (2000) model is calibrated for "hill-country" fed rivers characterized by frequent flood events and large sediment supply rates. Approximately 90% of the rivers used by Biggs (2000) for calibration of his model had a FRE3 greater than 7, which when combined with the sediment supply and unstable beds result in periphyton growths being readily dislodged. In contrast, he pointed out, many rivers in the Upper Waitaki Catchment have an estimated FRE3 of 3.8 or less, with only one (Twizel) having a FRE3 >7. Because the rivers and streams in the Upper Waitaki are largely flow controlled, Snelder is of the view that algorithms applied by MWRL are inappropriate and will lead to misleading estimates of maximum periphyton biomass.

10.56 In summary, Dr Snelder did not consider Dr Coffey's suggested threshold of a 25% increase to existing maximum biomass to be scientifically robust or defensible given its arbitrary development. He also considered that the annual maximum biomass alone is not a sufficient basis on which to define nutrient management of the rivers and streams of the catchment. He noted that some values (e.g., fishing, recreation, visual amenity) might be more sensitive to the total duration at which periphyton biomass exceeds a threshold than to the maximum annual biomass.

S42A Officer's Views

10.57 Dr Meredith considered that the nutrient concentration thresholds (ANZECC trigger values for upland (>150m) streams) used by GHD are unsuitable for streams in the Mackenzie Basin because

(a) the dataset from which they were derived was poorly represented by alpine streams (primary evidence, #16), and so the 'default trigger values' bear little in common with the streams and small river types modelled by GHD;

(b) the threshold values chosen are inconsistent with the proposed objectives and standards in the ECan pNRRP that covers this area (#18); and

(c) ANZECC (2000) guidelines are not the only recognised national guidelines.

10.58 Given the main environmental effect being targeted in this case is to control nuisance periphyton growths, Dr Meredith's views was that the much lower values given in the MfE periphyton guidelines are much more applicable and compatible with recommendations by officers on reporting on the pNRRP (#18).

10.59 Dr Meredith was also critical of the philosophy behind the trigger values proposed by MWRL in that they are 'causative', i.e. allow water quality to be degraded down to the threshold, rather than being effects-based which prescribe a stringent standard in order to avoid water quality degradation that may cause an effect (Meredith addendum #23).

10.60 Dr Meredith (addendum #14,17) argued that the 'conservative' approach taken by MWRL to estimate nutrient concentrations was not conservative with respect to estimating maximum periphyton biomass because high ("conservative") estimates of nutrient concentrations led to high estimates of periphyton biomass. The same approach when applied to baseline (before new irrigation) nutrient concentration would also lead to a higher estimate of periphyton biomass than has been observed in practice.

10.61 Dr Meredith (#73, addendum #17) was also critical of the MWRL predictions of maximum periphyton biomass because they are derived using modelled data as input (termed a second order model by Dr Meredith) and therefore the error in predicting maximum periphyton biomass is likely to be very large .

10.62 Dr Meredith (addendum #20) noted that the objectives of the pNRRP anticipate that existing effects (periphyton growth being an effect) will be maintained or improved such that there is no overall degradation below current levels. In Dr Meredith's opinion, if guidelines are derived from an estimated baseline that is greater than that currently measured, this will not be the case. Dr Meredith clearly considers that the more conservative guidelines (based on Biggs (2000)) recommended by pNRRP officers are more appropriate to the Upper Waitaki environment (addendum #85). This view is echoed by Dr Freeman (additional sec 42A #12).

Rebuttal and Right of Reply

10.63 In his rebuttal evidence Coffey (#6.08) supports further periphyton sampling (monthly over a year) but in his right of reply (#3.08) emphasizes that the purpose of this sampling should be to test / confirm the goodness of fit for predicted and measured maximum annual periphyton biomass at these nodes (rather than to describe the existing environment).

10.64 Dr Coffey (right of reply #3.03) was critical of the approach recommended to the PNRRP Commissioners, saying they (the proposed thresholds) are "work in progress" and expressing doubts as to whether the guidelines could ever be achieved.

Our consideration of the issue

10.65 We agree with Dr's Bright and Robson that the ANZECC (2000) guidelines are nationally recognised for toxicants, but as pointed out by Dr Meredith, nutrients are not [usually] toxicants, The table from which the WQS thresholds were abstracted (Table 3.3.10 in ANZECC (2000) are default trigger values, which are only are only intended to be used until ecosystem or site specific values can be generated.

10.66 The pNRRP did not set a target threshold for nutrient concentrations but rather set thresholds for periphyton biomass with the objective that existing conditions should be maintained or improved. The thresholds set for periphyton (Table WQL5) in terms of chlorophyll a and % filamentous algal cover, are conservative and consistent with the NZ periphyton guideline for the maintenance of benthic biodiversity. We note the above approach and Table WQL5 remains in the NRRP following the Commissioners' decisions on the NRRP.

10.67 We agree with Dr Meredith's assessment and his conclusion that adopting ANZECC (2000) default nutrient trigger values for slightly disturbed upland streams is inappropriate in this case and will not protect Mackenzie Basin streams from excessive periphyton growth.

10.68 We agree with Drs Coffey and Ryder that adopting the NZ Periphyton Guidelines (MfE) will probably permit no further increase in nutrient concentrations in McKenzie Basin streams. This would imply that any such increase would lead to nuisance growths of periphyton as defined by the guidelines (otherwise they would permit an increase). If the guidelines (for

nutrient concentrations) were shown not to result in nuisance periphyton growths then it would be straightforward to argue that 'nutrient' guidelines are irrelevant. We note that, in any case, the primary focus of the NZ Periphyton Guidelines is on the outcome (i.e. nuisance periphyton biomass in relation to various stream uses). We agree that the guidelines are not clear with respect to inputs (i.e. nutrient concentrations). Nevertheless they do make it clear (Note of caution, p104) that compliance with the benthic diversity guideline (the most restrictive) should not be governed by measurements of nutrient concentration alone, but rather focus on the in-stream management objectives (diversity of macroinvertebrate communities in the case of the benthic biodiversity guideline). We note that Dr Meredith's evidence emphasized the importance of outcomes rather than inputs and that the NRRP also reflects this philosophy.

10.69 We note that the NZ Periphyton Guidelines are a national guideline and should therefore be afforded some weight. We do not accept Dr Ryder's argument that because (in his experience) the guidelines, have been unduly restrictive in other environments, we should not adopt them in the Mackenzie Basin; particularly as the evidence given for their widespread exceedance is weak. In our view, declaring that they are not applicable in an environment like the Mackenzie Basin is tantamount to declaring that they are not applicable anywhere in New Zealand. We don't accept this argument.

10.70 In our view, whether a 25% increase in mean annual maximum periphyton biomass would be observable to the casual user is not the central issue. The more critical issues are:

(i) Should these streams be managed on a basis that allows a deterioration of the status quo? i.e., the philosophy of allowing a 25% increase.

(ii) What is the baseline from which the 25% increase is calculated? i.e. is the estimate of maximum periphyton biomass prior to any nutrient from additional irrigation well-grounded and sensible?

(iii) Is maximum periphyton biomass the only appropriate metric to manage the effects of irrigation in Mackenzie Basin streams?

10.71 We agree with Dr Snelder and Dr Meredith that the MWRL proposed periphyton threshold has little scientific credibility because:

(i) It uses nutrient data predicted from the WQS as primary input to the periphyton model. The errors in predicting nutrient concentrations are indeterminate and MWRL have not presented any sensitivity analysis to demonstrate the sensitivity of the modelled periphyton biomass to nutrient concentrations. Nor have they presented any data to demonstrate the robustness of the model by presenting (for example) modelled versus actual maximum periphyton biomass.

(ii) The relationship upon which the GHD periphyton model is based was developed in streams with different hydrological characteristics (higher flood frequency) than those in the Mackenzie Basin, which are largely subject to flow control.

(iii) Errors in the WQS model arising from an unrepresentative and inadequate database of nutrient measurements will probably result in an overestimate of existing (pre-irrigation) periphyton biomass. Thus the foundation from which a 25% increase is calculated is likely to be inflated in the first place, leading to (if adopted) a significant permissible degradation in stream ecosystem quality.

10.72 We also agree with Dr Snelder and Dr Meredith that in addition to the lack of scientific credibility, the evidence for the MWRL periphyton threshold being required in the first place is weak.

10.73 We also agree with Dr Meredith that as with the proposed adoption of the ANZECC default nutrient thresholds, the philosophy of the proposed MWRL periphyton threshold is one of permissible degradation up to that threshold which is contrary to the objectives of the pNRRP (at the time of lodgement) and the now operative NRRP.

10.74 We note Dr Coffey's advice to us with respect to the weight we place on the recommendations to the pNRRP commissioners. Since this time the NRRP has become operative and we discuss the issue of weight we give to that document and the reasons for it earlier in this decision.

Can consent monitoring plug the gaps?

10.75 During the course of the hearing, and in response to evidence from, and caucusing with submitters and s42A officers, Dr Coffey (for applicants) changed his position with respect to the role of consent monitoring. Because this debate 'unfolded' during the hearing rather than being led from the applicant in primary evidence, it will be easier to follow as a single block rather than presenting the views of applicants, submitters, s42A officers in sequence.

10.76 In his rebuttal evidence (#6.0) and right of reply evidence (#5.02) Dr Coffey agreed with Dr Snelder's conclusion (addendum #9.0) that that increased certainty in biological responses to nutrients will only be possible through further monitoring. The reasons for Dr Snelder coming to this conclusion are set out above, but in summary are because MWRL relied almost exclusively on modelling to predict such responses and many of the assumptions used in that modelling are questionable.

10.77 In his primary evidence, Dr Snelder (#48) recommended a year to 18 months of monthly sampling be required to establish the necessary relationships and provide a reasonable baseline of the current state. Dr Coffey (as above) and Dr Ryder (#3.3) maintain that this can be provided as part of pre-irrigation monitoring; in other words once consents have been granted. Dr Snelder (#52) appeared to pre-emptively caution against such an approach stating: "*It is my opinion that the lack of verification of the Biggs (2000) model means the assimilative capacity of the streams and rivers in the Upper Waitaki Catchment has not been established. There is a genuine risk that the criteria suggested by MWRL have overestimated assimilative capacity by an amount larger than the possible reduction in nutrient concentration by mitigation*."

10.78 Dr Coffey (right of reply # 3.09) was critical of Dr Freeman who he "*understood*" (no paragraph reference given) could see no value in an additional years monitoring, because of the possibility of atypical conditions. Dr Coffey then cited other biological experts (Ryder, Snelder, Sutherland) who could see such value.

10.79 However the important distinction between the applicants' witnesses (Coffey, Ryder) and the submitters' witnesses (Snelder, Sutherland) is that the latter did not agree to post-consent monitoring as an alternative to pre-consent monitoring. In other words, they considered the monitoring presented in the AEE inadequate and proffered alternative monitoring they considered necessary in order for the applicant's claims with respect to biological response to nutrients to be properly evaluated.

Our consideration of the issue

10.80 It is noteworthy that that the applicant's stance on the confidence we could place on predicted periphyton response mellowed during the course of the hearing. In response to some strong arguments by submitters and Section 42A officers, they (Dr's Coffey and Ryder) conceded that further monitoring is required to have confidence in the robustness of the relationships advanced by MWRL. However, the applicants have argued that we can address any uncertainties in the MWRL scientific evidence through conditions requiring further monitoring before the consent is exercised. However, in our view this route is not appropriate because:

(a) the ability to mitigate against nuisance periphyton growths in streams and rivers is a fundamental part of the MWRL case. Phytoplankton growths in the Ahuriri Arm, and groundwater were considered more 'limiting' to irrigation development than was nuisance growths of periphyton in streams;

(b) the current biological state of the streams (with respect to nutrient enrichment) is less degraded than Dr Coffey described;

(c) the section of the AEE and evidence describing the current environment was inadequate in relation to the scale of the proposed development; particularly with respect streams and rivers in the Upper Waitaki catchment

(d) there is almost certainly a biological response to existing irrigation in some streams;

(e) there is a lag time of the order of years (see discussion of groundwater evidence) from leaching beyond the root zone to the effects of that leachate being manifest in surface waters;

(f) there is likely to be a much greater biological response to increased nutrient load than that calculated by MWRL because the nutrient (N or P or both) limiting periphyton growth may vary between streams and because the algorithm used by MWRL to calculate maximum periphyton biomass may be inappropriate.

Key conclusions on effects on rivers and streams

10.81 The concept of nodes proposed by MWRL for monitoring points of compliance is sound in principle, however the design needs refinement. In particular, better understanding of groundwater pathways is required to be confident that nodes 'capture' the majority of upstream nutrient load, and that the sources of nutrients measured at nodes are known and understood to a higher degree than is currently the case.

10.82 The information presented by MWRL experts on the current state of streams and rivers is inadequate for a proposal [all applications] of this scale. Systematic monitoring over 12-18 months is needed to give a basic understanding on the biota within affected streams and rivers, and to provide a baseline state of the existing environment.

10.83 There is some evidence that existing irrigation is resulting in nuisance growths of periphyton (above NZ Periphyton Guideline Values) though the scale of the problem has not been adequately assessed.

10.84 There is good evidence that periphyton growth in streams and rivers of the Upper Waitaki catchment are nutrient limited by nitrogen, or phosphorus, and sometimes a combination of both nutrients.

10.85 Because of this nutrient limitation, together with the relatively stable hydrology, many of the rivers and streams of the Upper Waitaki are likely to be very sensitive to nutrient inputs; much more so than predicted by MWRL.

10.86 The default nutrient trigger values for slightly disturbed upland streams given in ANZECC (2000) guidelines are inappropriate and will not protect streams in the Basin from excessive periphyton growths.

10.87 Although there are instances of breaches in the MfE NZ Periphyton Guidelines, these breaches do not appear widespread. We disagree with MWRL that these guidelines are not appropriate in the Mackenzie Basin.

10.88 We reject MWRL's alternative guideline for an up to 25% increase in annual maximum periphyton biomass. We find that their suggested method is unnecessary, not based on sound scientific method, and would allow a deterioration in the state of streams and rivers.

10.89 Because of our rejection of much of the MWRL evidence relating to streams and rivers outlined above, our view is that it would not be appropriate to 'plug the gaps' in knowledge through consent conditions.

11 PREDICTING NUTRIENT LOSS FROM FARMS

Is the chosen modelling approach appropriate?

11.1 As with other aspects of the MWRL case, the applicants have used models to predict the

losses of nutrients (N and P) from future irrigated farmland. The type of models used (deterministic or empirical), how well they represent the important processes leading to nutrient loss on irrigated farms, and examples of where similar models have been accepted for similar applications, is all useful information that assists in assessing the credibility of the modelling approach chosen.

Applicant's Views

11.2 Drs Bright and Robson introduced the methodology whereby MWRL modelled the nutrient loads (current and future) arising from activities on land and routed via streams and groundwater to Lake Benmore. The WQS model was the principal vehicle for prediction of nutrient loads, however the WQS was supported by Farm Systems modelling carried out by AgResearch. Evidence on Farm Systems modelling was given principally by Dr Snow, but supported by Dr Monaghan.

11.3 Dr Snow holds a Bachelor of Agricultural Science (1983) and a Ph.D. in soil physics (1992) from Massey University. She has 18 years of research experience having been employed as a soil physicist and systems modeller at Michigan State University, USA (1992-1993), CSIRO, Australia (1994-2001), HortResearch (2001-2003), and AgResearch (2003 onwards). She currently leads the Systems Modelling Team within the Agricultural Systems Section in AgResearch, which develops and applies several different types of simulation models to (mainly environmental issues facing pastoral systems. Dr Snow has published at least 20 papers in peer reviewed scientific journals on issues relating to soil physics and simulation modelling.

11.4 Dr Monaghan is a research scientist working within the Climate, Land & Environment (CLE) Group at AgResearch, based at Invermay. He has a Bachelor's degree in Agricultural Science (Hons) and a PhD in Soil Science (University of Reading, England). 3. He has 20 years research focusing on (i) defining the impacts of intensive pastoral agriculture on soil and water quality, and (ii) identifying cost-effective options to reduce these impacts where mitigation is deemed necessary. As part of his role with AgResearch, Dr Monaghan has contributed to the validation and development of various components of the OVERSEER model. As with Dr Snow, Dr Monaghan has published more than 20 papers on his research in peer reviewed scientific literature on topics relating to nitrogen and phosphorus transformations in soils, transport of these plant nutrients and faecal indicator bacteria to streams, and mitigation options for reducing the amount of nutrients and bacteria from reaching streams. Both Dr Snow and Dr Monaghan are highly-respected scientists in their respective fields and we have given their evidence considerable weight.

11.5 Dr Snow's evidence gave us the background to the Farm System's modelling approach chosen and its overall role within the cumulative effects study. She described the 3-tier approach used, which involved

(a) quantifying the current pasture (or crop) growth and the likely future growth should the area be irrigated;

(b) inputting this information into farm systems models which determine realistic stocking rates that could be supported by the projected pasture growth; and

(c) using this stocking rate information, plus information about the fertiliser use, production, soil and weather data to predict whole farm nutrient losses using the OVERSEER model.

11.6 Dr Snow outlined the important factors that need to be taken into account in modelling nutrient losses from grazed pastures systems. She told us that most of the leaching from pastoral farms originates from urine patches, and that therefore the quantification of the pattern of urine patches in both space and time is one of the most important factors for modelling N leaching on farms.

11.7 She explained that while dynamic daily timestep models are intrinsically attractive for estimating nutrient losses because they can directly relate input information (soils, fertiliser inputs, climate) to outputs (nutrient losses), such models do not accurately

represent urine patches, and they also have difficulty representing whole farms (as opposed to single paddocks).

11.8 OVERSEER on the other hand, is:

(a) Not a dynamic model,

(b) works on an annual-average time step representing a typical year, uses empirical relationships, internal databases, and readily available data from a "feasible" farm to estimate the nutrient inputs and outputs at farm or paddock scale, and presents them as a nutrient budget,

(c) models the whole farm, not individual paddocks, but does sub-divide the farm into blocks that are differentiated by pasture type, soil or management characteristics; and,

(d) unlike dynamic models which have a robust representation of the whole-farm system and of the effect of urine patches on leaching.

11.9 OVERSEER, Dr Snow explained, has two settings designed to simulate developed soils and highly developed soils. The developed (default) setting reflects organic matter build-up and immobilisation of nitrogen. The highly developed setting is designed for the situation where the immobilisation slows to the point that further nitrogen additions to the soil will pass through without being incorporated into organic matter.

11.10 Dr Monaghan endorsed the approach chosen by Dr Snow and reiterated that "*the systems approach she has used ensures that the farms are biologically feasible and as near a representation of reality as biophysical and human factors allow*".

11.11 Drs Bright and Robson told us that the approach used by MWRL was a straightforward application of the same nutrient balance models used elsewhere in New Zealand for similar purposes – notably for establishing nutrient management regimes for Lake Taupo and the Rotorua Lakes.

11.12 Dr Monaghan told us that OVERSEER had been reviewed as part of the planning regulations surrounding nutrient management in the Lake Taupo catchment and was found to be the most suitable tool available. This was, Dr Monaghan said, based on there being "a remarkable degree of agreement, among the scientists called on behalf of the parties, on estimates of the total load to the Lake" (Environment Court Decision No. A 123/2008); all parties accepted that OVERSEER should be used to determine the N leaching rates for farming activities.

Our consideration of the issue

11.13 We agree that the 3-tier Farm Systems modelling approach described by Dr Snow provides the best method currently available for estimating nutrient leaching losses (particularly nitrate) at a farm scale. While dynamic models such as SPASMO can model specific physical, chemical and microbiological processes resulting in nitrate leaching, such models cannot at present simulate urine spotting, or the changes in grazing density inherent in operating a successful farm.

11.14 We agree that urine spotting and grazing density are the most important variables controlling nitrate leaching and that the AgResearch Farm Systems modelling approach is the best tool currently available for reflecting both these variables at a farm scale and also the changes in farm management that may reduce (or increase) nitrate leaching.

11.15 Notwithstanding the above, our view is that it is important to realise the limitations of the AgResearch Farm Systems modelling with respect to its application in the Mackenzie Basin, and the purpose for which MWRL has used its results.

11.16 We acknowledge and appreciate expert evidence given to the Environment Court considering a nutrient management regime for Lake Taupo endorsed the use of OVERSEER

(the final link in the Farm System Modelling package described by Dr Snow) as the most appropriate model for managing nitrogen 'leached' to the lake from farming activities.

11.17 Indeed Dr Clothier (s42A technical advisor in this case) stated to the Court that OVERSEER was the most suitable model for managing inputs to Lake Taupo "because it is based on a wealth of experimental data and understanding developed by world-class scientists who have turned this knowledge into a well-known and easy-to-use comprehensive model that considers on-farm practices and environmental impacts" (Brent Clothier #7.1 Evidence to Environment Court in Regional Plan Variation 5).

11.18 Given his endorsement of OVERSEER in the Lake Taupo case, we were puzzled by Dr Clothier's apparent opposition to its application in the Upper Waitaki as given in his initial s42A report. This opposition changed in his addendum evidence when it became clear that OVERSEER was not being used directly to model catchment nutrient loads and its primary purpose was to model nitrate leaching from farms and to test the effects of changes in farm systems management.

11.19 Much of Dr Clothier's earlier confusion (and ours) may have stemmed from statements made by other MWRL witnesses, which inferred that OVERSEER was used at Taupo to estimate total N load to the lake (e.g. Monaghan #13). To be clear, this was not the case, and the "remarkable degree of agreement, among the scientists called on behalf of the parties, on estimates of the total load to the Lake" referred to in the Environment Court decision was based upon more than thirty years of monitoring as well as deterministic catchment modelling carried out by NIWA.

11.20 The Environment Court decision did not provide an endorsement of OVERSEER for managing nitrate leaching but helpfully summarised as follows:

> *"The OVERSEER model provides an estimate of the nitrogen leaching from the root zone of farming systems. This is an established model and its precision and accuracy have been confirmed by a considerable body of research. The long-term equilibrium approach of OVERSEER considers the impact of changes in land use or management approaches and expresses those impacts immediately in the newly calculated leaching rate. Thus any changes in nitrogen inputs is immediately reflected as a change in outputs even though the actual leaching rates will trend up or down (depending on the changes made) over a period of years."*

11.21 In our view there are marked differences between Lakes Taupo and Benmore with respect to the confidence that can be placed upon the current nutrient status, and the environmental effects of subsequent management changes to farming systems upon that status. However with respect to using OVERSEER as a management tool for controlling nitrogen leached from farms, we are of the view that the risks to the environment are considerably lower in the Taupo situation than in Benmore. This is because at Taupo OVERSEER will be used to regulate a reduction in nitrogen leached below an established threshold whereas at Benmore the applicants propose that OVERSEER will be used to regulate an increase in nitrogen leaching up to a threshold.

What assumptions does OVERSEER make, and what are its strengths and weaknesses?

Applicant's Views

11.22 Dr Snow told us that in calculating nutrient losses, OVERSEER assumes that best management practices have been followed such as following the fertiliser code of practice and preventing stock from accessing streams.

11.23 Dr Snow informed us that OVERSEER is not suited for examining the dynamics of a farm in rapid transition; but it can reasonably be used to assess the before and after transition states. Dr Monaghan reiterated that OVERSEER is an equilibrium model and that it therefore should not be used for examining year-to-year changes in nutrient losses (#26).

11.24 In her subsequent rebuttal evidence, Dr Snow discussed the application of OVERSEER for monitoring compliance with an NDA. She reported that the participants in the nutrient

caucus agreed (Snow rebuttal #10) that OVERSEER modelling to monitor compliance to NDA should be done annually, but that it should be calculated as an average of the previous 3 to 5 years with the duration of the averaging depending on the transport time lags in the subcatchment.

11.25 Dr Monaghan also emphasized that the algorithms within OVERSEER are based on research data using best practice (#18) for various inputs and thus it is important that farmers adhere to best practice guidelines in order for OVERSEER predictions to be valid. Dr Monaghan considered adherence to best practice by farmers (in the Upper Waitaki); particularly with respect to achieving optimum irrigation rates "quite an optimistic scenario" but the most practical option to model in the first instance" (#22).

11.26 Dr Snow conceded (rebuttal #42) that OVERSEER could not model some of the intended farm management systems proposed by applicants currently.

Submitter's views

11.27 Dr Ryan commented (#17) that the OVERSEER model is principally driven by stocking rate and is sensitive to nitrogen fertiliser inputs, in particular nitrogen fertiliser inputs, which can have a large effect on the magnitude of soil nitrogen leaching estimates produced by the model.

11.28 Dr Ryan has a Bachelor of Agricultural Science (Hons) and Doctor of Philosophy in Soil Science both from Lincoln University. In addition he holds a Graduate Certificate in Applied Computing and a Certificate of Proficiency in Hydrogeology. Since the completion of his PhD in 2002 Dr Ryan has been involved in a number of projects that have involved soil nutrient modelling of agro-ecosystems specifically to assess the environmental impacts of farming operations. Most recently, this has included being part of the team assessing the environmental impacts of farm intensification in South Canterbury associated with the proposed Hunter Downs Irrigation Scheme. Whilst not having the same research pedigree as Dr's Snow and Monaghan, Dr Ryan is a well-qualified and experienced practitioner, with good local knowledge of soils and farm management practices. His evidence was given careful consideration.

Our consideration of the issue

11.29 As we heard from Dr Snow, modelling nitrogen leaching rates at a farm scale is complex as there are many variables to be taken into account including rainfall patterns, soil types and variability, stocking rate and movements, and fertiliser application rates and distribution. Modelling this complexity at short time steps using a process-based model is fraught with difficulty. OVERSEER overcomes some of this difficulty by (a) using annual time-steps, and (b) through reference to known leaching rates from similar farms, on similar soils under similar climatic conditions. For developed soils and farms similar to those included within the OVERSEER database this is appropriate since any changes in N leaching brought about by changes in farm management will be slow and take many years to effect. Hence the reference to OVERSEER as an equilibrium model – that is, it reflects relatively slow changes in a stable system.

11.30 In contrast the changes in soil nutrient status brought about by irrigation in the Upper Waitaki will be rapid, especially where new highly-stocked farms are being developed from essentially an undeveloped state (no pasture, no organic matter in soil) at present. As we have heard, OVERSEER is not appropriate for modelling such rapid transitions, and our view is that it will only be appropriate once the 'developed' farms reach some kind of equilibrium. We were not given guidance on how long this might take.

11.31 We are concerned that the OVERSEER database contains no sites from the Mackenzie Basin, nor any from sites with similar climate and soils. As was noted in the discussion on lakes modelling it is not good modelling practice to extrapolate empirical relationships beyond the range for which calibration/validation data is available.

11.32 We are also concerned about the lack of clarity over which Farming Systems proposed by the applicants cannot currently be modelled with OVERSEER.

How was the Farm Systems Modelling used in the WQS?

11.33 The manner in which the Farm Systems Modelling (FSM) was applied in the WQS was a source of confusion during the presentation of primary evidence. Dr Clothier for one was initially of the view that the FSM (OVERSEER as final output) was used to calculate nutrient loads to the lakes directly. Much of his early criticism of OVERSEER (and promotion of alternative models such as SPASMO) was centred on this belief. Once it became clear that this was not the case and that OVERSEER was used principally to disaggregate the agreed total nutrient load he withdrew his opposition on this point. While the manner in which OVERSEER was used by GHD is made clear by Dr Snow, statements made by other witnesses puzzled us. In this section we set out Dr Snow's statements on how OVERSEER was applied by GHD as a backdrop to our view on the robustness of the approach selected.

Applicant's View

11.34 Dr Snow explained that the role of the modelling that she carried out was used in the cumulative effects study to:

(a) assist with validation of the surface water and ground water modelling by providing the source information about nutrient losses from the farmed areas of the catchment, and,

(b) assist with the disaggregation of the nutrient loads that each water body can tolerate into Nutrient Discharge Allowances (NDA) for each applicant.

11.35 Dr Snow told us (#45 ii a) that apart from validating the GHD model, the FSM had no role in the calculation of tolerable nutrient loads to water bodies, but that it was used to construct future irrigated farms and to predict the impacts of mitigation measures.

11.36 GHD used the average losses from different land uses across the 7 modelled stations to provide loss coefficients that gave values for each land use. The area of each land use (unimproved tussock, developed pasture, forage cropping, and irrigated pasture) determined from the landcover database was multiplied by the appropriate coefficient to give the total nutrient loading for each land use. These were then summed to give the total nutrient loading for the current case.

11.37 Dr Snow told us that GHD checked the current case by using the regression equations (between stocking rate and nutrient loss) to determine total existing nutrient loading at the property level.

11.38 Similarly for the nutrient loads generated in the future (irrigated case) Dr Snow told us that GHD simply used the information supplied by land managers of proposed irrigation areas and multiplied by the appropriate nutrient generation coefficient. As a check on future loads GHD selected the best match for each property (in terms of the appropriate farm system) using the highly developed setting to provide a second estimate of property level nutrient loss.

11.39 Dr Snow told us that all the N modelled as leaching was assumed to enter the groundwater system by GHD. Some of N transported to the stream through gley soils was assumed to denitrify using attenuation factors. This adjustment was made by GHD and was not part of the OVERSEER modelling.

Submitter's views

11.40 Dr Ryan pointed out (#20) that although it was not clear in any of the technical reports of the Water Quality Assessment, and as Dr Snow has stated in her evidence (see her # 40.iii), the average nutrient loads for the different land uses (i.e. dryland, irrigation etc.) from these existing farms were also extrapolated to calculate the nutrient loads from farms under the future case scenario with further irrigation development using an average nitrogen leaching estimate from the developed status of 9 kg N/ha/yr.

11.41 Dr Ryan summarised (#47) the evidence of Mr Potts on denitrification losses and concluded that catchment scale denitrification losses of soil mineral nitrogen simply cannot be currently quantified and any model relying on this assumption is flawed, and will underestimate the nitrogen-leaching load into receiving surface waterbodies.

Our consideration of the issue

11.42 It is clear from Dr Snow's evidence that apart from validating the WQS the Farm Systems Modelling (OVERSEER as final link) had no part in the calculation of tolerable nutrient loads to waterbodies.

11.43 We endorse Dr Snow's statement that:

> *"It must be acknowledged however that that the effects of transport time lags and uptake by aquatic plants makes the comparison of nutrient loads leaving the farm boundary to those measured in ground and surface water problematic and it may be that the good agreement between the two data sets is coincidental."*

11.44 Given that this is a significant component of the WQS validation we are not confident that validation of the WQS has been demonstrated.

11.45 GHD used average losses from different land uses across the 7-modelled stations to provide loss coefficients for both present and future cases. While this is a pragmatic approach to modelling nutrient loss over large areas we are not convinced that the resulting baseline or estimate of future loads is sufficiently robust.

11.46 We conclude that OVERSEER has only marginal relevance in the setting of total nutrient loading. It is of more relevance to the agreed total allowable nutrient load, and it is highly relevant in terms of whether not future irrigated farms will comply with their NDAs.

11.47 Our understanding is that GHD only used the regression equations (between stocking rate and nutrient loss) as a check on their estimates derived from the loss coefficient methods above. We were not presented with this comparison, nor the equivalent future case comparison derived from selecting the best match for each property in terms of farm system proposed.

11.48 We note that GHD applied a denitrification factor (i.e. reduction in N transported to streams) through gley soils, post-Farm Systems modelling. We agree with Mr Potts, Mr Hansen and Dr Ryan that there was no evidence that the conditions necessary for denitrification to be a significant process actually exist within the areas identified by GHD, and that it is more likely that they do not. Therefore the reductions in N invoked by GHD cannot be justified. We note, however, that Mr Callander has observed that in any case, the MWRL output (WQS) does not seem to incorporate denitrification losses.

Baseline and future case modelling

11.49 AgResearch initially modelled 7 existing dryland stations in the Upper Waitaki catchment to provide information on farm systems for a range of stocking rate, climate, and soil conditions.

11.50 Dr Snow showed the relationships between predicted N (or P) loss and stocking rate (her Figure 6). She noted that there was a good relationship for N in both developed and highly developed states but only when two 'outliers' were removed (Ōhau Downs and Simon's Pass). The reasons given for removing these outliers were (i) high proportion of forage crops (Ōhau Downs), and (ii) high proportion of light soils (Simon's Pass). Similarly a moderate relationship was obtained between P loss and stocking rate, but only when Haldon and Ribbonwood stations were removed (high proportion of deer stocking and hill country soils, respectively).

11.51 Future irrigated farms were modelled, Dr Snow told us, using the same methods used for the baseline dryland farms except that all the farm systems modelled were hypothetical systems designed, to make effective use of the forage likely to be grown under irrigated

conditions in the Upper Waitaki region. The specifications of future farm systems (#38 Snow) were based on farmers' aspirations.

11.52 We were not convinced by the reasons given by Dr Snow for rejecting some stations from the regression as 'outliers'. It would have been known prior to undertaking the analysis that, for example, Simon's Pass station had a large area of light soils (as does Simon's Hill). In our view if this was a reason to exclude it from the regression, an alternative station should have been selected prior to the analysis, rather than excluding it post analysis because it did not conform to the expected relationship.

How important are errors in Farm Systems Modelling?

11.53 For any predictive model (other than conceptual) it is necessary to have a good understanding of the likely errors in those predictions. Understanding the magnitude, distribution, and type of errors arising from the modelling is useful to assess the confidence with which one can place on model predictions.

11.54 In the following sections we consider firstly errors in general (they may be random of systematic), and secondly systematic errors. Systematic errors can arise by having incorrect inputs to a model, setting incorrect parameters within the model, or through using the model outside of the range of conditions for which it was developed (important for an empirical model). The systematic errors considered here reflect the concerns of submitters and s42A officers are: (a) soil types and climate, (b) developed vs. highly developed settings, (c) dry matter production, (d) extrapolating nitrate leaching losses, and (e) modelling phosphorus losses.

Errors in General

Applicant's views

11.55 Dr Snow did not provide a quantitative estimate of errors or sensitivity analysis for the FSM. However she discussed in qualitative terms what the implications of such errors would be to the outputs of the cumulative effects study.

11.56 Dr Snow concluded that under or over-estimates in the current case farm nutrient losses would diminish the (current) very good correspondence with catchment water modelling. She also acknowledged (#44) given the lag times in groundwater, uptake by aquatic plants etc. the current good agreement between the outputs (FSM) and catchment modelling (GHD) may be coincidental.

11.57 Dr Snow also noted (#46 i(b) that under or over sensitivity of current case farm nutrient losses to climate or farming intensity practices, might affect the calibrated factor for denitrification in shallow groundwater.

11.58 Under or over estimates of future case farm nutrient losses would have no effect on the disaggregation of nutrient loads to NDAs according to Dr Snow. (This is because the total future nutrient load was derived from simple multipliers). The FSM simply disaggregated the total, and sensitivity of FSM to soil, climate farming intensity practices will affect the relativity in nutrient discharge allowance (NDA) between properties but not the theoretical total discharged to water bodies.

11.59 However under estimates of future farm nutrient loads has the potential to lead to farm systems that exceed their NDA and therefore result in intolerable decreases in water quality. Therefore Dr Snow advocated detailed farm plans and monitoring to ensure compliance. Similarly insufficient sensitivity of FSM to soil, climate, farm intensity factors might lead to an imbalance in water quality at the nodes with some nodes having lower nutrient concentrations than calculated as tolerable.

11.60 Dr Monaghan also gave us some quantitative assessments of uncertainty (variability) in estimates arising from OVERSEER (#23,24). For developed mode in climates where it has been developed these estimates are ±20%. With the uncertainty associated with shallow soils this could rise to ± 35% -answers to questions). However, he stated, where one is

comparing farm management on the same property, this uncertainty is reduced because many of the inputs (particularly climate and soils) will stay the same.

11.61 Dr Monaghan also pointed out the difference between uncertainty and accuracy saying that the main indicator of the latter was a comparison between modelled and measured leaching rates. He presented a graph (his Figure 1) which showed a good fit between modelled and measured leaching rates from a range of soils around NZ.

11.62 In response to questions from Commissioners, Dr Monaghan produced a graph showing OVERSEER-predicted nitrate leaching losses (extrapolated to the whole catchment) versus actual measured nitrate losses at the catchment outlet (from catchment studies around NZ). In all cases predicted nitrate losses were greater than measured losses (much greater in some cases).

Our consideration of the issue

11.63 Dr Snow's discussion of the implications of under or overestimates of nitrogen losses in OVERSEER modelling was helpful in identifying where modelling errors are likely to have the most impact. The errors that give us most concern are underestimates of future farm nutrient loads, which potentially lead to farms that exceed their NDA.

11.64 We accept Dr Monaghan's evidence that the uncertainty (random error) in estimates arising from OVERSEERS using the developed setting is ±20% and that where one is comparing farm management on the same property this uncertainty will be reduced.

11.65 We infer from Dr Monaghan's evidence that the uncertainty of estimates will increase (i) on shallow soils, and (ii) using the highly developed setting; since both of these cases are outside of the current range of validated OVERSEER modelling.

11.66 We accept Dr Monaghan's argument that there is a marked difference between uncertainty and accuracy and that a good 'fit' between modelled and measured leaching rates is a good indicator of accuracy within the range of experience of model applications (i.e. developed agricultural soils).

11.67 However, as illustrated by Dr Monaghan's graph there is a much poorer fit between modelled leaching rates and measured catchment N exports with catchment exports being consistently lower than modelled leaching losses. This is not a surprising result as it is well known that catchment attenuation processes usually result in less N at a catchment outlet than is theoretically input (such as from N leaching in this case).

11.68 On the one hand (as Dr Monaghan argued) this should give us some comfort in that actual N losses should be less than that modelled (i.e. the modelling provides a conservative maximum). Whilst this may be true, the difficulty in this case is ascribing realistic attenuation factors for the Upper Waitaki catchment given that the potential range (as illustrated in Dr Monaghan's graph) is very large.

11.69 As there is no evidence that riparian denitrification is at all significant in this catchment, the only other significant attenuation process is likely to be uptake by periphyton. Given the Mackenzie basin climate, periphyton uptake is likely to be a significant attenuation process only in summer/early autumn and then only in streams with a large width: depth ratio.

11.70 It should also be pointed out that where nutrient uptake by periphyton is significant (in terms of the total N export) it would almost certainly be accompanied by conspicuous growths of green periphyton in excess of MfE guidelines. Such periphyton growths will eventually be sloughed off and enter the lake so there will be no net decrease in N exported over an annual cycle.

11.71 Given that the WQS does not explicitly model attenuation processes (other than a factor for denitrification already discussed) our view is that it is reasonable to assume no attenuation. i.e. all the leached N predicted by OVERSEER will be exported.

Systematic error 1 - Soils, climate and database

Applicants Views

11.72 Dr Snow noted (#56) that OVERSEER does not contain calibration data from the Upper Waitaki area, nor from other areas with a similar climate.

11.73 In Dr Monaghan's peer review of the FSM work his main concern related to OVERSEER predictions of N leaching from shallow soil types, which occupy about one-third of the proposed irrigable area. His view was that leaching rates for these soils will be 30-60% (#22b) higher than for equivalent deeper soils and that overall it is likely that leaching losses in the GHD report are underestimated by 10-20% (#17).

11.74 In her rebuttal evidence Dr Snow (#38) conceded that nutrient estimates in the AgResearch modelling are likely to be low for the lighter soils and stated: "As a worst case scenario perhaps the leaching from the dairy farms on the lightest soils might be 8 kg N/ha/y higher than that modelled and presented in Figure 7 and Table A3 of my primary evidence." She expanded: "This is about equal to the difference between the 'Developed' and 'highly developed' scenarios for the more intensive farm systems."

11.75 In contrast, Dr Monaghan's rebuttal evidence (#5) stated: "As a worst case scenario perhaps the leaching from the dairy farms on the lightest soils might be 7-15 kg N/ha/y higher than that modelled and presented in Figure 7 and Table A3 of Snow (2009)."

Our consideration of the issue

11.76 We agree with Dr Monaghan that N leaching losses from shallow soil types comprising ~one-third of the irrigable area will be significantly greater than from equivalent deeper soils. During our field trip in January 2010 we augered several holes in shallow soils and observed no organic matter or soil structure that might immobilise N. We defer to Dr Monaghan's estimates that N leaching on such soils will be 30-60% greater than on deeper soils and that overall it is likely that leaching losses in the GHD report are underestimated by 10-20%.

11.77 We find it difficult to reconcile the statements made by Dr Snow and Dr Monaghan in rebuttal evidence with respect to the projected increase in N leaching from dairy farms on shallow soils (at most 8 kg N/ha/y – Dr Snow, and 7-15 kg N /ha/y - Dr Monaghan).

11.78 Our view is that one reason for this apparent discrepancy may be the lack of experience in using OVERSEER with similar soil types and climatic conditions. There are no Mackenzie basin shallow soils (or indeed any soils) contributing to the OVERSEER database from which relationships between N inputs and N leaching are drawn.

Systematic error 2 – Developed vs. Highly Developed Setting

Applicant's view

11.79 Dr Snow told us that analysis of the OVERSEER outputs for some irrigated blocks showed very large amounts of immobilisation of nitrogen in the soil organic matter, which, in her view, may be due to the absence of calibration data specific to the Upper Waitaki area or regions with similar climate and soils. She told us that while it is normal for there to be substantial increases in soil organic nitrogen after a dryland is irrigated these rates of immobilisation couldn't be sustained indefinitely.

11.80 Dr Snow recommended that to obtain more conservative estimates of long-term leaching under irrigated conditions, OVERSEER should be set to "Highly Developed", which prevents immobilisation and so gives an upper bound on the leaching from the irrigated blocks. Snow reiterated that "highly developed" is the most appropriate setting to use in this case because of considerable uncertainty in the duration of the immobilisation phase.

11.81 Dr Monaghan (nutrient caucus notes, Annexure A to rebuttal evidence) on the other hand was of the view (#21 in primary evidence) that because OVERSEER was validated using

data from "developed" soils and there was no scientific justification for using the Highly Developed setting as a default.

11.82 In her rebuttal evidence Dr Snow agreed with Dr Clothier that the highly developed setting provides an upper limit to nutrient losses from the farms but did not state whether she now agreed with Dr Monaghan that the developed setting should be used for the FEMPs.

11.83 However Dr Snow stated (rebuttal #8b and after caucusing) that "*those farms that would not meet their Nutrient Discharge Allowance at the highly developed setting in OVERSEER, but would meet their Nutrient Discharge Allowance at the Developed setting should be: (i) Required to undertake some degree of monitoring of soil development status, (ii) Use interpreted data from representative lysimeters, and (iii) Should consider using mechanistic modelling to support the monitoring data, and that (iv) The greater the N immobilisation estimated by OVERSEER at the Developed setting, the greater the monitoring requirement should be."*

Submitter's Views

11.84 Given the perceived shortcomings in the modelling (see next section), Dr Ryan's view (#38) was that the Water Quality Assessment should have been based on the nitrogen leaching estimates modelled under the highly developed soil scenario. In his addendum he backtracked on this and agreed that the developed setting should be the default (addendum #8) because the highly developed setting essentially doesn't have any scientific justification and is only useful to give an indication of extreme upper bound nitrogen leaching values.

11.85 In his addendum evidence Dr Ryan challenged the statements of Snow and Monaghan that the WQS is sufficiently conservative because it is based on the highly developed setting in OVERSEER. Dr Ryan states (addendum #24) that: "Just to clarify, the WQS has been based on the projected nitrogen leaching loads from developed soils only, or Scenario 2. The proposed leaching loads from highly developed soils under Scenario 4 have been presented in the WQS Reports and been used solely to provide a potential upper bound nutrient concentrations in some receiving environments when the soils eventually reach a point of a highly developed state." He believed Dr Snow had corrected this misunderstanding in her supplementary evidence. However #46 and 52 of Dr Snow's rebuttal evidence makes it very clear that the highly developed setting was used for the future irrigated case.

S42A Officer's View

11.86 Dr Clothier asserted that in terms of prudence the highly developed setting of OVERSEER should be used in the FEMPS, especially given there can be large increases in predicted leaching losses between the two settings (Annexure A to Dr Snow's rebuttal evidence).

11.87 Dr Clothier holds a B.Sc. (Hons) from the University of Canterbury, a Ph.D. [1977] in oil physics from Massey University, and a D.Sc. [2002] from Massey University. He is currently the Science Group Leader of the Systems Modelling Group of Plant and Food Research in Palmerston North with responsibility for over 30 scientists in the teams of: Modelling, Biometrics and Production Footprints. He has been elected a Fellow of the Soil Science Society of America [1992], a Fellow of the Royal Society of New Zealand [1994], a Fellow of the American Agronomy Society [1995], a Fellow of the New Zealand Soil Science Society [1995], and a Fellow of the American Geophysical Union [2005]. He has published over 195 scientific papers on soil science, measurement and modelling of water movement, chemical flows in the rootzone of plants, ground and surface-water protection, and the management of soils, nutrients, pesticides and irrigation. He is Joint Editor-in-Chief of the international scientific journal of Agricultural Water Management. Dr Clothier is an internationally-recognised expert in his field, and we have given his evidence considerable weight.

11.88 Despite the recommendations from both Dr Snow and s42A technical experts that the highly developed setting be used, and the recognitions by Darren McNae (#20) that development setting has a high impact on the output of OVERSEER, the applicants appear to have standardised on using the developed setting. McNae (addendum # 6A) reports

that it is now his understanding that it was agreed in caucusing that that it is acceptable that a farm meets its threshold using on the developed setting.

11.89 Dr Clothier advised that in cases where an NDA could only be met using the "developed setting" mechanistic modelling should be the preferred method to provide additional evidence that the NDA will be met. In his view, lysimeter measurements and soil status measurements really only assist with OVERSEER parameterisation and development.

Our consideration of the issue

11.90 We accept Dr Snow's expert view that using the developed setting in OVERSEER resulted in very large amounts of N immobilisation, which she considered unsustainable. Our view is that because many of the shallow soils are currently devoid of organic matter, there will be a lag before any immobilisation occurs. We note that accumulation of organic matter in the soil is likely to be less in a cut and carry system than a conventionally grazed system and that therefore the lag time before significant immobilisation occurs will be longer on irrigated dairy farms with housed stock. We therefore agree with Dr Snow that the highly developed setting is more appropriate on such soils because it ignores immobilisation and provides a more conservative estimate of N leaching when these shallow soils are irrigated.

11.91 However we also accept Dr Monaghan's view and Dr Ryan's belated conclusion that the OVERSEER database was derived using the developed setting. Using the highly developed setting in OVERSEER is, therefore, questionable as a default. Nevertheless it appears to be a pragmatic response that should lead to conservative upper bound. We accept that the uncertainty associated with using the highly developed setting will be greater than that of the developed setting, but on shallow soils it is more realistic (at least until there is accumulation of organic matter).

11.92 Mr McNae advised us that the applicants have standardised on using the developed setting for their FEMPS. We assume this was because of advice received that the highly developed setting lacked scientific credibility, and that this also prompted the nutrient caucus (Dr's Snow, Monaghan, Ryan, and Clothier) to recommend various measures in the event that a property failed to meet its NDA using the highly developed setting, but met it using the developed setting.

11.93 We agree with Dr Clothier that checks on soil development status and using lysimeter data really only help with OVERSEER development and parameterisation. We also question whether mechanistic modelling (recommended by Dr Clothier) is realistic as an operational tool to provide certainty a property would meet its NDA, especially as there appears to be a deficit of information about immobilisation rates on these shallow soils.

<u>Systematic error 3 – Dry matter production</u>

11.94 The amount of pasture grown under irrigated conditions has a direct bearing on the amount of nutrient (particularly nitrate) leached from the rooting zone, since the greater the amount of pasture that is grown per unit of fertiliser, the more nutrient is taken up to support that growth (greater efficiency of both water and nutrient use). In addition lower dry matter production than predicted could lead farmers to use more N fertiliser to boost production - leading to higher rates of N leaching.

Applicant's Views

11.95 Dr Snow foreshadowed the debate that was to follow with a detailed justification of the pasture growth rates (dry matter production) modelled using ECOMOD. These dry matter production figures were subsequently input to FARMAX (sheep and beef) or UDDER (dairy) to model the sustainable carrying capacity for the irrigated farms, and the modelled stock units, as well as fertiliser, climate etc. were input to OVERSEER for estimates of nutrient loss. Dr Snow's analysis (Appendix 5 of her primary evidence) provided estimates of 13.6 T DM/ha/y (UDDER) and 14.2 T DM/ha/y (FARMAX) which are significantly higher than the accepted literature values for maximum growth rate achievable in the region for irrigated pasture of 11.9 T DM/ha/y.

11.96 Dr Snow concluded that her estimates were scientifically defensible and were derived in consultation with farmers currently irrigating using centre pivot technology. The higher modelled growth rates were achieved by increasing early spring growth rates and removing the traditionally observed (with less advanced irrigation technology) drop in growth rate in February.

11.97 In her rebuttal evidence Dr Snow reported that after caucusing, the theoretical dry matter production figure was still disputed. Drs Clothier and Ryan asserted that in contrast to the predictions from Ecomod (14 tonnes/ha/y), a more reasonable estimate was about 12 tonnes/y. Dr Snow rebutted this point of disagreement (#9-26) using simulations from Ecomod to show that the rate of production, particularly on light soils, was governed by the irrigation return period. The 2-3 day return period typical of pivot irrigators was capable of producing the 14 tonnes/ha/y drymatter.

11.98 Drs Clothier and Ryan argued that if a shortfall between predicted and actual drymatter production occurred, farmers would use additional N fertiliser to overcome this imbalance, which would result in additional N leaching. Dr Snow countered this saying that even if extra N fertiliser were used, it would not necessarily result in additional N leaching. In addition Dr Snow argued that farmers' abilities to add extra N would be constrained by their NDAs (rebuttal #40].

11.99 Dr Monaghan's did not have a firm view as to whether the 9 kg N/ha/y estimate derived by AgResearch or the 11 kg N /ha/y estimate argued by Dr Ryan for the partially irrigated farm model were correct, but pointed out that that agronomically there was no real difference between the two estimates.

Submitters Views

11.100 In his primary evidence Dr Ryan gave some useful background material on the nutrient status of soils in the Mackenzie Basin. He told us that the soils are low in organic matter and therefore have a low potential to supply plant available mineral nitrogen. In the Mackenzie Basin, legumes are generally able to fix from 100 to 200 kg of mineral nitrogen per hectare per year with moderate to high levels of superphosphate fertiliser inputs. However even with legumes, dry matter production is limited by N availability. Large yield responses (>60%) have been observed from the application of mineral nitrogen fertilisers, however because of the large areas involved, topdressing with N is not economic. Hence pasture production in these extensive dryland areas is severely capped to a low level (< 5 t /ha/yr) which ultimately severely restricts the stock carrying capacity (generally < 2 SUs/ha) of the land.

11.101 Dr Ryan was of the view (#25) that rather than using the irrigated blocks from existing farms used in the baseline assessment, the projected nitrogen leaching loads in the proposed developed irrigation scenario should have been based on the partially irrigated farm model used in the MWRL's Economic Impact Assessment (EIA). The EIA partially irrigated farm model was based on the assumption that an irrigated block with a moderate nitrogen fertiliser loading of 200 kg/ha/yr would produce around 10.2 tonnes dry matter consumed per year, enough to support around 16 - 18 stock units per hectare (#26). The farm assumptions outlined in the EIA partially irrigated farm model are a fair reflection of the average farm under the proposed developed irrigation scenario in the Upper Waitaki Catchment in Dr Ryan's opinion.

11.102 Dr Ryan stated that even in favourable climates it is now common practice to apply moderate amounts (100 to 200 kg N/ha/yr) of nitrogen fertiliser inputs to intensive pastoral systems in order to increase pasture growth and achieve production targets, as most grass/clover pastures are chronically nitrogen deficient despite nitrogen fixation by clovers.

11.103 Given the farm assumptions used in the EIA, Dr Ryan's view was that Dr Snow's expected level of pasture production able to be achieved relative to the levels of nitrogen fertiliser and irrigation inputs is overly optimistic compared to actual levels that will be able to be achieved by the majority of farmers within the Upper Waitaki Catchment.

S42A Officers Views

11.104 In his s42A addendum (#7-10), Dr Clothier acknowledged Dr Snow's cogent analysis given in her rebuttal evidence but was still of the view that the yield range, as predicted through EcoMod/OVERSEER-linked modelling, with inputs of just modest amounts of nitrogen fertiliser, was high. He agreed with the comments of Mr Harris, that we must be cautious as to the ability of models to replicate extreme conditions. Dr Clothier cautioned that to achieve this high pasture yield with frequent, short watering, would probably require consent conditions; because farmers would not voluntarily do it because such irrigation would increase both capital and running costs.

Applicant's rebuttal

11.105 Dr Robson defended not using the EIA as the basis for OVERSEER modelling, stating that AgResearch used actual on farm activities across more than 50,000 ha in the Upper Waitaki, which were felt to be the most robust data available to indicate losses from similar activities in the basin in the future. In addition, Dr Robson stated, the EIA work referred to by Dr Ryan post-dated the beginning of the WQS.

11.106 At the time of giving her primary evidence, Dr Robson was a Senior Environmental Scientist with GHD in Auckland. During the course of the hearing she changed employers and was working for Ryder Consulting. Dr Robson holds a BSc (Hons) I degree in Tropical Environmental Science conferred by the University of Aberdeen, an MSc in Integrated Water Management and Advanced Irrigation from Cranfield Institute of Water Management at Silsoe, and a PhD in Plant and Soil Science conferred by the University of Aberdeen. She has completed the UK Fertiliser Advisers Certification & Training Scheme (FACTS) and the Intermediate Sustainable Nutrient Management Course run by the Fertiliser and Lime Research Centre at Massey University. Dr Robson has 10 years of postgraduate experience and since 2004 has been working specifically to reduce diffuse pollution from agriculture both in a regulatory role and through voluntary schemes. From 2004 – 2008 she worked as an Agricultural Environment Officer for the Environment Agency working with farmers to reduce nitrate losses and meet regulations with respect to nitrate losses, groundwater protection, slurry, silage and fuel oil, pesticide use and containment and general pollution prevention. Part of this experience included working on the 'Landcare' project which was rolled out as part of a UK-wide project to address diffuse pollution from agriculture and is used to deliver water quality improvements required under the European Union Water Framework Directive. Dr Robson is an experienced consultant and one of few actively working in the field on mitigation of diffuse pollution. We gave her evidence careful consideration.

Our consideration of the issue

11.107 All witnesses addressing this point had credible arguments. Dr Snow's ECOMOD output supports her arguments that shortening the irrigation return period (as is possible with pivot irrigators) increases dry matter production and that 14 tonnes/ha/y is possible. However the counter arguments by Dr Ryan and Dr Clothier that while Dr Snow's dry matter production is theoretically possible, it doesn't represent the likely <u>average</u> dry matter production, and that farmers are more likely to find it cost-effective to increase N fertiliser application (because short irrigation return periods also have cost implications) is also credible. We are also mindful of Dr Monaghan's and Mr Pott's evidence that achieving the OVERSEER-assumed BMP of optimum irrigation may be difficult to achieve in practice.

11.108 We agree with Dr Robson that it is better to use actual farm data as the basis for modelling the future irrigation case (with respect to dry matter production) rather than a theoretical farm (as is the case with the partially irrigated farm presented in the economic impact analysis by Mr Harris). However Dr Ryan's argument that the partially irrigated EIA farm scenario is more representative of likely average farm management (on sheep and beef properties) than that derived from the relatively small existing irrigation on AgResearch's 7 modelled farms, is also convincing. On balance we agree with Dr Ryan that the partially irrigated EIA farm case, would have resulted in a more conservative assessment of dry matter production on irrigated sheep and beef properties

Systematic error 4 – Extrapolating nitrate leaching losses

11.109 Predictions of how much N will leach from future irrigated farms is central to the issue of whether the proposed NDAs allocated to those farms are achievable. OVERSEER predictions of nitrate leaching are dependent on reliable estimates of dry matter production (although not solely) and may also be affected by shallow soils. The FSM was not used to calculate future nutrient loads directly but nevertheless the estimates of nitrate leaching derived for the irrigated farm case were multiplied by the area under the designated land use and summed to give predicted nutrient load to the lake. Therefore any errors in choosing appropriate leaching rates will be propagated through to predicted lake load.

11.110 Dr Snow gave the method whereby AgResearch calculated N leaching in her primary evidence. Because this section deals primarily with criticisms of that method by submitters and s42A officers, we have reversed the usual order of documenting the views of the expert witnesses and placed the applicant's view (as rebuttal) at the end.

Submitter's Views

11.111 Dr Ryan pointed out that the OVERSEER leaching estimates made using the partially irrigated farm model are significantly greater with the same stocking rate than the estimates used by MWRL (11 kg N/ha/y instead of 9 kg N/ha/y).

11.112 Dr Ryan pointed out (#20) that the average nutrient loads for the different land uses (i.e. dryland, irrigation etc.) from these existing farms were also extrapolated to calculate the nutrient loads from farms under the future case scenario with further irrigation development using an average nitrogen leaching estimate from the developed status of 9 kg N/ha/yr.

11.113 Dr Ryan made the point the although Dr Monaghan stated there was no real difference between the 9 and 11 kg N/ha/y, when scaled up to the whole catchment it increased the total N load from 264 T/y to 323 T/y. Given there was no sensitivity analysis of key variables undertaken in the OVERSEER modelling that would have provided upper bound leaching estimates and a degree of comfort for projected leaching losses, his view was that the partially irrigated farm model estimates under the developed scenario at least provide a more conservative bound.

11.114 The implication of the N leaching underestimate in Dr Ryan's view (# 41) was that the calculated assimilative capacity for water bodies within the overall catchment has likely been over-estimated on the basis that the assimilative capacity stated represents the difference between the proposed nutrient load and the environmental threshold. The effect of this over-estimation is that the stated level of required on-farm mitigation has been under-estimated.

11.115 Dr Ryan recalculated the maximum allowable leaching load different subcatchments using the MWRL target and recalculated assimilative capacities (his tables 5-7). He concluded (#48) that even using the less conservative developed scenario, the level of mitigation required after the correction is significantly more than MWRL have predicted. In his addendum evidence Ryan revised Table 5 to just use the developed setting. With this revision (of Ahuriri catchment as the example) he calculated that mitigation on irrigated sheep and beef properties would need to be at least12 kg/N/ha/y (addendum #10-12).

Applicant's Views (rebuttal)

11.116 Dr Snow spent considerable effort (#29, 50,51,54) in countering the claims of Dr Clothier and Dr Ryan that their own modelling had shown significantly greater leaching rates than the AgResearch modelling. Much of the argument centred around nitrogen fixation (Dr Snow's view that the rate in the Mackenzie basin is very much less than the 200 kg N/ha/y claimed by Dr Ryan), dry matter production as discussed above, fertiliser requirements and effects on N leaching, and effects that stocking rate inputs had on OVERSEER predictions.

11.117 Drs Clothier and Ryan argued that if a shortfall between predicted and actual drymatter production occurred, farmers would use additional N fertiliser to overcome this imbalance, which would result in additional N leaching. Dr Snow countered this saying that even if extra N fertiliser were used, it would not necessarily result in additional N leaching. In addition Dr Snow argued those farmers' abilities to add extra N would be constrained by their NDAs.

11.118 Dr Robson stated that Dr Ryan's assertion that an average N leaching estimate of 9 kg/ha was used for future case scenarios in the WQS was only partially correct, and that substantially higher N loss estimates of 26-35 kg N/ha were used for dairy farming scenarios.

11.119 Dr Robson was of the view that Dr Ryan had failed to appreciate that MWRL had calculated much higher N losses for irrigated dairy farms (than sheep and beef) in his comparison between the EIA with either 150 kg N/ha or 200 kg N/ha fertiliser additions and the MWRL modelled N losses.

11.120 Dr Robson argued that the difference (1174 T N/y) between the 'developed' MWRL case and the 'highly developed' EIA case asserted by Dr Ryan cannot be substantiated and that if MWRL has underestimated N losses it is at most by 56 T/y (2 kg N/ha/y) which is the difference derived from Dr Ryan's Table 3 of the two 'developed' cases.

11.121 Dr Robson went on to argue (#13) that using this 'maximum difference' between the two input scenarios of 2 kgN/ha/y for the Ahuriri catchment, there was still approximately two-thirds of the available cushion (40,000 kg N/y) available before the MWRL-calculated threshold for oligotrophic conditions would be breached (assuming 6,200 ha of new and proposed irrigated sheep and beef in the catchment).

Our consideration of the issue

11.122 We agree with Dr Ryan that in the absence of a sensitivity analysis it is prudent to adopt a conservative scenario for the purposes of calculating the total N load leached from irrigated soils, and the partially irrigated EIA farm case fulfils this criteria for sheep and beef properties

11.123 We therefore prefer his estimate of 11 kg N/ha/y rather the 9 kg N/ha/y promoted by MWRL. We appreciate Dr Monaghan's view that from an agronomic perspective there is no significant difference between the two estimates, but point out that from a limnological perspective such an increase may be critical.

11.124 It follows that we also support Dr Ryan's logic that the level of on-farm mitigation required is likely to have been underestimated by MWRL.

11.125 We accept Dr Snow's evidence that Dr Clothier and Dr Ryan overestimated the amount of N fixation achievable by legumes in the Mackenzie Basin environment, but point out that Dr Ryan's comparisons were made using only OVERSEER modelling.

11.126 We agree with Dr Robson that comparing the developed MWRL case with the highly developed EIA case (as done by Dr Ryan) is not sensible. However even comparing the developed MWRL case with the developed EIA case increases the total N load to the lake from 264 to 323 T/y (59 T N) while comparing the two highly developed cases increases the N load by over 500T.

11.127 We agree with Dr Robson's logic that if we accept the maximum difference between the MWRL scenario and the EIA scenario as 2 kg N/ha/y then there is still two-thirds of the available cushion before the MWRL-calculated threshold is exceeded. However this conclusion is predicated on accepting both MWRLs definition of 'limiting ecosystem' and accepting that the calculated thresholds are correct.

11.128 We do not agree with Dr Robson that Dr Ryan did not take into account irrigated dairy properties. He clearly stated in his evidence that his concerns related to sheep and beef properties.

Systematic error 5 – Modelling phosphorus losses

Applicant's Views

11.129 Dr Snow told us that GHD assumed that future P losses would be split between surface water and groundwater pathways –the split determined by local hydrogeology.

11.130 Dr Monaghan pointed out (#25) that strictly speaking the P loss estimate in the OVERSEER model is a risk assessment index rather than a predicted load, "even though the index does correlate reasonably well with measured loads for the limited number of sites for which good data is available."

Submitter's Views

11.131 Mr Potts (#52.3) noted that there was no consideration of phosphorus in the migration of groundwater.

11.132 Mr Potts is the National Environmental Science Leader of the multidisciplinary consulting firm CPG New Zealand Limited (CPG) (formerly Duffill Watts Limited and before that Glasson Potts Fowler Limited) and have worked in the area of water resources and environmental engineering for over 30 years. Mr Potts has a New Zealand Certificate in Engineering (Civil); BE (Hons) from the University of Canterbury) and a Graduate Diploma in Hydrology (Groundwater) from University of New South Wales). He is a Member of the Institute of Professional Engineers NZ (MIPENZ) and is a Chartered Professional Engineer (CPEng). He is also a member of Water New Zealand, New Zealand Irrigation Association, and New Zealand Land Treatment Collective. Mr Potts has been involved in numerous irrigation scheme development projects and water resource investigations in New Zealand and overseas in various roles: project management; assessing plant water requirements; assessing groundwater resources; assessing soils; designing on and off-farm irrigation infrastructure; measuring and modelling nutrient losses; and assessing the effects of irrigation development. Mr Potts is a very experienced practitioner in his field and we considered his evidence carefully.

11.133 Dr Ryan stated that the very low soil P losses presented by MWRL (≤ 1 kg P/ha/yr) did not appear unreasonable, and that any attempt to differentiate the small reported differences in P leaching between land use or farming systems is unrealistic because they are almost certainly within the margin of error of the OVERSEER model.

Applicants Right of Reply

11.134 Dr Romero's analysis of the component parts of the TLI showed a high sensitivity of the Ahuriri River TP TLI index (TLITP) to small increases in the TP load multiplier, which highlighted, in his view, also the need to maintain no increase in the phosphorus fluxes.

Our consideration of the issue

11.135 Whilst MWRL have estimated both nitrogen and phosphorus fluxes the main emphasis of the WQS has been on nitrogen. This caused little comment from experts appearing for applicants, submitters, and s42A experts until Dr Romero's right of reply evidence showed a high sensitivity of the Ahuriri Arm to phosphorus, which highlighted in his view, the need to maintain no increase in phosphorus fluxes.

11.136 Whilst we appreciate Dr Ryan's advice that any attempt to differentiate small differences in P leaching between land uses or farming systems is unrealistic probably within the margin of error of OVERSEER, this is not in our view an excuse to ignore phosphorus but rather highlights the need to use a different model.

11.137 If P was of only minor concern this could be acceptable but Dr Romero's evidence suggests that it may be very important. We also need to take into account that in these shallow Mackenzie soils, a significant proportion of P loss appears to be to via groundwater, whereas conventional wisdom (incorporated within P risk indices) is that almost all P loss is via surface runoff to streams (slope, stocking rate, erodibility being key predictors). This

would not appear to be the case in this instance and therefore the ability of OVERSEER to predict P loss must be questioned.

How are the proposed mitigation measures reflected in OVERSEER?

11.138 The MWRL case is that some farms will need to reduce their nutrient leaching rates to less than that commonly achieved through good agricultural practice. This will be achieved through the implementation of Farm Environmental Management Plans (FEMPs) and on-site Farm Environmental Risk Assessments (FERA). The FEMPs are designed to reflect the predicted reduction in nutrient leached, whereas the FERA are for site-specific issues that may not be reflected in a modelled nutrient budget on the irrigated areas. In this section we consider the methodology behind the FEMPs in general, and their ability to reflect the range of mitigation options proposed. We do not consider individual FEMPs (or FERAs) which are discussed in Part B of this decision.

Applicant's Views

11.139 Dr Robson described the mitigation toolkit in general - which included "a section that describes each of the mitigation measures in detail with reference to implementation, efficacy, limitations to use and impact on other pollutants."

11.140 Dr Robson also described the development of the FEMPs which was in three sections:

(a) The first section describes some mandatory good agricultural practices (MGAPS) that need to be implemented across the farm, and include the base assumptions of the OVERSEER model.

(b) The second section, Dr Robson explained, is the construction of a representative farm model in OVERSEER, cross checking with the WQS modelled outputs from the farm, and confirmation of the required mitigation. She told us that once the mitigation requirements have been established, the proposed farm practices could be altered and modelled to give the required mitigation for the sub-catchment and receiving environment.

(c) The third section is the completion of an on-farm environmental risk assessment (FERA), and the choosing of management options or techniques to mitigate these specific risks.

11.141 Dr Robson listed (#20) the MGAPS adopted for the WQS, which are:

(a) Fertiliser application according to FERT Research (2002) code of practice for fertiliser use;

(b) Using a nutrient budgeting system to recommend the amount of fertiliser required;

(c) Accounting for all sources of nutrients including soil reservoirs as well as imported sources through regular soil testing and nutrient budgeting;

(d) Calibrating and optimising fertiliser spreaders at least annually to ensure the even application of fertiliser;

(e) Calibrating and optimising irrigators annually to ensure the even application of water and/or effluent;

(f) Good design of irrigation systems to match soil properties;

(g) Robust irrigation scheduling to prevent summer drainage; and,

(h) Recording crop, cultivation, nutrient inputs and yields on paddocks.

11.142 Dr Robson described the mitigation options from the mitigation toolkit in some detail (#30-105). Mitigations options were categorised into groups by the source of the loss as follows:

(a) Soil

(b) Effluent

(c) Stock loss

(d) Fertiliser

(e) Irrigation water

(f) Runoff water

11.143 For each group of options, Dr Robson described:

(a) The main mechanisms whereby the mitigation practice would achieve the intended result,

(b) Literature examples of previous use, and,

(c) Literature examples of measured effectiveness of the mitigation practice.

11.144 Dr Robson used Glen Eyrie downs as an example of how a FEMP was developed. The example illustrated the principles of:

(a) Declaring the applicable MGAPS,

(b) Modelling the expected nutrient losses from the proposed farm system after irrigation (as declared by the farm owner),

(c) Comparing modelled nutrient loss with the threshold determined from the most limiting ecosystem (Lake Benmore, and Wairepo groundwater in this case depending on location within the 2,200 ha property),

(d) Where modelled nutrient loss exceeded the threshold (as in this example), modifying the proposed farm system iteratively (by increasingly restrictive grazing) and running the model again until the proposed threshold is met,

(e) Conducting an on-site FERA to identify site-specific risks,

(f) Selecting appropriate mitigation practices from the toolkit to mitigate those risks,

(g) Designing a farm monitoring plan showing location, frequency, parameters measured, triggers, and contingency plans if triggers exceeded, and,

(h) An auditing plan giving examples of auditing measures carried out externally, internally, or either externally or internally; designed to provide assurance that the monitoring plan has been carried out effectively.

Submitters Views

11.145 Dr Ryan took issue with many of the mitigation measures proposed by MWRL to stay below the threshold loads at various nodes stating that only nitrification inhibitors or restrictive grazing (no winter grazing) offered any real mitigation benefits. The vast majority of other measures proposed by MWRL were, at best BMP's (MGAPs in Dr Robson's parlance) in his view, with many of them assumed within OVERSEER. In his addendum evidence (#21) he reiterated only 2 mitigation options are real possibilities, and they would reduce N loads by a maximum 27%. He also argued that there have not been any reduction factors presented in the WQS that would be used if any of these BMPs were actually employed in Farm Environmental Management Plans (FEMPs) to specifically reduce farm nutrient nitrogen leaching loads.

11.146 Dr Ryan presented a calculation for a hypothetical sheep and beef farm in the Benmore node, Ahuriri catchment (Table 10). He reasoned that in order to comply with its NDA, a sheep farm would need to employ the 2 on-farm mitigation options above , apply very low (i.e. < 45 kg N/ha/yr) amounts of N fertiliser, and would only be able to add an additional 11 stock units per hectare of irrigated land in their farming operation with developed soils[12]. This is significantly less than the 16 - 18 SUs/ha that irrigated land in the Upper Waitaki can potentially support. The overall net impact on the farm, is that the farm would have a net gain of only 950 stock units under developed soils if deciding to irrigate.

11.147 Dr Ryan agreed (#63) with the dairy farming scenario put forward by Drs Bright and Robson for Killermont and Glen Eyrie saying that where grazing is restricted and cows are essentially housed most of the year, the farms should have a significantly reduced leaching load compared to a typical New Zealand dairy farm system. He agreed that the type of dairy operations proposed would likely have nitrogen leaching loads less than the permitted maximum nitrogen leaching loads (21 and 16 kg N/ha/yr) for the sub-catchments mentioned, assuming that the environmental thresholds calculated for the sub-catchments are realistic.

11.148 However he maintained it was a different matter for the partially irrigated sheep and beef farms that would predominate in the catchment, and that these farms would need to have significant mitigation and or reduce their stocking density below the levels originally planned for to meet their NDAs.

11.149 Mr Potts (#40) commented that although the mitigation measures look good in theory, the MWRL assessments are very vague as to what has already been included in the input assumptions to the water quality work and where and how the various mitigation measures will be applied.

11.150 Mr Potts was also of the view that on-farm monitoring for compliance simply pushes the risk out and may make it difficult for consents for irrigation infrastructure to be reversed or unwound.

S42A Officers' Views

11.151 Mr Hansen was of the view that MWRL has not demonstrated that the outlined mitigation approach would indeed be effective. In his opinion, the assessment has not quantified the reduction in nitrate leaching loss that the measures would accomplish and that without quantifying the effectiveness of these measures, it is impossible to estimate which measures, or how many measures, will be required to meet water quality thresholds in the basin.

11.152 Mr Hansen noted that OVERSEER assumes that farms are already following best management practices with regard to nutrient management. He was sceptical that the mitigation measures suggested will achieve substantial further reductions in on-farm nutrient losses and that at any rate, the efficacy of the proposed mitigation measures needed to be demonstrated in a far more detailed and quantitative manner than that presented in the assessment reports.

Applicant's views (rebuttal)

11.153 Dr Robson argued that all the mitigation measures she cited, which were dismissed by Dr Ryan as being not viable, impractical, or already BMPs, were backed up by "reasonable research evidence" as to the effectiveness internationally as well as in NZ. She also rebutted similar arguments made by Mr Hanson saying that the FEMPs were not available for Mr Hanson's review at the time of writing his s42a report and that these FEMPs now illustrate how the thresholds are met through OVERSEER modelling.

11.154 Dr Robson agreed with Dr Ryan that the explicit assumptions behind OVERSEER form part of the Mandatory Good Agricultural Practices committed to by all farmers. But she also stated that it was precisely because many of the activities on farms that may have

[12] Dr Ryan also did a calculation for highly developed soils but we have discounted these because of his arguments in addendum evidence that the highly developed setting has no scientific credibility.

environmental impacts are not captured in OVERSEER, that the site-specific FERA is such a critical part of the FEMP process.

11.155 Dr Robson commented that the maximum 27% reduction in N leaching achievable with the only 2 mitigation options that Dr Ryan considered feasible (stock reductions and nitrification inhibitors) was "not an inconsequential amount" and that greater reductions could be achieved where the farm had a significant beef or dairy component.

11.156 Dr Robson defended the choice of Killermont Station and Glen Eyrie Downs as examples of effectiveness of mitigation (criticised by Dr Ryan as not being typical) saying they were examples chosen specifically to illustrate that the required mitigation was possible even with the most intensive systems and largest developments in the areas where most mitigation is required.

Our consideration of the issue

11.157 The MWRL presentation on the role of mitigation measures was confusing, particularly with respect to which measures were MGAPS (and therefore assumed already by OVERSEER), which were included within OVERSEER modelling to reduce nutrient loads below NDAs, and which were incapable of being modelled by OVERSEER. Some clarity on this aspect would have helped considerably.

11.158 The Glen Eyrie example given in Dr Robson's evidence illustrates the problem. Many of the mitigation measures identified are MGAPs which begs the question as to why are they identified as mitigations at the FERA stage.

11.159 We did not find the literature review on the effectiveness of mitigation measures in NZ and internationally particularly helpful. The range in effectiveness of some measures varied greatly and the way in which effectiveness was measured was inconsistent. It would have been more helpful if the effectiveness of each mitigation option assumed in OVERSEER modelling were documented.

11.160 We agree with Dr Ryan that that of the mitigation options presented by Dr Robson, only nitrification inhibitors or restrictive grazing offer any significant benefits to sheep and beef farmers in terms of reducing N leaching.

11.161 We also agree with Dr Ryan that there are few mitigation options available to sheep and beef farmers (compared to dairy farmers) that reduce N leaching, without having a marked impact on farm viability.

11.162 Our view is that at least some of the confusion about the role of mitigation in OVERSEER modelling is due to the word being used with two distinct meanings. For example Dr Robson (#16) "Once the mitigation requirements have been established, the proposed farm practices can be altered and modelled to give the required mitigation for the sub-catchment and receiving environment." Meaning "Once the amount of nutrient reduction has been established, the proposed farm practices can be altered and modelled to be below the required thresholds for the subcatchment and receiving environment". In other words OVERSEER models the changes in farm practices (stocking rates, stock type, effluent disposal etc.) rather than "mitigations" in the sense used in the mitigation tool kit. When discussing the toolkit (e.g. #29 of Dr Robson's evidence) mitigations are the actual practices that will assist in achieving the desired nutrient reductions. However these cannot necessarily be modelled in OVERSEER.

11.163 In order to have confidence in the process, the actual nutrient reductions achieved through changes in farming systems (from that proposed) must finish at step 2 of Dr Robson's 3-step programme. Any nutrient load reduction due to the third step (FERAs and implementing the mitigations in the toolbox) cannot reliably be accounted for in OVERSEER modelling.

Key conclusions on predicting nutrient losses

11.164 OVERSEER is the best method currently available for estimating nutrient loads (particularly nitrate) resulting from changing farm systems and management. However it does have limitations, and it is important to recognise these limitations with respect to how OVERSEER modelling results have been used for these applications in the Mackenzie Basin.

11.165 Whilst OVERSEER has been used for other similar applications in New Zealand (the most notable being to manage the nitrogen cap imposed on the Lake Taupo catchment) there are distinct differences between the two cases. At Taupo OVERSEER is used to regulate a reduction in N leaching to below an established threshold, whereas at Benmore the applicants propose that OVERSEER will be used to regulate an increase in N leaching up to a threshold. In our view the risk to the environment of relying on OVERSEER are greater at Benmore because any errors will result in a significant adverse environment effect, whereas at Taupo the effects of errors will be minimal since any reductions in N load will be beneficial compared with the status quo.

11.166 With respect to this specific application of OVERSEER in the Mackenzie basin we have concerns about:

(a) The absence of any Mackenzie basin sites (or other sites with similar climate and soils) in the OVERSEER database,

(b) The ability of OVERSEER to estimate nutrient losses from farms in rapid transition (as will be the case with large areas of currently undeveloped land), and the absence of guidance on how long it will take before an equilibrium state is reached,

(c) Lack of clarity over which Farming Systems proposed by the applicants cannot currently be modelled.

11.167 We acknowledge that OVERSEER was not used directly to calculate the contribution of each farm to the nutrient load on Lake Benmore, however we are of the view using the average losses from different land uses across the 7 stations modelled by AgResearch to provide loss coefficients for each land use (used in the WQS) is not a superior method.

11.168 Our view is that there is no demonstrable evidence justifying the use of a denitrification factor in 'gley soils' post-OVERSEER modelling, and that submitters and Section 42A officers have provided valid arguments why denitrification will not be a significant loss process in this catchment.

11.169 The minimum uncertainty in OVERSEER estimates of leaching rate appears to be ±20% and this uncertainty will be higher on (a) shallow soils, and (b) using the highly developed setting. This uncertainty does not appear to be factored in to calculation of individual NDAs.

11.170 The increase in leaching on shallow soils (above that estimated in AgResearch technical reports) may be as great as 15 kg N/ha/y for dairy farms. Overall it is likely that leaching losses in the WQS are underestimated by at least 10-20%.

11.171 Only the developed setting in OVERSEER has been validated. However using the developed setting results in unrealistic immobilisation rates on some shallow soils. Therefore using the highly developed setting is preferred to define a pragmatic upper bound to leaching rate even though it is accepted that such an estimate is subject of greater uncertainty. We were not convinced that any of the measures proposed by the nutrient caucus would be able to routinely demonstrate that a property would comply with its NDA in the event it could not meet it using the highly developed setting. Mechanistic modelling is the best of alternatives suggested but its cost-effectiveness needs to be established.

11.172 The amount of dry matter produced on irrigated land without the use of N fertilisers is a key determination in the amount of N leaching. To date the arguments have been based upon theoretical modelling and are dependent upon input assumptions. There is an urgent

need for some field verification of dry matter yield and leaching rates on these Mackenzie Basin soils; particularly the shallow soils lacking organic matter.

11.173 In the absence of verification of modelling assumptions and/or a sensitivity analysis of all model parameters, nitrate leaching losses should be based on conservative scenarios of farming systems likely to be readily achievable by the majority of farmers.

11.174 Phosphorus has been identified as a limiting nutrient both in some stream ecosystems and possibly also in the Ahuriri arm of Lake Benmore. There is some evidence that dissolved phosphorus can be lost to groundwater. There has been insufficient emphasis placed upon modelling phosphorus losses from irrigated farms in the catchment and the use of OVERSEER for this purpose is questionable given the risk indices built into OVERSEER are based upon surface-runoff pathways.

11.175 The mitigation options that can be modelled by OVERSEER are ill defined as are any assumptions about the effectiveness of each option. In the absence of such definition, we would expect that any reductions in nutrients (through toolkit mitigation options) to meet NDA's at the property level are justified through concept design within each FEMP.

11.176 While we acknowledge that the Farm Systems modelling approach in general, and OVERSEER in particular is the best tool currently available for estimating nitrogen loss from farms in New Zealand, our view is that has significant shortcomings for this particular application at this particular location. In our view further research and development of OVERSEER is required in the Mackenzie Basin before it can be utilised confidently to manage NDAs in this sensitive environment.

12 ADAPTIVE MANAGEMENT

12.1 Adaptive management arises primarily in the context of the proposed conditions. In particular, the circumstance where, if consent is granted with conditions in place and the application activity is in operation and a particular nodal discharge threshold is exceeded. The irrigators contributing to nutrient loads, which affect that node, are required to identify and adopt methods to ensure the relevant water quality standard in the WQS is met. This remedial action plan is to be approved by the consent authority. This is the context in which we discuss adaptive management.

Applicant's Views

12.2 Mr Whata set out the definition of "*adaptive management*" as being:

> "*An experimental approach to management or "structured learning by doing". It is based on developing dynamic models that attempt to make predictions or hypotheses about impacts of alternate management policies. Management learning then proceeds by systematic testing of these models, rather than by random trial and error. Adaptive management is most useful when large complex ecological systems are being managed and management decisions cannot await for final research results.*"[13]

12.3 Mr Whata noted that the Environment Court has accepted that adaptive management plans can be controlled by enforceable resource consent conditions[14]. He also drew to our attention the potential for beneficial effects arising out of an adaptive management strategy was acknowledged in the case of *Biomarine Ltd v Auckland RC*[15]. He quoted from that decision as follows:

> "*It appears to be common ground before the Court that all these potential effects can be addressed by the proposed conditions, including extensive monitoring, review and adaptive management provisions. It was not disputed before this Court that these effects are appropriately avoided, remedied or mitigated. We also*

[13] *Golden Bay Marine Farmers et al v Tasman DC* W19/03 (EC) at 405.
[14] *Golden Bay Marine Farmers* at 409.
[15] A14/07 EC at page 123.

acknowledge that there are beneficial effects which may occur as a result of the grant of consent."

12.4 Mr Whata told us that adaptive management is most useful when large complex ecological systems are being managed and management decisions cannot wait for final research results. He submitted it was not new to resource management and is commonly being used in large projects where the applicant is prepared to incur the very significant costs associated with multifarious conditions of consent. He provided us with some examples.

12.5 He drew to our attention by reference to the *Clifford Bay Marine Farm Ltd* decision[16] that adaptive management is only appropriate where two key elements can be satisfied. They are:

(a) the adaptive management strategy proposed can detect adverse effects, i.e., monitoring of the risk involved; and

(b) the adaptive management strategy can remedy any effects that might arise before they become irreversible, i.e. the efficacy of mitigation.

12.6 Mr Whata submitted that both criterion are satisfied in the current case because a comprehensive monitoring system is required by the conditions of consent, which requires monitoring at both a sub-catchment and farm level. Further, if monitoring detects an increase in nutrients above the WQS thresholds, effective mitigation measures can be put in place to ensure the effects are appropriately addressed.

12.7 Mr Whata then set out an analysis of the risk of adverse effects arising if the thresholds are breached. He detailed a 5-step approach to risk assessment that has been developed as follows:

(a) identify the risk;

(b) identify the consequences for each relevant effect;

(c) estimate the probability of harm;

(d) evaluate the significance of the risk. This involves a value judgement under the objectives and policies of the relevant plan;

(e) conduct a comparative risk assessment.

12.8 He informed us the following factors are relevant in the assessment of risk, namely:

(a) annual monitoring is proposed so that any upward trends in nutrient levels will be identified at an early stage;

(b) increases in nutrient levels are likely to be gradual and over a number of years;

(c) nutrient reductions in the affected sub-catchments are reduced by set quantum 12 months after Environment Canterbury is notified of a breach and remain in effect until the remedial plan is put in place.

12.9 Mr Whata noted that we must be satisfied in relation to conditions affecting adaptive management strategy that the conditions:

(a) avoid, mitigate or remedy the effect or risk of it;

(b) are practicable; and

(c) are enforceable.

[16] Clifford Bay Marine Farm Ltd v Marlborough DC C131/03 (EC) at [118].

12.10 Mr Whata referred us to a recent interim Environment Court decision[17], in which the Court noted that adaptive management plans do not alter the requirement for resource consent conditions to be sufficiently certain.

12.11 Mr Whata noted the Court set out the tests for conditions derived from Newberry[18], quoting directly from *Housing New Zealand v Waitakere CC*[19] noting:

> "*A condition must also be certain. It can leave the certifying details to a delegate, using a person skilled and experienced but cannot delegate the making of substantive decisions.*"

12.12 Mr Whata submitted that the WQS sets out very clear environmental thresholds that must be met. He contended a comprehensive, yet practical system of monitoring is proposed at both the sub-catchment and farm level to ensure that thresholds are met. He noted if the thresholds are breached, the mitigation toolbox provides a range of mitigation options, which can be implemented to ensure that nutrient discharges are brought back within the threshold limits. The remedial action plan must, he said, be approved by the consent authority. Should the approach taken fail to satisfy the breach, the consent authority can undertake a review of all consents in the sub-catchment under section 128 of the RMA.

12.13 In summary, it was Mr Whata's submission the proposed condition of consent allow the irrigation to be implemented in a way that is responsive to change over time or unforeseen circumstances.

Mr John Kyle

12.14 In his evidence of 2 September 2009 on behalf of MWRL, Mr Kyle discussed adaptive management as a tool. He noted that while the WQS, in his view, provides a comprehensive assessment of the potential environmental effects associated with more intensive farming practices and the measures that need to be taken "*on farm*" to mitigate those potential effects on downstream water quality, there remains uncertainty surrounding those potential impacts and an adaptive management approach needs to be utilised and adopted.

12.15 In his discussion surrounding adaptive management, Mr Kyle cited work from Nyberg[20]. He quoted as follows:

> "*Adaptive management principles are derived from new scientific and ecological insights that interpret the natural world as dynamically changing, full of uncertainty, and continually surprising. Measures are designed to systematically monitor results and modify the measures through constant feedback. Management actions in monitoring programmes are carefully designed to generate reliable feedback, clarify the reasons underlying outcomes, and objectives are then adjusted based on this feedback, and improved understanding.*"

12.16 Put simply, and in the context of conditions and monitoring, Mr Kyle suggested that if the results of monitoring indicate that the farming regimes are leading towards adverse effects that left unaddressed may become significant, then these findings can be used to require the consent holders to adapt their farm management practices. He recognised the importance of lag time, noting that it was critical that the environmental indicators be triggered early so as to avoid effects from becoming significant. In particular, he noted lag effects arising and occurring in recognising discharges in groundwater. Thus groundwater monitoring is not suited to adaptive management techniques, he said, because of lag time and the risk to the environment that lag time represents. Thus surface water quality measurement at sub-catchment nodes was the chosen environmental indicator or trigger to the utilisation of adaptive management techniques.

---

[17] Royal Forest & Bird v Gisborne DC WO26/09 (EC) at [85].
[18] Newberry DC v Secretary of State for the Environment 1981 All ER 7312 (HL).
[19] 2001 NZRMA 202 (CA).
[20] An Introductory Guide To Adaptive Management For Project Leaders And Participants, January 1999.

12.17 It was important, he noted, that the adaptive management techniques be applied in broad terms to all of the landowners in the Upper Waitaki catchment. Therefore the consent holders within a specified sub-catchment are held responsible collectively for devising remedial action to address any identified water quality impacts that emerge.

12.18 He noted that taking this approach, scope is provided to determine whether the remedial action needs to be undertaken by one or more of the consent holders within a given impacted sub-catchment. He was clear that the mitigation measures could be spread across a number of land holdings, if deemed appropriate for the situation.

12.19 Adding to this point, he noted that it would be important that all resource consents issued would need to incorporate conditions that ensure that all properties "*upstream of a defined monitoring point comply with stipulated thresholds that are tailored to reflect the circumstances that apply in a given sub-catchment"*; and that all "*upstream*" consent holders contribute to common off-farm monitoring.

12.20 In his evidence when he discussed conditions with us, Mr Kyle noted that there were a number of conditions relating to adaptive management whereby off-farm monitoring of water quality at specific monitoring points are used to determine whether on-farm management practices and farming regimes need to be altered. The purpose of these conditions, he said, is to ensure that the consent holders are committed to undertaking mitigation where necessary in the future, even though that mitigation may not be foreseen at the time of issuing the consent.

12.21 He told us the conditions are structured so that when a particular off-farm environmental threshold is exceeded, those that contribute to the cause of that exceedance are compelled to identify and adopt methods for adapting farming methods in order that the effects on water quality are returned to an acceptable level. He noted that the conditions recognise that a collaborative approach to mitigation involve a number of consent holders within a particular catchment could be necessary. In such instances, he said, consent holders will need to work together to determine the optimum approach to mitigation. He noted that professional assistance from an appropriately qualified scientist is anticipated by the conditions.

12.22 He referred to the role of the Canterbury Regional Council as consenting authority in approving those mitigation measures to be adopted prior to these being applied. He expressed the view that if the respective consent holders could not resolve exceedances, conditions specifically enable the consent authority to invoke a formal review of the consents that issue. He told us that he thought that such a condition acts as both a 'carrot and a stick' to ensure that ultimately appropriate environmental thresholds remain intact.

Melissa Robson and John Bright

12.23 In their principal evidence for MWRL Dr Robson and Dr Bright discussed farm scale and catchment scale monitoring and corrective action programs.

12.24 They described that monitoring to verify allowed nutrient losses from each farm and ensuring that those collective losses from all farms in a particular catchment or feeding a particular node was required. Thus it was necessary to monitor nutrient concentrations throughout the Mackenzie Basin on both a farm scale and a catchment scale.

12.25 The correct action programs applicable at a catchment scale and also a farm scale were discussed. The objective was to ensure that farm practice maintains nutrient losses below a specified level, and in the event that catchment scale monitoring demonstrates that nutrient thresholds in those points are exceeded or can be expected on reasonable grounds to be exceeded within a defined period of time, then corrective action would be taken.

12.26 Here they referred to Mr Kyle's evidence advising us that Mr Kyle would present a suite of proposed consent conditions that encapsulated this approach, which he terms adaptive management.

12.27 In their evidence they went on to develop this concept of adaptive management in the context of the conditions.

12.28 To ensure compliance with the nutrient discharge allowance (NDA) they were of the view that a three-component monitoring program is required for each farm. The three components are:

(a) Development of an approved farm environmental management plan (FEMP); and

(b) Monitoring compliance with the FEMP.

(c) Monitoring compliance with the NDA

12.29 The farm manager would need to maintain a farm management diary that records sufficient details to demonstrate compliance with the FEMP.

12.30 Monitoring compliance with the NDA could be achieved by either:

(a) Annual use of OVERSEER, or approved equivalent with relevant details from the farm management diary to estimate annual nutrient losses; or

(b) Continuing monitoring of nutrient losses using approved monitoring methods, e.g., lysimeters and annual analysis of the data to calculate the annual nutrient loss at farm scale.

12.31 This data, they said, would be estimated or calculated and filed with Environment Canterbury.

12.32 If the monitoring showed the NDA was exceeded a review of the FEMP would be required to identify the further steps to be taken to reduce nutrient losses so they did not exceed the NDA. A review of the consent conditions relating to compliance with the nodal and property NDAs was also enabled by the conditions recommended by Mr Kyle, they said.

12.33 Dr Robson and Dr Bright then detailed catchment scale monitoring and a corrective action program.

12.34 The node points were identified by GHD (2009a) for the purpose of quantifying nutrient concentrations in waterways resulting from existing land uses and for quantifying the expected effects of the proposed development.

12.35 The WQS proposed that routine monitoring of nutrient concentrations and periphyton biomass at those nodes would be undertaken to verify the WQS thresholds are not being exceeded. We were provided with a map of the recommended monitoring sites and a description of the surface water monitoring program in Figure 6, Appendix B and Table 12 of the evidence.

12.36 Groundwater monitoring was to be undertaken at well locations as shown in Figure 6, Appendix B to the evidence. Where no suitable well existed a suggested location was given. A description of the groundwater monitoring program was provided in Table 12.

12.37 Turning then to the corrective action, it was proposed that if the monitoring revealed that a nutrient threshold was constantly being breached or the rate of increase in nutrient concentration gave reasonable grounds for expecting a nutrient threshold to be breached within two years, a string of actions should occur. These action steps included:

(a) Immediate notification to Environment Canterbury;

(b) Nutrient thresholds in the affected sub-catchment would be reduced by a set quantum coming into effect 12 months after notification;

(c) A cooperative approach to designing and implementing an investigation program that determines the nature and degree of any changes required to the

environmental standards currently in effect and to the nutrient discharge allowance;

(d) All farm management plants would be reviewed and altered where necessary to demonstrate the new nutrient discharge allowances could be met.

12.38 It was the opinion of Dr Robson and Dr Bright that the monitoring and corrective action program is sufficiently comprehensive and robust to manage the water quality effects of the proposed land uses with acceptable limits. They told us in their view it places the cost of meeting water quality standards on the consent applicants and they carry a substantial portion of the risks if the standards are not meet. They then referred to Mr Kyle's evidence, noting that he had recommended a suite of consent conditions that robustly encapsulate this concept. Both were of the opinion that his conditions were robust and appropriate in the context provided by the Basin and the nature of the proposals being advanced.

12.39 They were of the view that it was their understanding that this approach is more comprehensive and rigorous than other water quality management programs currently in use in New Zealand.

Dr Ryder

12.40 When considering the existing activities Dr Ryder in his evidence (#5.1) recognised the importance and significance of having available good baseline data covering existing irrigation operations against which to make assessments. It was his recommendation that monitoring of existing environment be continued in order to develop the baseline data set. He was keen to see the monitoring program established sooner rather than later because this would allow, he said, a more robust baseline to be established and it would also have the added advantage of enabling a wider range of environmental conditions to be considered under the baseline condition.

12.41 He also noted that given the scale of land use change under irrigation in the Mackenzie Basin there is potential for environmental change to surface-water should mitigation measures not be implemented in an appropriate manner. To minimize this risk he proposed independent verification of the monitoring program in mitigation measures at the catchment, sub-catchment and farm levels.

12.42 In his conclusions Dr Ryder noted that it was critical that farm management plans are tailored for individual plans within specific catchments and these are monitored and refined in response to environmental effects. He also noted that the level of monitoring required both on a spatial and temporal scale should not be underestimated. He also noted it was crucial that these processes be adopted and enforced on a catchment wide basis in order to ensure the environmental effects are acceptable.

12.43 Dr Ryder then noted that it was important to adaptively manage the management of the farm systems within the Mackenzie Basin should monitoring indicate the mitigation options were not adequately reducing the effects of irrigation on the receiving water environments. He supported the comments of Dr Bright that correction action programs applicable at a farm scale and at a catchment scale were also required.

12.44 Dr Ryder referred to Mr Kyle's evidence and agreed with Mr Kyle that if the results of monitoring indicated that farming regimes were leading towards adverse effects, which left unaddressed may become significant, then those findings could be used to require the consent holder to adapt their farm management practices. Dr Ryder noted that this statement from Mr Kyle is the sharp end of the knife and the adaptive management approach must be enforced in order for environmental effects to be maintained within acceptable levels.

Dr Melissa Robson

12.45 Relevant to this part of our decision Dr Robson provided evidence on the mitigation toolkit that she had prepared. The toolkit is designed to illustrate that the nutrient threshold set

in the WQS can be met through on-farm mitigation. It offers land managers guidance for formulating a Farm Environmental Management Plan (FEMP) to deliver the nutrient mitigation required by the WQS and to provide a suite of options for reducing diffuse pollution from site-specific environmental risks identified on their farms. We have discussed Dr Robson's evidence on FEMPs and the mitigation toolkit in Chapter 11.

12.46 Of particular relevance to this section was our view that for sheep and beef properties the only mitigation measures that would reduce nutrient loads to the degree required in sensitive catchments was reducing stock numbers or using nitrification inhibitors. The use of nitrification inhibitors was not proposed in any of the FEMPs we examined. In addition we noted that that the range in effectiveness of mitigation options cited in the toolkit was very large, such that it was extremely difficult to gauge their effectiveness, or what the scale and cost of such options would be to reduce nutrient loads below prescribed limits.

12.47 Because diffuse pollution sources were extremely difficult to trace to a particular property, Dr Robson told us, the emphasis of the mitigation toolkit was on the implementation of techniques that are known to reduce the contaminant.

12.48 Dr Robson concluded by saying the efficacy of all the management plans was, to a great extent, dependent upon their implementation. The principal risk of management plans, she said, was that once written they are not used or implemented. Therefore, she said, the plan needs to be not only technically competent but needs to be implemented, monitored and impartially audited. Thus robust monitoring and auditing processes are essential. The results of which would shape the FEMP into the future.

Submitters' Views

Meridian Energy Ltd

12.49 Ms Appleyard and Mr Williams (submissions dated 4 December 2009) summarized Meridian Energy's response to MWRL's adaptive management plan was that:

(a) The applicant's case places significant reliance on the use of adaptive management to respond to unforeseen problems that might arise;

(b) Adaptive management is appropriate for slight adjustments in mitigation in response to effects that cannot be completely understood prior to development. It is not a bandage to used to compensate for an inadequate assessment in the first place;

(c) For adaptive management to work, it needs robust baseline assessments against which to compare any effects that might occur. Meridian contended that MWRL do not have a proper understanding of the existing environment against which adaptations are to occur;

(d) This is not a situation where the position can be "cured' by work being carried out prior to the exercise of the consents.

(e) The additional work required may in fact indicate that consent should never have been granted due to the absence of any remaining assimilative capacity;

(f) The work might indicate a new level of mitigation, which would render the consent nugatory (i.e. of no value);

Department of Conservation

12.50 Legal Counsel for DoC noted (by reference to the Clifford Bay and Golden Bay Marine Farmers cases) that adaptive management was there adopted in a staged development approach. In other words, a limited trial and assessment of effects before the activity for which consent was being sought was fully implemented.

12.51 They suggested the MWRL proposal does not appear to involve staged development or indeed any sort of structured experimentation. Rather, the adaptive management proposed is responsive. It appears to require that when the nutrient thresholds from a particular node is exceeded, the irrigators contributing to that nutrient load measured at that node must identify and adopt methods in accordance with the mitigation toolkit to ensure that the relevant water quality standard is met.

12.52 Counsel referred to Mr Whata's submission that adaptive management was only appropriate where: (a) the adaptive management strategy proposed can detect adverse effects (i.e. monitoring the risk involved) and (b) the adaptive management strategy can remedy any effects that might arise before they become irreversible (i.e. the efficacy of the mitigation).

12.53 In DoC's view, on the basis of current information available in respect of the effects of these applications on the ecological values of the waterways of the Upper Waitaki Basin neither of these elements apply.

12.54 Dr Allibone (Native Fish Expert) was of the view that the monitoring proposed in terms of the adaptive management conditions would not detect adverse effects on the threatened indigenous fish in the basin and their habitat before significant damage occurs. Even if detected through means proposed by the applicant, Dr Allibone was of the view that the effects on the fish are potentially irreversible. The adaptive management regime proposed leaves uncertain the details of the response that would follow if adverse effects do indeed occur.

Ngāi Tahu

12.55 Mr Horgan provided a range of submissions in relation to adaptive management. Ngāi Tahu were unconvinced that an adaptive management approach would be effective in the present circumstances.

12.56 In Ngāi Tahu's view, an essential prerequisite for any adaptive management regime is that there is a clear understanding of the status of the existing environment. In the absence of such knowledge there will be no clearly defined baseline against which to measure change.

12.57 Ngāi Tahu's core point is they do not consider that there has been sufficient monitoring undertaken by the applicant in order to get an accurate gauge of existing conditions, nor is there any proposal by the applicant to carry out further sampling prior to the commissioning of the irrigation schemes. However, we do note that circumstance was modified over the course of the hearing.

12.58 Ngāi Tahu were of the view that the only way in which adaptive management could adequately work would be if it were combined with staging. Mr Horgan referred to various Environment Court cases in which staging was considered and supported.

12.59 In Ngāi Tahu's view however there were two significant obstacles in terms of staging. The first relates to economic considerations. Mr Horgan noted that significant infrastructure costs associated with the establishment of irrigation schemes. For example, intake structures, canals, dairy sheds, effluent ponds and centre pivots, etc. There also appeared to be, he said, a desire by the applicants to move into full production as quickly as possible.

12.60 The second challenge, he submitted, related to the slow rate or lag time at which groundwater takes to re-emerge and surface water bodies. Mr Horgan referred to the evidence of Mr Peter Callendar for Meridian in support, noting that it could take up to 10-20 years to see the full migration of nutrients through the system.

12.61 This meant that any staging of development would need to be conducted over a comparatively long timeframe so as to ensure that there is sufficient time to detect if the initial stages are having adverse impacts upon the quality of surface waterbodies.

12.62 Detection was another issue for Ngāi Tahu. Ngāi Tahu had reservations about the ability of the applicant in terms of the proposed monitoring regime to detect the occurrence of unsustainable levels of nutrients and to establish what is causing this.

12.63 A further point of concern for Ngāi Tahu was the chain of causation between an increase in nutrient loads and irrigation related activities. Ngāi Tahu considered this to be problematic. Mr Horgan suggested that it is likely to be a tendency of the consent holders to try and limit their exposure to the potentially significant cost associated with reducing nutrient loads. Further, he contended it would be difficult to pinpoint which irrigators caused the increase and for that matter whether such an increase is in fact being caused by irrigation related activities at all.

12.64 He also pointed to the reluctance of the UWAG group of applicants to endorse the nitrogen allocation mechanism proposed in the MWRL WQS.

12.65 Mr Horgan was also concerned about the ability of the applicant group to implement effective remedial action in the event that unsustainable nutrient loads were detected. He suggested that reducing the annual allocation of water for the subsequent irrigation season, as proposed by Southdown, Williamson Holdings, Five Rivers and Killermont Station would not necessarily be sufficient to address degraded water quality. He noted that any on-farm mitigation measures would be unable to prevent the re-emergence of nutrients into surface waterbodies. Nor will any remedial action be able to overcome the fact that internal nutrient loading will continuously replenish nutrient supply to the water colony for extended periods. The effect of this would be that it would take many years for degraded aquatic habitats to recover, if they ever do. In support, Mr Horgan referred to # 104 of Ms Sutherland's evidence.

Our consideration of the issues

12.66 Whilst we recognize that adaptive management is a valuable tool for managing large complex systems where the ecological responses to perturbations in the system are not fully understood. However our view is that the using adaptive management as a method for controlling nutrient discharges to rivers and lakes in the Upper Waitaki catchment as a whole is not appropriate and will not protect the water resources in the catchment with any measure of certainty. The primary reasons for us arriving at this conclusion are:

(a) We have rejected the MWRL case that all consents can be granted with conditions, without causing cumulative water quality effects,

(b) MWRL has not satisfied us that their proposed adaptive management can meet the criteria set out by the Court as being necessary for it to be a viable strategy,

(c) The geographic extent of the proposed irrigation is very large with multiple applicants, multiple catchments, and multiple receiving environments,

(d) Implementing the adaptive management would involve large resourcing issues and costs, not only for the applicants but also Environment Canterbury.

12.67 In Sections 8,9,10, and 11 of this Part A decision we set out our views of shortcomings in the MWRL case with respect to hydrology/geohydrology, lakes, rivers, and predicting nutrient loss from farms, respectively. In our view, these shortcomings, taken together, were sufficient for us to reject the MWRL proposition that we could grant all the applications before us without resulting in cumulative water quality effects.

12.68 It follows, therefore, that in rejecting MWRL's primary proposition, it would be inappropriate to grant consents with conditions reflecting an adaptive management strategy

12.69 We acknowledge that MWRL's secondary proposition was that an adaptive management strategy could overcome many of the deficiencies in both data and understanding that were exposed during the course of the hearing.

12.70 Mr Whata provided reference to the Court's finding on the elements that need to be satisfied before an adaptive management strategy should be contemplated. We agree with Counsel for Department of Conservation that neither of these elements apply in this case.

12.71 Our view is that the monitoring programme as proposed would be unlikely to detect adverse effects, and if it did, it could be too late to institute meaningful mitigation options. There are many reasons for this but those we consider of major importance are:

(a) Deficiencies in the nodal design whereby individual nodes do not reflect the full nutrient load that might be expected based simply on topography (groundwater bypassing),

(b) We do not accept the thresholds proposed by MWRL as discussed in Sections 9 and 10 of this Part A decision. They are indeed clear, as submitted by Mr Whata, but in our view they are not scientifically defensible.

(c) Significant, but largely unquantified lags in groundwater that recharges streams, rivers and lakes in the catchment. We note there is a poor understanding of where these recharge zones occur,

(d) A lysimeter network designed largely to provide improved verification of OVERSEER outputs, but spatially are inadequate for monitoring nutrient losses below the root zone,

(e) A dearth of groundwater monitoring wells. We note Mr Kyle's comments that such wells are not suitable for water quality monitoring because of lag effects, however such lags will also be apparent at surface water nodes below significant recharge zones.

12.72 We are also of the view that largely because of travel time considerations, and the quantity of nutrient that would already be entrained by the time an increase was detected at nodes, that the reduction in irrigation activities by a set quantum as proposed by MWRL will be ineffectual. In this respect we agree totally with the arguments set out by Mr Horgan. We are also of the view (contrary to that submitted by Mr Whata) that because of the number of applicants involved the conditions relating to adaptive management would be neither practicable nor enforceable. Requiring all consent holders within a specified subcatchment to be responsible for collectively devising and implementing remedial action as suggested by My Kyle , is in our view not realistic; particularly where there are differing farming objectives (e.g. large dairy operations versus traditional high country stations).

12.73 In addition, one of the central tenets of adaptive management is that the results or monitoring and research should feed back into improved understanding of the system (see above discussion of Nyberg by Mr Kyle). There is no evidence that this is proposed by MWRL in this case. Reducing the irrigation by a fixed quantum in the event of a breach suggests a 'suck it and see' approach rather than a measured testing of understanding, through for example, a deterministic model.

12.74 We do note that all of the cases advanced by MWRL illustrating adaptive management as part of consent conditions concerned a single applicant with a much more limited site in a geographical context. Even if the elements necessary for adaptive management were otherwise in place, the sheer scale, number of applicants, and catchment complexity would make the cooperative approach necessary for it to be effective very difficult to attain.

12.75 Thus, as we see it, compared to the previous application of adaptive management, MWRL is asking us to take a quantum leap in terms of these background circumstances to implement adaptive management.

12.76 We acknowledge that in line with the increasing use of adaptive management as a resource management tool in appropriate situations; it receives mention within the proposed Canterbury Regional Policy Statement at Policy 7.3.12, which provides for a precautionary approach in allocation within a planning framework.

12.77 The Policy requires the taking of a precautionary approach to the allocation of water for abstraction, the damming or diversion of water, or the intensification of land use or discharges of contaminants in circumstances where the effects of these activities on fresh waterbodies singularly or cumulatively are unknown or uncertain.

12.78 The methods provided for to implement the policy include setting objectives, policies and methods in regional plans to consider the use of adaptive management conditions on resource consents where potential effects can be managed by adjusting the quantity, rate or timing when water can be abstracted or used or contaminants discharged relative to the conditions of the waterbody or receiving environment.

12.79 In terms of the principal reasons and explanations found on page 69 of the document, it provides that many activities involving water or the discharge of contaminants are essential for health and economic and/or social wellbeing and many of the gaps in the knowledge will take lengthy research to fill. However, it is usually more difficult to remedy adverse effects of activities after the fact than to avoid them in the first instance.

12.80 Policy 7.3.11 signals a precautionary approach to dealing with fresh water issues where information is incomplete or relationships not well understood. A precautionary approach does not mean that all activity should be prevented. The degree of caution in a precautionary approach will vary, depending on the significance of the activity for people's wellbeing, the potential effects of the activity, the extent of knowledge, and the degree of concern over potential effects requires a case-by-case judgement to be made.

12.81 In this particular case, it is our strong view that granting consents with adaptive management conditions is not appropriate for the catchment as a whole. For the Ahuriri and Wairepo subcatchments there are significant consequences to lake ecosystems, which would be extremely difficult to reverse as well as potentially very expensive. We do not think the experimenting with adaptive management in these catchments is consistent with a precautionary approach.

12.82 For applicants in the Haldon Arm catchment, however, the consequences of error in adaptively managing large scale irrigation are must less, as the Haldon Arm is not at risk of increasing in trophic state beyond oligotrophy. We do think, therefore that there may be the opportunity for trialling adaptive management of a discrete application in that catchment particularly if other elements necessary for adaptive management to be successful are satisfied, and if the adaptive management also involved staging as discussed by Mr Horgan. This is discussed further in relevant Part B Decisions.

12.83 Policy 7.3.11. also lists the 'extent of knowledge' as one of the factors influencing a precautionary approach. In this regard we record here our view that MWRL and perhaps some of the wider applicant groups have failed to complete the necessary background research and assessments. This is not a case where there has been an inability to provide for "for final research results". The applicant group has had sufficient opportunity caused by the significant delay in bringing these matters on and ample time has therefore been available within which proper monitoring, research and analysis could have occurred.

Key conclusions on adaptive management

12.84 Granting consents with adaptive management conditions is not appropriate in this case as to do so could not guarantee that adverse environmental effects would be avoided, remedied, or mitigated.

13 LANDSCAPE VALUES AND RELATED ISSUES

13.1 A common ground of opposition to the applications was that further irrigation should not be allowed in the Mackenzie and Waitaki Basins due to the outstanding natural landscape and its associated values. Although there are many separate proposals before us, this opposition was not specific to a particular proposal. It was presented as a catchment-wide issue of relevance to the applications as a whole.

13.2 The purpose of this part of our decision is to consider and address the above point of opposition, which was primarily advanced by the Mackenzie Guardians. In particular, we have considered whether the landscape and associated values of the Mackenzie and Waitaki Basins justify a decision not to allow any further irrigation in the area.

13.3 In order to address this issue, we have considered the following key questions:

(a) Are landscape effects relevant?

(b) What is the existing landscape and the values associated with it?

(c) What changes will irrigation bring to this landscape?

(d) How significant are these changes?

13.4 Closely related to the issue of landscape are potential effects of the activities on terrestrial ecology. In addition, there are effects on matters such as recreation and tourism that are often dependant on the landscape in which they take place. We have considered these issues in this part of our decision where they are relevant at a catchment wide scale.

13.5 This part of our decision is not intended to provide a site specific assessment of the effects of a particular proposal on landscape and terrestrial ecology. This assessment is provided in our Part B decisions. At the end of this part, we have provided an outline of the approach we have adopted in our Part B decisions when considering landscape effects and related issues.

Expert witnesses

13.6 During the course of the hearing, we heard from many different experts on landscape and some of the related issues. The following is a list of some of the key experts that provided evidence on these matters. However it is important to note that this list is not intended to be exhaustive.

13.7 We have taken into account all evidence from all witnesses even if not listed below. If a particular expert is not listed, this simply means that we considered that the issues they raised were addressed in a similar manner by one of the other experts. We therefore determined that is was not necessary to directly refer to their evidence for the purpose of this discussion.

Experts for applicants

Mr Andrew Craig

13.8 Mr Craig is a landscape architect that presented evidence on behalf of UWAG.

13.9 Mr Craig holds a Bachelor of Arts degree and a Post-Graduate Diploma in Landscape Architecture. He is an associate member of the New Zealand Institute of Landscape Architects and has been practising since 1987. Previously Mr Craig was employed by the Christchurch City Council with 13 years in the area of environmental policy and planning. He told us his work since graduation and to date has involved him in landscape assessment and development of landscape policy. He has also taught landscape architecture at Lincoln University.

13.10 Of relevance he told us that he prepared landscape evidence in respect of the Waitaki Catchment Water Allocation Regional Plan and he has also been involved with the Waitaki District's Proposed Variation 2. He informed us he has lived and worked in the Mackenzie District and he has a good knowledge of the entire area within which the UWAG application sites are located.

Mr Stephen Brown

13.11 Mr Stephen Brown is a landscape architect that presented evidence on behalf of

Southdown Holdings Limited, Five Rivers Limited, Williamsons Holdings Limited and Killermont Station Limited.

13.12 Mr Brown holds a Bachelor of Town Planning (Auckland) and a Post-Graduate Diploma of Landscape Architecture from Lincoln University. He is a Fellow of the New Zealand Institute of Landscape Architects and an Affiliate Member of the New Zealand Planning Institute. Over the last 27 years he has specialised in landscape assessment and planning helping to develop regional and district strategies for landscape management and in doing so considering and addressing the landscape, natural character and amenity implications of individual development proposals.

Dr Michael Steven

13.13 Dr Steven is a landscape architect that presented evidence on behalf of Simons Hill Station Limited, Simons Pass Station Limited, High Country Rosehip Orchards Limited, Rosehip Orchards New Zealand Limited and Lone Star Farms Limited (Godley Peak Station).

13.14 Dr Steven holds a Doctor of Philosophy and Architecture from the University of Sydney, a Master of Landscape Architecture again from the University of Sydney, a Post-Graduate Diploma in Landscape Architecture from Lincoln College and a Diploma in Horticulture again from Lincoln College. He is an Associate of the New Zealand Institute of Landscape Architects and a member of the International Society for Resource Management and the Environmental Design Research Association. Dr Steven has some 25 years of experience and his particular area of expertise is environmental-behaviour studies particularly landscape perception and human factors in landscape design, planning and management.

Experts for submitters

Elizabeth Ann Steven

13.15 Ms Steven is a registered landscape architect having over 20 years experience in landscape architecture. She has been extensively involved in the tenure review process for the South Island high country pastoral leases. She has undertaken some 40 pastoral lease landscape assessments engaged by the Department of Conservation (DoC). She carried out assessments on Killermont, Simons Pass, Simons Hill, Maryburn, Irishman's Creek, and Godley Peaks' pastoral leases, among others in the Mackenzie Basin. She told us she was raised on Ferintosh Station on the western shore of Lake Pūkaki. She has been engaged in many work-related projects within the Basin.

13.16 Ms Steven provided us evidence relating to the landscape values in respect of the Maryburn, Simons Hill, Simons Pass, and Killermont Station proposals and how those landscapes would be affected by those proposals if allowed to develop irrigated pastoral farming.

13.17 Because of Ms Steven's focus on individual proposals it is more challenging to place her evidence in the context of the questions we have posed within Part A to do with landscape. Where we think it would add value to our considerations we have drawn on her evidence to assist us with answering those questions.

Diane Lucas

13.18 Ms Lucas is a landscape architect and director of Lucas Associates Limited. She presented evidence on behalf of Mackenzie Guardians.

13.19 Ms Lucas holds a BSc in Natural Sciences, a post-graduate diploma, a Master of Landscape Architecture and Planning. She is registered with the New Zealand Institute of Landscape Architects and was made a Fellow of New Zealand Institute of Architects in 1987. She is very well experienced and regularly assesses areas with respect to their ecological significance in terms of representativeness, the sustainability of their natural values, and their landscape and amenity values.

13.20 More particularly, she told us she has prepared the Canterbury Regional Landscape Study jointly with Boffa Miskell to identify significant outstanding natural features and landscapes of Canterbury. She noted the Mackenzie Basin was assessed in that study to comprise an outstanding natural landscape (ONL). She also prepared an analysis of landscapes of all of the Waitaki District. She has been involved in assessments of a number of sites within the Mackenzie District. She has been involved in Plan Change 13 hearings for the Mackenzie District Plan.

Dr Susan Walker

13.21 Dr Susan Walker is a professional plant ecologist employed by Landcare Research, a Crown Research Institute, to focus on the conservation/restoration of indigenous terrestrial ecosystems. She presented evidence on behalf of Mackenzie Guardians in relation to the terrestrial ecology in the Mackenzie and Waitaki Basins.

13.22 Dr Walker holds a MSc and PhD degrees in Plant Ecology from the University of Otago. Her primary field of expertise is the ecology and conservation management of indigenous grasslands, shrub land vegetations and plants in southern New Zealand, and biodiversity assessment, conservation prioritisation, and achievement reporting, including assessment of significance, quantitative biodiversity measurement and mitigation or offsets. Dr Walker told us she is well experienced in the consent areas of the Mackenzie Basin and its surrounds, and she has carried out extensive research and ongoing experimental ecosystem restoration projects within the Mackenzie Basin.

Section 42A Reporting Officers

13.23 Mr Chris Glasson presented the section 42A report that focused on and provided an assessment of the actual and potential effects of the proposed activity on landscape and visual effects.

13.24 Mr Glasson is a very experienced landscape architect, having been in practice for 30 years. He told us he has undertaken a range of landscape assessments and design work in the Mackenzie Basin so he said he understood the physical and cultural conditions of the landscape. He told us he was very familiar with the location, having travelled through the Mackenzie Basin on many occasions over the past 30 years to undertake work in Mount Cook village. More specifically, he had visited the Upper Waitaki catchment on three occasions over the past two months, namely in June and July 2010.

Are landscape effects relevant?

13.25 We were presented with a number of differing and, at times, competing views on the relevance of landscape effects. The first issue for us to determine is therefore whether such effects are a relevant issue to take into account in relation to the current applications.

The applicants' position

13.26 The various applicants before us did not adopt a common position on the relevance of landscape effects. The following is a summary of the views put forward by several different groups of applicants on this issue.

13.27 Mr Whata and Mr Kyle addressed the issue on behalf of MWRL, Southdown Holdings Limited (SHL), Williamson Holdings Limited (WHL), Five Rivers Limited (FRL), and Killermont Station Limited (KSL). Their position is best expressed, we think, in Mr Kyle's opinion found at paragraph 3.86 on page 32 of his principal brief of evidence. There he had this to say:

> *"It is my opinion that matters relating to landscape need be addressed at the district level given the responsibility for such matters clearly rests with the local authorities. It is not a relevant matter to consider at the regional level outside of the landscape effects that might arise within the affected waterbodies."*

13.28 This position was largely based on the fact that in terms of land use effects, farming activities and irrigation are generally permitted in the Waitaki, Mackenzie and Waimate Districts[21]. Therefore, the effects associated with greening of the landscape are specifically addressed in district plans and the permitted activity status for farming activities, such as irrigation, forms part of the permitted baseline.

13.29 Mr Kyle in arriving at his viewpoint also considered various provisions of the Canterbury Regional Policy Statement (CRPS) and also provisions of the Proposed Natural Resources Regional Plan (PNRRP) that related to landscape matters. However, in doing so, he expressed the view that the policies he identified should be reflected and given effect to in the district plans of the region.

13.30 In particular, when he was considering Chapter 8 Landscape Ecology and Heritage of the CRPS, he noted that Policy 3 provided that natural features and landscape that meet the relevant criteria of subchapter 20.4(1) should be protected from adverse effects of the use, development or protection of natural and physical resources and their enhancement should be promoted. He noted the policy continued and provided:

> *"The particular sensitivity of these natural features and landscapes to regionally significant adverse effects in terms of subchapter 20.4(2) should be reflected in the provisions of the district plans in the region."*

13.31 So, it was on this basis that he contended the method chosen by the CRPS to provide for natural features and landscapes was to require that those matters be addressed in the district planning regime. Thus, landscape effects were not a matter that need trouble us when we were determining water allocation issues.

13.32 Mr Ewan Chapman, legal counsel for the UWAG group, took a different view and approach from both Mr Whata and Mr Kyle. Mr Chapman's view was that we could take into account the effects of irrigation on the landscape, the greening effect. However, he considered those effects must be considered taking into account the fact that the relevant district plans in large part had not attempted to control or regulate landscape effects.

13.33 In support of his submission he referred to *Aquamarine Limited v Southland Regional Council*[22], where the Court determined that relevance of an effect is not dependent on the need or otherwise for a resource consent for that effect or whether such effects can be subject to other controls. Rather, it is dependent upon giving a sufficiently wide interpretation to Section 104(1)(a) of the RMA to ensure that in achieving its purpose, all the reasonably foreseeable effects, whether positive or adverse, can be considered by the consent authority and on appeal by the Environment Court. The Court held that to exclude such effects on the ground the resource consent is not required or that they cannot be controlled by conditions could lead to the circumstance of granting consents which, because of their effects, may not achieve the purpose of the RMA.

13.34 However, Mr Chapman was of a similar view, at least in part, to that advanced by Mr Whata and Mr Kyle that very little weight should be given, he said, to the effects described as greening because the three relevant district plans all permit farming and contemplate irrigation. He did note, like Mr Kyle, that consent is required for irrigation in outstanding natural landscapes under the proposed Waitaki Plan, but in all other areas in the Waitaki and throughout the Mackenzie and Waimate Districts consent is not required for irrigation.

Section 42A Reports

13.35 In relation to Mr Glasson's report, while it was not explicit in terms of his written presentation, it was clear from reading his materials that Mr Glasson was of the view landscape effects were a relevant consideration for us. The approach he took rested, in part, upon a Section 6 RMA analysis to determine whether or not the Mackenzie Basin was an outstanding natural landscape.

[21] The main exceptions to this are that dairying is a controlled activity in the Waimate District and that irrigation in outstanding landscape areas in the Waitaki District requires consent as a non-complying activity

[22] C7996.

13.36 From there he traversed provisions of the CRPS. However, it is fair to say he concentrated on the district council provisions. Thus, he focused on the issue of the relationship between landscape and district plans. In terms of the district plans he considered that the information and approach taken in those plans provided what he termed "*useful technical reference points*".

13.37 Dr Michael Freeman also covered landscape effects in his report and in his addendum report. He considers the relevant provisions on the RMA and referred to Section 6 as supporting his view that landscape effects were relevant. He also discussed with us Section 7 RMA issues. He drew attention to the point that under Section 104(1)(a) RMA, we need to consider the actual and potential effects on the environment and in terms of Section 104(1)(b) RMA, we need to have regard to all relevant planning instruments.

13.38 In terms of policy and planning background Dr Freeman referred us to the CRPS, Chapter 9, Objectives 1, 2 and 3, noting that objectives specifically included provisions relating to landscapes. He also referred us to CRPS Chapter 8 Landscape Ecology and Heritage and Objective 2.

13.39 In terms of the WCWARP he referred to Policy 32, noting that it referred to natural character landscapes at subparagraph (b) of that policy. Dr Freeman's view was that this policy provided for natural character and landscapes in relation to high natural character waterbodies. He was of the view that the WCWARP is the regional plan for the allocation of water in the catchment. He was of the view for wider issues, such as those relating to landscape effects, that the PNRRP was the primary regional plan with policy provisions.

13.40 Dr Freeman was of the view that regard should also be given to the objectives of the relevant district plans because of the local community involvement that would have been involved in developing the specific provisions. These objectives reinforce, extend and complement, the objectives and policies in the CRPS, the WCWARP, and the PNRRP. The district plan objectives, he thought, were worthy of consideration.

<u>Our conclusions on the relevance of landscape effects</u>

13.41 We conclude that landscape effects are a relevant consideration in terms of Section 104(1)(a) and s104(1)(b) RMA.

13.42 Section 104(1)(a) RMA requires us to take into account all reasonably foreseeable effects of the proposed activity. In this instance, two key effects are the effects of taking water from the waterbodies and the effect of application of water to land. In that respect we are in agreement with the approach put forward by Mr Chapman and Dr Freeman in terms of the wide purview that Section 104 RMA provides to us.

13.43 We also accept and agree that in terms of Section 104 RMA we are required to have regard to relevant district and regional and other planning instruments. In this respect we agree the WCWARP focuses on the landscape effects on waterbodies caused by or linked to the allocation of water. The only departure is via Policy 32 WCWARP, when the waterbody is in a high natural character area; that brings landscape considerations directly into play under the WCWARP.

13.44 In terms of the interplay between the planning instruments, we accept the approach put forward by Dr Freeman in that regard. Section 5 of the WCWARP makes it clear that the plan itself addresses issues relating to water allocation in the Waitaki Catchment. However water allocation has relationships with other aspects of resource management, including landscape. The WCWARP does not provide comprehensively for such matters and specifically states that it has been prepared with the assumption and expectation there will be parallel management provisions that address these related aspects of resource management that fall outside the issues that are addressed in the WCWARP.

13.45 So in terms of Section 104(1(b) RMA we are to have regard to the relevant planning instruments. The WCWARP provides in its own terms clear signals about what that plan provides for and its inter-relationship with other plans, which deal with other aspects of resource management arising from water allocation, including landscape. Thus, we

determine that the policies and objectives of the CRPS, PCRPS, NRRP and district plans in terms of landscape effects are matters for us to consider closely.

13.46 For the sake of completeness, we note that in terms of Section 104(1)(c) RMA, we should have regard to any other relevant matter. In this regard, matters raised by the Canterbury Aoraki Conservation Board in reference to the Conservation Management Strategy would fall for consideration under that head of Section 104, which again is another pathway, we think, for the result that landscape effects are indeed relevant as a matter for our consideration.

13.47 Finally, we observe that after considering the effects in terms of landscape (whatever they may be) the conclusions we reach on that point are informing in terms of our Section 6 and Section 7 RMA considerations, which outcomes inform our Section 5 RMA evaluation.

What is the existing landscape and the values associated with it?

13.48 Various witnesses provided descriptions of the existing environment and the values associated with it. We have attempted to summarise some of the key points below to provide the foundation for the discussion that follows.

Mr Craig

13.49 In assessing the landscape effects of irrigation Mr Craig contended what was critical in his view was the existing character of the environment as this he said set the baseline against which the effects are measured.

13.50 Mr Craig considered that the Upper Waitaki catchment was a diverse landscape that included a wide range of land forms among them mountains, hills, valleys, terraces, lakes, wetlands and rivers. It contains a broad range of land uses including, pastoral farming, conservation, electricity generation and transmission, tourist operations and settlements. The vegetation cover is primarily grasslands comprising a mix of exotic pastures and tussocks with seasonal variations. There are areas of naturalness embodying least modification, and areas where man made features are dominant. It contains high scenic values with dramatic presentation of natural features such as areas west of State Highway 8 generally facing the main divide and in the Upper Waitaki valley orientated east towards the Waitaki River and lakes.

13.51 Mr Craig was of the opinion that the amenity of the catchment in its entirety is undoubtedly derived from its scenic qualities. The attractiveness of the qualities is not evenly distributed across the landscape. They do vary considerably. The landscape contains charismatic or iconic views and features, namely Aoraki/Mount Cook, the main divide and the lakes particularly where they combine as a single viewing entity. The visual amenity according to Mr Craig is also subject to a hierarchy within the catchment with some scenes being significantly more attractive than others.

13.52 Also, he drew a demarcation between features of the landscape, which he termed as "iconic", such as the lakes and the mountains, and the basin floor upon which this transitional and agricultural-led farming change had been occurring for quite some time.

13.53 Mr Craig was of the view that in considering natural character it is important to note that natural character is subject to a spectrum ranging from highly modified to highly natural landscapes. He considered that additional irrigation is a further step in the modification of this environment; where that modification has been undertaken in the farming context for a very long period of time.

13.54 In summary Mr Craig told us the Upper Waitaki catchment can be summed up as a dramatic and powerfully assertive landscape due to a combination of its elements and the contrast between them. It was his view that human activity while clearly present in many places within the catchment because it is such a sublime landscape these human activities are subservient to the landscape.

Mr Brown

13.55 In his evidence he described the Mackenzie Basin identifying for us its extent and its core components such as the glaciated ranges of the Southern Alps, a series of lakes, some natural some man-made and a landscape that has been physically shaped and substantially dominated by the natural landscape building, glacial and fluvial processes that have given rise to its geomorphic structure. He referred to extremes of climate in summer and winter, its distinctive vegetative cover and the multitude of activities carried across the Mackenzie and Waitaki Basins.

13.56 He noted with its expansive mantel of tussock and grasslands affording a foundation for panoramic and frequently spectacular views of the Southern Alps, the Mackenzie country has long held a strong sense of place and identity in the folklore and perception of both the South Island and New Zealand. The sense of place was well established even before the advent of European occupation as Māori quarried stone for tools, fished for eel and birds and established summer camps along the rivers and lakes. Māori place names provide evidence of early occupation.

13.57 Interestingly Mr Brown noted that anyone now visiting the Mackenzie country and Upper Waitaki Basin can from what they see clearly recognise that the productive nature of the plateau grasslands has evolved very substantially since Māori first told early settlers of the existence of these grassy plains within the South Island's interior. Energy production which was traversed in the Hay Report of 1904 has come through to be realised as evidenced by the chain of canals from Lake Tekapo southward and artificial lakes Benmore and Ruataniwha.

13.58 There are also the small settlements of Tekapo, Omārama and surrounding farms which he contended were pervasive but demonstrated a shift in the content and character of the landscape. He noted the impact of Douglas fir and wilding pines. Those pines in conjunction with more coordinated plantings of woodlots shelter belts is starting to recast he contended the character of both the Upper Waitaki Basin and Mackenzie country.

13.59 He also noted that pastoral farming is the other land use component directly associated with the Upper Waitaki Basin which includes top dressing, use of rye grasses and clover and borderdyke irrigation and the more recent advent of rotary irrigation matched by the progressive transition from sheep to dry stock and dairy farming over recent years.

13.60 Mr Brown recognised that the landscape is a dynamic entity that has already changed very fundamentally from its natural state. It is his view that such change is predicated by a historic sequence of land management practices. Mr Brown sees that irrigation and greening parts of the Waitaki Basin represent a stage of landscape evolution that begin with the earliest of sheep and cattle runs starting near Lake Tekapo in the 19th century. He sees a trend of this continuing rationalisation and related consolidation of predominantly cultural and natural landscapes within different parts of the Waitaki and Mackenzie country.

13.61 While acknowledging change, Mr Brown contended that the Upper Waitaki remains very substantially defined by the mountains and foothills that frame it. However he noted the balance and interplay of elements within the Upper Waitaki and Mackenzie country is creating an increased demarcation between the natural and cultural halves of the landscape as a whole. He noted the lakes remain key centrepieces across the greater Basin and the various mountain ranges on its fringe are clearly key landscape touch tones. However, he contended that much of the central plains and terrace landscape is now as much defined by farming and other human activities as it is by the landform profiles which underpin it.

13.62 He noted that there is now an increasing level of contrast between the more natural periphery of these central grasslands landscape and its maintained perimeter with the tussock lands that were once central to the identity of both basins increasingly pushed back by woodlots wilding pines and the evolution of farming activity. He contended this changed pattern is clearly established and has already changed the identity of the area significantly.

13.63 He also noted that taking a future aspect it is important to acknowledge that much of the land already employed for grazing has changed fundamentally from its tussock dominated pre-European state to an almost depauperate state with coarse grasses now intermixed with remnant pockets of tussock, Matagouri, hieracium, and sweet briar and other weed species.

13.64 Mr Brown contended that left as it is much of the land will remain physically and ecologically impoverished. In his view, continued farming of the high country without water and nutrient supplementation will inevitably result in more of the existing grasslands succumbing to hieracium and other weeds and rabbits and thus create an alternative dichotomy high country tussock v wasteland. He claimed there was no ecological status that can be relied on to maintain the landscape status quo.

Dr Steven

13.65 Dr Steven emphasised that there are already significant areas within the Basin that are subject to irrigation and intensive farming practices. He noted that pastoral farming development has brought with it many changes that have impacted negatively upon the landscape such as changes to the tussock grassland ecology through burning and grazing, the invasion of woody and herbaceous wood species, noxious animals, wilding pines and significant soil erosion.

13.66 Dr Steven's comments on soil erosion were consistent with the evidence we received from Dr Painter (water resources engineer) on behalf of MWRL and various individual applicants. Dr Painter provided some helpful background on the existing soils in basin and the ongoing wind erosion that is occurring.

13.67 Dr Steven's core contention was that the view expressed by some submitters and section 42A officers that the entire Mackenzie Basin is in a natural state was based upon an aesthetic image of what is natural. That evaluation fails he said to acknowledge the very significant extent of human intervention and human induced modifications in degradation to the Basin floor landscapes. It was his opinion that such comments reveal a surprising lack of awareness of the modified and degraded nature of the landscape and the Basin.

13.68 He then referred to landform changes brought about by hydro-electricity development and noted apart from those interventions the Mackenzie Basin landforms and physical elements (the mountains and lakes) are substantially intact. However it was his view that vegetative communities and ecological systems on the basin floor have however undergone substantial changes though direct and indirect human intervention.

13.69 When discussing views to landscapes Dr Steven expressed the view that the relatively flat, basin-like character of the Mackenzie Basin landscape and the scale of the enclosing mountains create a situation in which the mountains are persuasive elements in views and vistas throughout the Mackenzie Basin. He noted however that because of the scale of those views they may incorporate multiple landscapes. He noted that within the Mackenzie Basin, views to the outstanding natural landscapes of Aoraki Mount Cook National Park and the Ben Ōhau Range are likely to be strongly influential in the environmental experience of many residents and visitors to the Basin. He noted that in many areas of the Basin one's experience of outstanding natural landscapes occur at some considerable distance and those views of an outstanding landscape are mediated by intervening landscapes of lesser significance.

13.70 It was his view that the visitor experience of the Mackenzie Basin is typically represented by a few iconic views which become emblematic of the experience of the Basin as a whole. The most widely recognised of these views is that of Aoraki Mount Cook as seen from the southern margins of Lake Pūkaki. Similar views towards the Southern Alps are to be had from many locations along State Highway 8 and in Dr Steven's opinion it is the sum of those views and in particular the few iconic views to Aoraki Mount Cook among them that most shape visitor experiences in the Basin.

Ms Lucas

13.71 Ms Lucas noted that in terms of the Canterbury Regional Landscape Study, the Mackenzie Basin was identified as:

> *"The most extensive outstanding natural landscape in the region. It was one of the most investigated, painted, written about, visited, eulogised and argued over landscapes in New Zealand."*

13.72 Ms Lucas was clear as to the aesthetic values that this particular locality has given rise to. Those values were clearly demonstrated within the evidence of the likes of Mr Geoff Ensor, Mr Graham Sydney, Ms Jane Zusters, Mr Brian Turner, Mr Sam Neil and many others.

13.73 She referred us to various writings and literature in terms of the Mackenzie. Noting that these works, along with tourism, recreation, planning research and art and literature analysis, contributed to the investigation of the values of the Mackenzie, and identified the values which are shared and recognised.

13.74 She was of the very strong and clear view that the Mackenzie Basin is a distinctly different type of landscape. She contended it was highly unusual to be able to easily and variously access a vast enclosed landscape of such naturalness as the Mackenzie Basin, which existed in strong contrast to the adjoining landscapes coastwards. It was her view that the Basin is considered by many people, for many reasons, to be, in total, a very special place. She noted that there are special features and relationships within the place and a holistic approach was needed.

13.75 She formed the view that landscape involves seeing with experience, with memory, and with knowledge. She contended landscape or the appreciation of landscape was not merely about seeing frames and printing them on a blank canvas in the brain. She contended that there is knowledge and expectation of views and journeys through and various experiences within the Mackenzie that would be endorsed or countered by what is seen on any particular visit and in any particular part of that visit

13.76 She further developed her evidence covering grassland naturalness, noting that in terms of grassland there were various naturalness categories available. She noted that naturalness ratings recognise that lands that had been cultivated but not irrigated can have very high naturalness, such as the contrast between new cultivation and greenfield crops. She noted that these cultivated drylands contribute very differently in terms of aesthetic values, both in terms of memorability and naturalness with extensive, intensively irrigated and managed lands.

13.77 One of her four core points was that, as recorded in science, art and research:

> *"the naturalness of the Basin floor lands is very highly valued. She expressed the view that while the mountain slopes behind may be more visually prominent, the broad, open, uncluttered grass and landscapes of the Basin floor is the scene-setter. It is the floor that is passed through, that is overviewed, and that is widely recognised as an exemplary experience of distinctive landscape. The naturalness of the floor lands, their broad natural patterns and their detail, are enjoyed in association with the mountain lands beyond. The floor and wall lands together form a Basin that is experienced as highly natural. Within the highly natural land surfaces and vegetation patterning, the mountain lands draining into the lakes and to the outwashes below are clearly legible as pathways of former glaciers".*

13.78 Also, it appeared to us that she did not recognise or accept the degree of modification that had already occurred within the Basin areas. While she did acknowledge that the degree of naturalness in Basin areas varies, it varies, as she saw it, in response to management and the seasons. She saw these seasonal changes as being limited in scale and intensity and they should be read, she said "*as supporting the surrounding extensive natural landscape and confirming legible activity nodes that tell of a layer of heritage in the Basin"*.

Dr Walker

13.79 Dr Walker's evidence focussed on ecological issues and stated that the Mackenzie Basin is a bio-geographically distinctive part of New Zealand containing the most extensive and intact sequences of low-lying naturally rare terrestrial ecosystems.

13.80 She did note that it was modified in stature and composition. In her view it was poorly protected and it was subject to ongoing decline; although she noted that the remaining less-developed communities are still predominantly native in character. She noted that those communities support several of New Zealand's most endangered plant species and regionally endemic and threatened invertebrate and freshwater fish faunas, and internationally important populations of migratory wading birds (gulls and terns).

13.81 She expressed the view that intensive agriculture development is rapidly transforming less developed grasslands in the Mackenzie Basin from habitat for terrestrial indigenous species, including threatened species, into wholly exotic pastures – as has already occurred over most of Canterbury's lowland mountain and coastal zones.

13.82 Dr Walker noted the inter-related adverse effect of this habitat destruction on the landscape's indigenous biodiversity are both cumulative and accelerate as the ratio of converted land to unconverted indigenous species habitat increases. She saw the situation as worsening over time.

13.83 It was her view that the protected land areas that are available at the Mackenzie are inadequate to maintain the Basin's biodiversity. She noted that highly degraded ecosystems appear capable of some recovery with conservation management, but the Basin's protected areas are becoming isolated with an increasingly developed landscape that threatens their viability.

13.84 It was her view that many of the remaining less developed grasslands of the Mackenzie Basin are significant, especially the plant and animal communities of extensive, largely undeveloped landform sequences remaining to the north and east of Twizel. It was her view that these areas meet all of the PNRRP and Canterbury Regional Policy Statement criteria for significance, are present on land environments that are distinctive and are mainly or wholly confined to the Mackenzie Basin, and they almost entirely comprise naturally rare ecosystems.

Mr Glasson

13.85 Mr Glasson provided a discussion of the physical character of the Upper Waitaki catchment, He said the catchment separates into four well-defined geomorphic units, being the moraines in the north-west, terrace and floodplains, fans and wetlands.

13.86 He also noted the Upper Waitaki comprises four major tributary basins of Tekapo, Pūkaki, Ōhau, and Ahuriri. He noted that all of these are basins with the exception of the Ahuriri, which contains large glacially formed lakes. Above and below the lakes, the rivers run in braided gravel beds except where the riverbed is occupied by the three hydro-lakes of Lake Benmore, Lake Aviemore, and Lake Waitaki. Of the major rivers only the Ahuriri remains without significant change while other rivers exist as partially dry riverbeds as the water normally flowing in them is diverted into power canals and through the power generation stations.

13.87 Turning to landscape character, Mr Glasson was of the view that the Upper Waitaki catchment is a special place in terms of New Zealand's landscape types and has its own distinct identity with its much admired lakes and mountains, its vastness, dryland vegetation, and the tawny alpine landscapes. Mr Glasson was of the view that the most enduring landscape features of the Basin are its vastness and openness contained by the grandeur of a mountain backdrop.

13.88 However, he was of the view the Waitaki Lakes part of this landscape from Omārama to Waitaki Dam while inheriting many of the Mackenzie Basin characteristics, is somewhat

different due to landscape modifications with hydro-schemes and farm development and is more contained as a river value landscape with smaller and more intimate landscapes.

13.89 Mr Glasson noted that the forest and scrub-land landscape of the Upper Waitaki catchment was transformed into tussock grasslands by both periodic natural fires around 600 years ago by Polynesian burning. With the advent of European pastoralism as the major land use in the Upper Waitaki, from the 1850s onwards, animal grazing became firmly established. This often eliminated, he said, or severely reduced the frequency of tall tussock at lower altitudes and native grass species and, in conjunction with the introduction of rabbits in the 1880s, lead to the development of the current widespread short tussock grassland in the Basin.

13.90 In discussing tussock grasslands Mr Glasson referred to the work of Dr H Connor. Between 1976 and 1992 the tussock grasslands had been devastated and became a herb-land because of the extent of the hieracium hawkweed, especially in the outwash plains in moraine areas. Mr Glasson told us the environmental results of this depleted tussock landcover are wind erosion (due to the ground being exposed), loss of soil structure and/or organic matter, winter frost lift, rabbit infestation, increase in weedy growth, and the intrusion of wilding pines.

13.91 In terms of wilding conifers, Mr Glasson identified them as being another threat to the Upper Waitaki catchment landscape. He noted that the trees are of little commercial value and spread in a vigorous manner. He noted that in terms of weed growth hieracium is a problem weed in the catchment because it has a competitive advantage over tussock grassland communities. He noted its presence decreases the amount of available grazing. He told us that Environment Canterbury has classified both wilding conifers and hieracium as biodiversity pests in the Regional Pest Management Strategy.

13.92 He noted rabbits are a major pest in the Upper Waitaki catchment as the environment is ideal for the existence. The environmental effects they cause include depletion of tussock grasslands, increasing areas of bare ground, physical disturbance to soil leading to erosion, and reduction in soil organic matter.

13.93 In terms of man-made influences, he noted that other than the introduction of farming the Waitaki power scheme, the creation of the Waitaki hydro-lakes and development of Twizel and related developments are the most significant landscape modifications caused by man.

13.94 He noted the indicators of this modified landscape include, in many areas, diminished vegetative land cover, dark-green colour of coniferous shelter belts and woodlots, some green pasture, the presence of housing and lifestyle blocks within Twizel, Tekapo, Otematata and Omārama and adjacent to lakes, and the presence of isolated industrial structures associated with the hydro scheme and irrigation. Such changes, he said, are not evident everywhere in the Basin but they do exist and are part of the growing transformation of this landscape.

13.95 Mr Glasson noted the Upper Waitaki catchment is in a state of change; that change is caused by and from loss of soils, weed infestation, wilding pine infestation, and the invasion of rabbits. Mr Glasson observed that the 'greening up' is part of the Upper Waitaki catchment's continually evolving landscape since man first occupied the area. Such changes will not, he said, affect the whole catchment and will only occur in the lower areas where water is available.

13.96 In terms of visibility of the Upper Waitaki catchment, Mr Glasson told us that this can most easily be appreciated from State Highway 80, SH83, and other minor roads. These roads, he said, form important connecting threads through this vast and open landscape. The visual landscape catchment from the road is often the main means that the traveller will appreciate a landscape and visual effects that occur within it. It was his view because the Upper Waitaki catchment offers wide, panoramic views from the highway in a significant New Zealand landscape, the treatment of the immediate and distant roads environs are, he said, vitally important for the impression the traveller forms of their journey.

Our conclusions on the existing environment and values

13.97 We accept that the Mackenzie and Waitaki Basins as a whole comprise an outstanding natural landscape with iconic vistas that is highly valued by many aspects of society. This is provided by the dominant natural features, including the mountains and lakes, and is expressly recognised in the relevant planning documents, which we discuss further below.

13.98 Notwithstanding the above, we accept that the landscape is not uniform. Although there are some areas with clear natural character, there are other areas that are highly modified and degraded. The continued degradation of the landscape was an outcome that was apparent to us on our site visits where we were shown large tracts of land that were weed and wilding pine infested. These areas may have previously been tussock lands, but they certainly presented to us as being in a high state of degradation.

13.99 We accept the evidence of Dr Stevens, Mr Brown and Mr Glasson that there are already significant areas within the basin that are subject to irrigation and intensive farming practices. Overall, we preferred the opinions of these experts over that of Ms Lucas. Their view of the extent and effect of farming and pastoral modification to the Basin appeared to us to be closer to the reality of the circumstance.

13.100 Many of the experts and legal counsel addressed us on the dynamism of landscape, impressing upon us that we should not view landscape, or try and assess landscape, as static. Rather, we needed to understand and accept that a view of landscape always needs to have regard to the dynamism of many of its elements. That dynamism can be represented in terms of hydrological and ecological systems as well as through continued evolving and changing human interplay and interventions through agricultural activities and hydro power generation.

13.101 We find ourselves in agreement with Mr Brown's opinions relating to dynamism and evolution within the landscape. The change in land use activities, particularly moving from extensive pastoral grazing to more intense irrigation based activities was readily apparent to us as we undertook our site visits. So our assessment must cater for and recognise, we think, this change and evolution in activities, particularly on the basin floors.

13.102 In relation to Dr Walker's conclusions on the existing terrestrial biodiversity, we consider that there remains some uncertainty about the actual extent and significance of biodiversity present. This seemed to be recognised by Dr Walker where she noted the lack of information about terrestrial biodiversity in some areas. We also note that based on our observations, the degree of biodiversity is highly variable, a point we return to below.

What changes will irrigation bring to this landscape?

13.103 There was general agreement between the experts that irrigation will bring change to the landscape of the Mackenzie and Waitaki Basins. The potential effects of irrigation on landscape character and amenity can be divided into two broad categories:

(a) The "greening" of the landscape; and

(b) The infrastructure of irrigators, pump houses, race intakes etc.

13.104 The comments from some of the different experts in relation to the nature of these effects are summarised below.

Mr Craig

13.105 Mr Craig notes the chief effect from greening arises from an obvious change in colour or tone that is most apparent when in contrast with surrounding vegetation. He also noted that new geometric patterns will be introduced especially the circular ones caused by pivotal irrigators.

13.106 He noted the visible presence of weed species will disappear in the areas subject to irrigation and that landscape coherence or homogeneity will be diminished where blocks of contrasting tone are introduced into the overall landscape.

13.107 Mr Craig noted that the apparatus of irrigation centre pivots, hard-nosed hose guns and pump sheds have the potential to affect views because they introduce a vertical dimension to the landscape. He did note that the visual effects of irrigation are going to vary considerably depending on the context of its setting and the seasons. Overall Mr Craig noted that the greatest effects are going to be those where the highest degree of change will be apparent to the viewing public.

Mr Brown

13.108 Mr Brown conceded that irrigation proposals will result in increased demarcation between the rural productive parts of the Upper Waitaki mainly occupying the Basin floor and river, lake terraces and the remnant natural areas found closer to its lakes, wetlands, ponds, rain areas and hill margins. His view is this transition will be incremental but it will also have quite a discernible impact.

Dr Steven

13.109 Dr Steven acknowledged the potential for irrigation to bring about broad scale landscape change within the Mackenzie Basin. He noted that the landscape character of the Basin has changed as a consequence of farm development for more intensive production. He noted this change will continue as large areas of extensive dry land pasture farming give way to more intensive production of irrigated grassland, cereals and fodder crops.

13.110 In his view the most predictable and widespread changes are likely to include:

(a) The appearance of irrigation infrastructure, particularly centre pivot irrigators and related pumping and water supply infrastructure;

(b) Greener pastures as modified by fescue grassland and other generally degraded communities give way to improved pastures and fodder crops;

(c) Further farm subdivision for grazing management;

(d) The possibility for additional built infrastructure.

13.111 Dr Steven accepted that naturalness changes will occur as a greater degree of human intervention in the landscape becomes more apparent. He noted that the "complexity" of the environment will increase as uniform colours and textures in the vegetation give way to blocks of different colours and textures predominantly shades of green but occasionally browns as well. It was his view the addition of centre pivot irrigators will also increase the complexity through the addition of an element generally absent from the Basin although increasingly common between Twizel and Omārama.

13.112 It was his view that sequential cumulative effects will predominate in the Mackenzie Basin as a consequence of irrigation and farming intensification. He said this is due to the confinement of irrigation proposals to the fluvial glacial soils of the low lying land to the Basin. He noted as a consequence a traveller on State Highway 8 from Burke's Pass to the Ahuriri Valley will see evidence of irrigation at many locations in sequence (but not continuously). However he said there are few locations from which multiple areas of irrigated land will be seen.

Mr Glasson

13.113 Mr Glasson noted that the landscape effects associated with the irrigation development can be divided into three categories, namely:

(a) On-farm works;

(b) Off-farm works; and

(c) Long-term management.

13.114 On-farm works include earthworks, centre-pivot k-lines, pump sheds, races, fences, and spray irrigators. In terms of off-farm works, these are generally structures and include roads, intakes, pipelines and races. He noted that these works can reduce the level of naturalness.

13.115 Long-term management refers to the circumstance where irrigation can bring out significant management changes to the landscape. Here Mr Glasson was referring to changes to landscape character that result from colour (the greening of the landscape from its current ochre-red colour to green); patterns (these become geometric, especially with the use of centre-pivots); and texture (grassland versus cropping or horticulture). He noted the modification of landforms in vegetation affects the landscape's naturalness and visual quality. The effect of colour change, he said, has the most significant long-term change on the landscape.

13.116 He did note there was potential for adverse effects to occur to the landscape of the Upper Waitaki catchment as a consequence of the proposed irrigation development. In his view there could be a noticeable increase in the number of structures in the landscape and a reduction in its level of naturalness. These together, he said, with the extensive areas of landscape sensitivity indicate an overall potential for a loss of existing quality in these landscapes.

Dr Walker

13.117 In addition to the changes in the landscape discussed above, Dr Walker considered that further irrigation in the Mackenzie Basin would result in the clearance of naturally rare and vulnerable ecosystems within the proposed footprints of irrigated land and associated infrastructure. This would result in a substantial degradation and loss of natural ecosystems and indigenous species populations, including well beyond areas affected directly by irrigation.

Ms Steven

13.118 In the context of landscape that is already extensively grazed, and uncultivated with low producing tussock grassland and cushioned/mat cover, Ms Steven contended that irrigation would result in the following changes to the landscape:

(a) Removal of any existing vegetation cover, including all indigenous species (usually an irreversible loss) and also weed species;

(b) Complete disruption of invertebrate and lizard habitat;

(c) Disturbance of previously undisturbed soils;

(d) Removal of any surface features such as boulders, trees, shrubs, existing fences, shelter belts;

(e) Smoothing out of land forms and surface terrain;

(f) Destruction of wetlands through drainage, vegetation clearance, and cultivation;

(g) Natural patterns and homogeneity of cover with strong relationships to land forms and soil patterns are replaced with geometric ordered patterns of contrasting colours bearing little relationship to land form or soil patterns;

(h) In terms of landscape character, there is a fundamental shift from a timeless natural desert-like or extensive savannah character, almost wilderness in some areas, to a more environmentally amenable domesticated farming character, albeit of a large scale agribusiness quality;

(i) Stocking patterns change markedly. Instead of typically merino or cross-bred sheep spread out across an open landscape there are concentrated mobs of stock, including greatly increased numbers of beef and dairy stock;

(j) Construction of intakes and canals and buried pipelines to move water and associated access tracking; and

(k) Presence of irrigators, which can be over 1km long, having visual effects on the landscape.

How significant are these changes?

13.119 The biggest challenge for us in relation to the issue of landscape has been to evaluate how significant these changes are and whether they justify declining consent to further irrigation in the Mackenzie and Waitaki Basins. Ultimately, as we see it, we are called upon to make a determination about whether or not the developments through irrigation here proposed in this landscape, given its values, can be integrated in a sustainable way within the landscape while not offending the landscape's values.

13.120 To assist with this determination, we have referred to and relied on the various planning instruments that deal with landscape. The higher order planning documents (being the Operative and Proposed CRPS) have assessed the landscape values of the Mackenzie and Waitaki Basins and have determined that it is a landscape of outstanding natural features and outstanding natural landscape values. This classification is primarily as a result of the evaluation of the Basins being undertaken through the Canterbury Landscape Study and its more recent revision.

13.121 The policy thrust of both the Operative and Proposed CRPS seeks, in summary form, the protection of outstanding natural features and landscapes. However both higher order policy documents adopt an approach in respect of landscape-related management methods so as to ensure that land use change is not prohibited. The higher order documents, as we read them, provide - as part of sustainable management land use - that landscape change may occur. This is reflected in the corresponding objectives of the NRRP.

13.122 Another relevant document to which regard must be had is the Conservation Management Strategy ("the CMS"), being a 10-year plan for managing and protecting the natural and historic features and wildlife of the region. Mr Ines Stager on behalf of the Canterbury Aoraki Conservation Board noted that the CMS describes the landscape character as outstanding as a whole and seeks to prevent land use change from having adverse effects on landscapes. This is broadly consistent with the Operative and Proposed CRPS and we have had regard to the CMS in our considerations.

13.123 We also note that the above planning documents have been prepared in accordance with the purpose and principles of the RMA, including s6 and s7. In particular s6(b) requires that we shall recognise and provide for the protection of outstanding natural features and landscapes from inappropriate subdivision, use and development. We consider that these themes are clearly evident in the Operative and Proposed CRPS and the CMS and our consideration of the issue is therefore consistent with the requirements of the RMA.

13.124 Overall, the thrust of the higher order policy documents and the RMA is about protecting outstanding natural landscapes from inappropriate use and development. Having accepted that the Mackenzie and Waitaki Basins fit into this category, we then need to adopt an approach to be able to properly assess the competing expert evidence we received as to whether or not the intended use and development proposed is inappropriate.

13.125 The appropriate approach then seems to include asking the question, "how do we protect outstanding natural features and landscapes?". Some of the experts who provided us with evidence, namely Dr Steven and Ms Lucas, provided some helpful guidance. They said protection of outstanding features and landscapes will be achieved by maintaining or enhancing the values that make them outstanding. In addition, any management measures that we consider appropriate by way of conditions should seek to achieve the maintenance or enhancement of landscape values in relation to outstanding natural features or landscapes. If this is achieved, then that would also help us in determining

what inappropriate development was for those particular areas. We observe this the approach set out in both the CRPS and PCRPS.

13.126 The values identified within the CRPS and PCRPS include[23]:

(a) Natural science values - the geological, topographical, ecological and dynamic components of the landscape;

(b) Legibility (expressiveness) values - how obviously the landscape demonstrates the formative processes leading to its creation;

(c) Aesthetic values - including memorability and naturalness;

(d) Transient values - occasional presence of wildlife or its value at certain times of the day or year;

(e) Tangata whenua values;

(f) Shared and recognised values; and

(g) Historic values.

13.127 These values (or assessment matters) can be grouped. There are those that are part of the natural environment (or **biophysical values**); those that are the result of life experiences involving culture and history (**associative** values); and those that are the result of what we see (**sensory** values).

13.128 So then our approach is to evaluate whether or not the grant of consents (taking into account mitigation measures proposed) would have an adverse impact on the values listed above. Focusing on the values of the landscape and impact on those values is important because it is those values go to make the landscape an outstanding natural landscape.

Biophysical values

13.129 In relation to biophysical values, the proposed activities will not alter the geological or topographic features of the landscape. However they will have an impact on ecological components due to the application of water to land. We refer here to impacts on terrestrial ecology, as we have already considered aquatic ecology earlier in this decision.

13.130 We note our conclusions on the existing environment that is highly modified and contains a large number of pest species, including hieracium, wilding pines and rabbits. However we acknowledge the evidence of Dr Walker regarding terrestrial biodiversity and her view that the proposals will result in permanent net loss of significant vegetation and habitats for indigenous fauna that cannot be mitigated or reconstructed.

13.131 The matters that Dr Walker raised with us in respect of indigenous vegetation are clearly matters we can and should take into account in accordance with s6(b) and (c) of the RMA. However we consider that the level of protection provided for these matters in the relevant planning documents is relatively limited. We note her reference to the National Priorities for protecting native biodiversity, but this relies on local authorities bringing these priorities into their statutory RMA policies and plans. Overall we consider that there remains quite a gulf between what she contended should be protected and what the planning instruments themselves identified for protection.

13.132 Furthermore, in our view the real register of effect on terrestrial ecology is at the individual application level rather than at a catchment-wide level due to the high variability of biodiversity between application sites. We undertake that assessment within our Part B decisions on each individual application, taking into account Attachment 15 provided in Dr Walker's evidence and any mitigation measures that individual applicants have adopted for the purpose of protecting terrestrial biodiversity. In the end, it is a matter of weighting in

[23] Policy 12.3.1 of the Proposed CRPS

terms of providing for and protecting terrestrial biodiversity from adverse effects of development.

13.133 We also note and accept the evidence of Mr Craig, Mr Brown and Mr Glasson, that the irrigation development if designed and managed in a sensitive manner could bring benefits in relation to biophysical values. These benefits may include the freeing up of visually sensitive high country from extensive grazing and the control of weeds, wilding pines and soil erosion within application sites.

13.134 Another component of biophysical values is the legibility of the landscape, being how obviously the landscape demonstrates the formative processes leading to its creation. As demonstrated by the evidence we received, the visual manifestation of the geological processes, land forms and their legibility are significant factors in people's understanding and appreciation of a particular landscape.

13.135 Dr Steven discussed this issue and acknowledged the appreciation of geologic clarity require a high degree of prior knowledge of the formative factors of the landscape. The approach is to consider the formative factors of the landscape and then determine whether or not the geologic clarity is impacted upon by intensively farmed agricultural landscapes. He considered this not to be the case.

13.136 Dr Steven noted that irrigation is most likely to occur on flat areas of the Basin which areas will generally be seen against the backdrop of hills. It was his view the scale and character of these hills and the higher mountain ranges of the Basin will continue to be the dominant source of visual character and quality within the Basin landscape as a whole with the strong expression of naturalness associated with the hill and mountain landscape elements. It was his view that when considered in the holistic sense the overall effect on the biophysical natural character to the Basin will be slight.

13.137 Similar sentiments were echoed by Mr Brown who also agreed that the key changes for irrigation were affecting the basin floor. The mountains, lake and foothills still remained an outstanding natural landscape and could absorb this incremental and well-signalled change occurring on the basin.

13.138 Mr Glasson largely agreed with the above and considered that while these developments may change the visual character, the essential characteristics of mountains, hills, moraine downs, rock outcrops, terrace rises, rivers and lakes would, in most situations, with appropriate mitigation, remain highly natural in appearance. He appeared to agree with landscape architect Graham Densem in his landscape assessment of the Mackenzie Basin, where Mr Densem said:

> "*The mountains, sky, lakes and scale would continue to create a striking impression even with a somewhat "greened up" land surface*".

13.139 Ms Lucas did not agree that the outstanding mountains and hills would outweigh the prominence of extensive and intensively irrigated Basin floor lands and their effects on the naturalness of the Basin landscape experience. She clearly did not accept the views of the other landscape experts about the ability of large scale landscape (particularly having regard to physical features such as the mountains and lakes) to absorb change.

13.140 On this point, we were more persuaded to accept the views of Mr Craig, Mr Brown and Dr Steven about the ability of this large scale landscape to absorb the impacts of irrigation. We accept the view that because the irrigation here proposed is likely to occur on flat areas of the basin and will be seen against the larger scale character of the hills and higher mountain ranges, the legibility of the landscape as a whole will be retained because of the strong expression of naturalness associated with the hill and mountain landscape elements of the basin.

<u>Associative values</u>

13.141 Associate values include matters such as culture, heritage and recreation. On the issue of culture, we discuss tangata whenua values in the following part of this decision and do not

repeat this discussion here. We also recognise that the values discussed by various artists, poets, authors and other witnesses on behalf of Mackenzie Guardians (including Mr Graham Sydney, Mr Brian Turner, Mr Sam Neil and others). These values could also be described as cultural values and are important considerations to take into account.

13.142 We received very little evidence on heritage values, other than descriptions of the history of farming activity in the Basins. There were isolated pockets of particular historic significance (such as that at Irishmans Creek) which we discuss further in our relevant Part B decisions as relevant.

13.143 On this issue of recreation, we received evidence from Mr Greenaway on behalf of Meridian Energy Limited. However his evidence primary focused on the potential effects on the activities on water quality and how nutrient loading may compromise recreational fishing and other water based recreation. We accept his evidence that if water quality was compromised, this could have significant adverse impacts on recreational users of the water bodies in the Upper Waitaki Catchment. However we note that this issue relates to the changes to water quality rather than the changes we are here discussing, being the "greening" of the landscape and the presence of irrigation infrastructure.

13.144 Overall we consider that associative values are closely linked to the biophysical values of the landscape and its aesthetic appreciation. For the reasons provided above and to follow in our discussion of sensory values, we consider that allowing further irrigation in the basins would not compromises these associative values if properly managed.

Sensory values

13.145 The key issue we have considered in relation to sensory values is the aesthetic qualities of the landscape. Ms Lucas talked about these aesthetic values at length, as discussed above. She considered that evident change in particular locations or of a particular type, intensity or scale can significantly adversely affect the experience and the appreciation of the greater Mackenzie landscape.

13.146 In contrast, Dr Steven was of the opinion that values based upon a picturesque aesthetic have an undue influence in resource management and landscape protection within New Zealand. He was critical of this approach because he believed that this approach overlooks more complex and less visible aspects of the landscape such as the functioning of ecological and geo-morphological processes and systems. It was his opinion that the protection of the Basin landscape in its current state will create a situation in which a particular landscape aesthetic based upon uninformed notions of naturalness and values will ignore and override very significant issues relating to the sustainable management of natural and physical resources as referred to in section 5 of the RMA.

13.147 Dr Steven also reminded us that we should not assume that all or any of the changes he described caused by human intervention will be perceived as negative effects. He noted there are multiple communities of interest within the Mackenzie Basin with different communities holding different values with respect to the same aspects of landscape. In other words there are present communities which that would see changes brought about by the greater degree of human intervention in the landscape as positive and beneficial effects on the landscape.

13.148 When discussing effects on aesthetic factors Dr Steven set out a list of aspects of aesthetic quality that he considered were important in determining effects on aesthetic factors. It was his view that only two factors, complexity and ground surface texture that would change to any degree as a consequence of irrigation. Again he made the point that such changes as do occur will be restricted to lowland areas of the Basin floor, which is not he said, the dominant source of the aesthetic appreciation of the Mackenzie. He again stated that given the mountains and ranges are the dominant visual elements, the characteristics of those features would endure regardless of further development of irrigated farmland within the Basin floor.

13.149 He also noted that there is a high degree of unity in the design of pivot infrastructure and the layout of centre pivot systems. Thus there will appear a degree of similarity between application properties in that regard. It was his opinion that an increase in complexity will

be from a base that is low in overall landscape complexity and he considered the resulting landscape will still be well within the range of complexity considered necessary for the perception of visual quality. He also considered that centre pivot irrigators are low profile and semi-transparent structures and thus they will generally not interrupt long distant views of the Basin.

13.150 Turning to colour he noted that colour is an aspect of aesthetic appreciation although not one that serves as a reliable indicator of aesthetic quality in his view. He again returned to the topic of preferences for different colours within different communities of interest, some prefer greening, others do not. He particularly acknowledged a community of interest that holds the Basin is not meant to be green. However in his view this position was based on ideological considerations, that is the belief the Basin is or should be still an unmodified natural landscape as much as any aesthetic factors present.

13.151 Dr Steven was of the view that the pro-brown view is misplaced as the same brown colours can represent a healthy short tussock grassland or a highly modified and degraded mix of grassland with the predominance of exotic grasses such as brown top or indeed bare earth and hieracium. He contended that the extent that it is believed that the current prevailing brown tones are due to original grassland is flawed. He went on to say that to oppose irrigation in the Mackenzie Basin on the ground that landscape is not meant to be green is to overlook the fundamental changes that have occurred in over 100 years of pastoral farming.

13.152 Dr Steven told us that people's appreciation of the naturalness of the landscapes is often synonymous with the amount of open space and absence of structures. However he considered that equating of open space with naturalness overlooks many human induced less visible changes to the landscape that may also have a marked effect on naturalness and averts awareness and attention from the more insidious causes such as erosion, wilding pines and hieracium. He considered that the focus on vegetative communities and ecosystems is more appropriate than a focus on unmodified landforms in undertaking an assessment as to naturalness.

13.153 He also contended that the view that the lowland landscapes to the Basin should be retained in their current state fails to appreciate the imperative for farming practices to change to reflect changed economic, financial, technological and social circumstances. He expressed his view that the proposition that sustainable farming practices and sustainable landscape management should be subordinate to the maintenance of a particular visual landscape aesthetic was unsupportable. He noted that in this argument the fact that the preferred landscape aesthetic is itself the product of over 150 years of farming practices appears to be overlooked.

13.154 He went on to note that the notion that the Mackenzie Basin or any other rural landscape is meant to be a particular way would preclude agricultural production entirely. It is in the nature of agriculture to change landscapes. The landscapes of agricultural production are rarely if ever the way they are "meant to be".

13.155 An issue closely related to sensory values is the tourism benefits that are associated with the views and vistas of the Basins. We received evidence on this issue from Mr Geoff Ensor from the Tourism Industry Association of New Zealand. We accept the value of the landscape to tourism. However we note that the landscape will primarily be viewed and appreciated from scenic viewpoints and main roads. We also note that due to the different cultural values of some tourists, they may also have a varied aesthetic appreciation of the landscape.

13.156 In summary we consider that Ms Lucas' assessment placed too great a reliance upon aesthetic factors and agree with Dr Steven that the dominant source of aesthetic appreciation will be retained, even after irrigation. However we consider that the openness and colour of the landscape do play an important role in people's appreciation of the landscape and the values they attach to it. We consider that changes to these components of the landscape must be carefully considered, and that in some circumstances mitigation measures will be appropriate, as we will now discuss.

Mitigation measures

13.157 Another important factor to take into account when considering the significance of the change is the use of measures to avoid, remedy or mitigate adverse effects. Mr Glasson provided us with a helpful summary of suggested mitigation measures. The general types of mitigation measures he proposed include:

(a) Avoid areas that are highly visible such as adjacent to roads, waterbodies and viewing areas;

(b) New patterns need to be integrated with existing landform patterns, such as centre-pivot circles;

(c) Changes need to be compatible with existing landscape especially along rivers, lakes and roads and with the "grain" of the landscape;

(d) Avoid locating sites in SVA, LPA, SNNs, and LOAs;

(e) Maintain the quality of the view from the road;

(f) The further away from viewing areas the darker the colour becomes and the visible area diminishes into a horizontal band;

(g) Changes need to be contained so that they do not appear as arbitrary areas;

(h) Changes are best at transition points or junctions in the landscape such as where the hill slope meets the flat land;

(i) Irregular patterns integrate easier with landform patterns than geometric ones;

(j) Avoid following land tenure boundaries as this adds a geometric edge to irregular landscape;

(k) Locate near the modified areas;

(l) Locate significant buffer areas between the proposed site and roads, waterbodies and viewing areas;

(m) Create riparian vegetation areas for lakes, rivers, streams and wetlands so as to retain the natural character of locations;

(n) A buffer area of 10km from the public viewing area on Mt John;

(o) Treatment of structure and buildings in recessive manner.

13.158 Buffer distances were a critical mitigation tool according to Mr Glasson. He noted that the extent of the buffer distance was influenced by the scale of the environment, the size of the irrigated area, the importance of the view, the type of landscape, type and land cover adjacent to the view, and the importance of the location and level of modification. These factors influenced how large the buffer area should or need be according to Mr Glasson.

13.159 Ms Steven when she assessed the proposal sites earlier described did consider mitigation tools. Her approach was similar to that of Mr Glasson, Mr Craig and the other landscape experts in terms of focusing on avoiding areas to irrigate that were highly visible from roads and viewing areas. It seemed to us her core mitigation tool was buffer distances and separation distances.

13.160 Mr Craig also addressed mitigation measures and generally agreed with the range of measures outlined by Mr Glasson. However he noted that overall avoidance, remediation and mitigation is very much a contextual matter. It was his view because of this it was important that blanket application of these matters is avoided. Instead he said they should be considered as a guiding principle where each case is considered on its merits

particularly with regard to avoidance, remediation and mitigation of adverse landscape effects.

13.161 We consider and comment on mitigation measures for individual sites in our Part B decisions. However we record here that we agree that mitigation measures can play a significant role in reducing the adverse effects on landscape values. In particular, we consider that buffers and setbacks from mains roads and public viewing points can be effective mitigation measures in some circumstances.

Our overall conclusions

13.162 We accept that the Mackenzie and Waitaki Basins represent an outstanding natural landscape that is iconic and highly valued. However it is a landscape that is also highly variable, degraded in parts, and has been visibly modified by human intervention over many years. We have taken into account this existing state of the environment and its history of change when considering the appropriate future use.

13.163 All parties accept that there will inevitably be changes to the landscape as a consequence of irrigation, particularly the "greening" effects and the presence of structures. However it does not necessary follow that these changes will be adverse if properly managed. There may also be positive benefits for the ecological health of the landscape as a consequence of this change.

13.164 We consider that the primary features that give the landscape its values are its vertical elements, namely the mountains and ranges of the basins. Overall, we consider that, subject to appropriate mitigation, allowing further irrigation on the basin floors will not significantly detract from the legibility or aesthetic appreciation of the landscape.

13.165 In reaching this view, we have primarily focused on the visibility of the landscape when viewed from public viewing points and main roads, as these are the most common areas from which the landscape is appreciated. Mitigation measures will be required in some of these areas to ensure that any adverse effects on landscape values are adequately addressed, as discussed in our Part B decisions.

13.166 To answer the question posed at the start of this part of our decision, for all of the above reasons we are not persuaded that there should be no further irrigation in the Mackenzie Basin. We consider that this conclusion is consistent with the requirements of the relevant planning instruments and the RMA and reflects the opinions of several of the landscape architects that appeared before us (namely Messrs Craig, Brown, Glasson, Ms Steven, and Dr Stevens). Even Ms Lucas (on behalf of Mackenzie Guardians) was not suggesting that there should be no further irrigation in the Basin.

13.167 Notwithstanding the above, we stress that this does not mean that the landscape effects of all the proposals will be acceptable. Each proposal needs to be considered on its merits, taking into account the environment in which it is located, the nature of the activities, and any proposed mitigation measures. We have completed this assessment in our Part B decisions and set out our general approach to this exercise below.

Approach to Part B consideration

13.168 In light of the above conclusions, we have considered the potential effects on landscape and terrestrial ecology within our separate Part B decisions as relevant. The following section provides an outline of the approach we have adopted on this issue throughout our Part B decisions.

<u>Segmentation of landscape</u>

13.169 In completing his assessment of landscape effects, Mr Glasson concluded that the scale of the catchment is so great that it precludes the catchment from being considered in landscape terms as one single entity. Thus Mr Glasson broke down the Waitaki catchment into eight discreet units based on physical character.

13.170 Overall, Mr Glasson was of the view that adopting this unit-type approach to the Mackenzie Basin was appropriate. He noted that each unit has specific landscape components that give that unit its own identity. He noted some of the units can absorb and accommodate change more easily, due to the more modified and less natural landscapes, such as Aviemore; while changes to more sensitive landscapes of the Grays-Mary Burn, Pūkaki, Omārama and Quail Burn would result in changes that are more difficult to absorb without applying significant mitigation measures.

13.171 Mr Craig agreed with this approach and he also agreed with the identification of those eight discreet units. Mr Craig was of the view the reason why this approach need be taken is that the catchment has a diverse landscape character. Ms Lucas applied a similar approach by dividing the landscape into segments. Although the division was somewhat different to Mr Glasson's, there was a level of commonality between her approach and Mr Glasson's approach.

13.172 We have carefully assessed Mr Glasson's approach to segmenting into his eight discrete landscape units. We agree with this approach and the basis for it. We think that the basis upon which he identifies those units is appropriate because he does so having proper regard to the values we have earlier identified to assist him in determining the appropriateness of the landscape units. We consider that dividing the landscape in this manner assists with the evaluation of effects of particular proposals on the landscape and have applied this approach when considering landscape effects on our Part B decisions.

Relevant Plans

13.173 Within the landscape, some areas are much more sensitive to change than others. These areas require more careful consideration in relation to potential adverse effects on the landscape. To guide our consideration of which areas are most sensitive, we have referred to and relied on the relevant district plans. This is the approach adopted by Mr Glasson, who referred to the district plans as providing "useful technical reference points".

13.174 He noted that the applications come under three District Councils and he then set out for us the policies and objectives from the rural sections of the Waitaki, Waimate and Mackenzie District Plans. He expressed the view the policies and objectives are relevant to landscape issues, including visual amenity, areas of outstanding natural features, landscapes, lakes and lakeside protection areas.

13.175 He then proceeded to undertake an audit of the various district planning maps to identify areas of significance. These areas included:

(a) Scenic viewing areas - Mackenzie District Plan

(b) Sites of national significance - Mackenzie District Plan and Waimate District Plan;

(c) Lakeside protection areas - Mackenzie District Plan and Waimate District Plan;

(d) Outstanding landscape areas - Waitaki District Plan.

13.176 In addition to the above, the WCWARP identifies High Natural Character Water Bodies that are worthy of a high level of protection and where effects on natural landscape and character is identified as an important issue. When considering landscape effects in our Part B decisions, we have considered the proximity of the application sites to these sensitive and significance areas identified in the relevant plans.

Cumulative effects

13.177 In addition to considering each separate proposal on its merits, it is important that we take into account the potential for cumulative effects if multiple applications are granted. In other words, while one site may not threaten the visual coherence of a landscape unit, it may be that the combined effects of multiple sites could exceed the threshold and become modified and incoherent.

13.178 Most of the experts we heard from did not provide much discussion on cumulative effects and focussed instead on specific application sites. The evidence that we found most helpful was that of the reporting officer Mr Glasson who provided an overview and assessment of cumulative effects throughout the landscape.

13.179 Mr Glasson noted that cumulative effects result from additional changes to the landscape or visual amenity caused by the proposed development in conjunction with other developments associated with it or separate to it or actions that occurred in the past, present or are likely to occur in the foreseeable future. He said cumulative effects can arise not just from the greening of the landscape, but also from a mixture of accessory parts of irrigation development such as structures, roads, water intakes, buildings and canal structures.

13.180 He said that the degree of cumulative effect is a product of the number of and distance between individual irrigation sites, the interaction between the zones of visual influence, the overall character of the landscape, its sensitivity to irrigation sites, and the location and design of the irrigation sites themselves. Mr Glasson told us that he had assessed the cumulative effects arising from selecting viewpoints through the Upper Waitaki catchment from places like routes, features and waterbodies.

13.181 Cumulative landscape effects consist of two broad categories: combined and sequential. Combined effects are where a viewer can see multiple developments from one viewpoint. Sequential effects are those that are experienced sequentially as one moves through the landscape, such as travelling along SH8. This was a distinction that was supported by Dr Steven in his evidence.

13.182 Mr Glasson addressed the issue of when should cumulative effects be judged unacceptable. He noted in this regard that the concept of a threshold for adverse cumulative effects was a crucial element in his assessment. He told us that he had determined the threshold above which cumulative adverse effects become significant in pragmatic terms. This threshold is based on a well-considered judgement informed by his professional assessment of landscape sensitivities on the limits and extent of scale and distribution of irrigation development, which could be accepted within an area.

13.183 In broad terms, we agree with the approach Mr Glasson has applied to assessing cumulative effects, including the identification of viewpoints to assess both combined and sequential effects. In particular, we consider that the appreciation of the landscape whilst travelling through the landscape by road is an important register of cumulative effects. This does not mean that we necessarily support all of his conclusions and the "thresholds" that he has applied in each case. We leave this issue for comment in our separate Part B decisions in relation to individual applications within the discrete landscape units.

13.184 Finally we note that the issue of cumulative effects may raise the issue of priority between applications in some circumstances. We discuss the issue of priority later in this decision and have applied those principles to the consideration of cumulative landscape effects in our Part B decisions.

<u>Summary of assessment approach for Part B</u>

13.185 Taking all of the above into account, our assessment approach for landscape issues in our Part B decisions includes the following key components:

(a) Consider the nature of the existing environment, taking into account the landscape unit in which it is located.

(b) Identify the effects of the proposal in terms of the changes to the landscape that would result from granting consent;

(c) Evaluate the significance of these changes, taking into account:

(i) Any areas of significance identified in the relevant plans;

(ii) The visibility of the site from public areas, including main roads and scenic viewing points;

(iii) Any mitigation measures proposed; and

(iv) Nearby existing and proposed developments that may result in cumulative effects.

14 TANGATA WHENUA VALUES

14.1 This part of our decision provides a discussion on the tangata whenua values that are associated with the Upper Waitaki that may be impacted by these applications. We considered it appropriate to address this in Part A given the holistic nature of cultural values, the importance placed on those values in the RMA and planning instruments, and the commonality of issues across multiple applications.

14.2 We understand that the Waitaki waterways and catchment in its totality from the peak of Aoraki to the Pacific Ocean is of cultural significance to Ngāi Tahu whānui (Ngāi Tahu, Ngāti Mamoe and Waitaha). The Upper Waitaki is an important and connected subsection of that tribal landscape, evoking a strong spiritual and identity anchor for manawhenua, those with a customary or whakapapa link. A link consolidated through traditions, place names, waiata, whakapapa and the cornerstone activity of mahinga kai (seasonal food gathering).

14.3 The people with manawhenua status in the Mackenzie Basin are generally affiliated to one or other of the three Papatipu Runanga, namely Arowhenua, Waihao and Moeraki, whose takiwa or area of influence are described in the Schedules of the Te Runanga o Ngāi Tahu Act 1996.

14.4 The tribal authority Te Runanga o Ngāi Tahu does not hold manawhenua status, but provide support to Ngāi Tahu whānui in matters of policy and advocacy where requested or a tribal interest is in contention.

14.5 The Crown, in the Ngāi Tahu Claims Settlement Act 1998 recognised the significance of the Ngāi Tahu association with the Waitaki catchment (inclusive of the Mackenzie Basin) by provision of Statutory Acknowledgements that transcend the catchment.

Planning and Statutory Context

14.6 The relevant planning and statutory context for consideration of these applications is discussed earlier in this decision. The following sections highlight those parts of the RMA and the planning instruments that are particularly relevant to cultural values.

National and Regional Policy

14.7 The Freshwater NPS contains a specific objective and policy (D1) to ensure that tangata whenua values are identified and reflected in the management of freshwater. This includes an obligation for local authorities to take reasonable steps to ensure that these values are reflected in any decision making on freshwater in the region.

14.8 Objective 3 of the operative Regional Policy Statement (1998) includes; c) safeguarding their existing value for providing mahinga kai for Tangata Whenua; d) protecting waahi tapu and other waahi taonga of value to Tangata Whenua.

14.9 The Proposed Regional Policy Statement (2011) uses different wording but seeks outcomes that are consistent described in Chapter 4 "Provision for Ngāi Tahu and their relationship with resources", and Objective 7.2.3 regarding management of freshwater resources which recognises the Ngāi Tahu ethic of "Mountains to the Sea" and "Kaitiakitanga".

Regional Plans

14.10 Objective (1) of WCWARP is cast in the context of sustaining the qualities of the environment of the Waitaki River and associated beds, banks, margins, tributaries, islands, lakes, wetlands and aquifers.

14.11 Objective 1(a) of the WCWARP states the strategic intent of the plan for tangata whenua as follows:

> *"recognising the importance of maintaining the integrity of the mauri in meeting the specific spiritual and cultural needs of the tangata whenua, and by recognising the interconnected nature of the river".*

14.12 There is no corresponding word that explains the word "mauri" in English, the NRRP applies the term "mauri" as a physical, biological and cultural parameter to assess flow regime, abundance and diversity of fauna. This gives a tangible basis to the term and bypasses the difficult issue of assessing the intangible aspects of mauri. Objective (1) and (1)(a) interact and provide a broad intent that is consistent with the RPS, and NRRP provisions. Despite the "interpretation" matter, Objective (1)(a) provides a sound framework to assess the overall case of the applicants against the specific spiritual and cultural needs of tangata whenua in the context of an interconnected resource.

14.13 Objective 1(a) importantly seeks to maintain the existing standards and integrity of the waters of the river. This is a holistic reference to the "river" which includes beds, banks, margins, tributaries, islands, lakes, wetlands and aquifers that interconnect from the mountain tops to the sea, to create the ancestral waters of the Waitaki River.

14.14 The spiritual and cultural needs of tangata whenua in Objective 1(a), imposes a duty to be careful to at least maintain and not create further diminishment of current water quality and quantity standards. We take this interpretation as the most basic way we can be consistent with the Objective 1(a), that any adverse effects on water quality and quantity of the proposed activities would offend spiritual and cultural values also.

14.15 The policies of the WCWARP interact to add further expression to the intent of Objective (1)(a), and as the primary planning instrument that we are required to assess the proposed activities against Objective 1(a) in the context of Part A of our decision is of primary importance.

14.16 The operative NRRP has a range of Objectives and Policies that are consistent with provisions of the WCWARP that address the spiritual and cultural needs of tangata whenua. A principal variance is the removal of the term "mauri" from the NRRP issues, objectives and policies as an indicator for setting flow regimes. The basis for that being the word is a broad concept that cannot easily be assessed, whereas terms such as flow regime, abundance and diversity of fauna are physical, biological and cultural parameters that can be used.

Part 2 RMA

14.17 Sections 6(e), 7(a) and 8, inform but do not deter judgement of how to achieve sustainable management but S.6 matters must be given due emphasis[24].(Section 8 refers to the principles of the Treaty of Waitangi, as defined in the well known judgement of *NZ Māori Council v Attorney General*[25]. We are required to take into account those principles and have done so in consideration of cultural values.

[24] Harrison v Tasman District Council W42/93 (PT) and EDS v Maunganui County (1989) 3 NZLR 257 (CA)
[25] (1987) 1 NZLR 6411 (CA)

Other relevant documents

14.18 There are three iwi management plans that are recognised by Te Runanga o Ngāi Tahu and lodged with Environment Canterbury:

(a) Te Runanga o Ngāi Tahu Freshwater Policy (1999)

(b) Te Whakatau Kaupapa – Ngāi Tahu Resource Management Strategy for the Canterbury Region (1990)

(c) Kai Tahu ki Otago Resource Management Plan (2005).

14.19 Whilst these plans do not contain any statutory requirements under the RMA, they identify the Tangata Whenua values associated with the land and water resources in the Waitaki Catchment and have been considered by us under s104(1)(c) in relation to these applications.

14.20 In addition to the RMA, another relevant piece of legislation is the Ngāi Tahu Claims Settlement Act 1998. The Settlement Act includes statutory acknowledgements, which recognise the special relationship of Ngāi Tahu with a range of areas in the South Island. The purpose of statutory acknowledgements are to ensure that the particular relationship Ngāi Tahu has with these areas is identified, and Ngāi Tahu are informed when a proposal may affect one of the areas.

14.21 In the upper Waitaki catchment, Aoraki/Mt Cook, Lake Aviemore (Mahi Tikumu), Lake Benmore (Te Ao Mārama), Lake McGregor (Whakarumoana), Lake Tekapo (Takapo), Lake Pūkaki and Lake Ōhau are all statutory acknowledgement areas.

The Applicants' Case

The Cultural Impact Assessment

14.22 Mackenzie Water Research Limited (MWRL), formed by the applicants in January 2008 to investigate the cumulative effects of the proposed irrigation in the Upper Waitaki. This included the development of a cultural impact assessment (CIA) to address the impacts of irrigation on water quality and environmental values.

14.23 The CIA was commissioned by Ryder Consulting Ltd on behalf of MWRL through the engagement of Gail Tipa of Tipa Associates. The CIA was completed in February 2009. There was no formal presentation of the CIA or its contents to the hearing, however copies of the CIA were provided to commissioners as part of the MWRL pre hearing information from Mr John Kyle.

14.24 The value of the CIA in understanding the potential effects of the proposed irrigation activities on cultural values was limited due to the CIA report being prepared in the absence of key technical reports (aside from the draft social impact and economic impact assessments). However despite the "limitations", the 101 page CIA, including appendices, provided a broad understanding of the Ngāi Tahu cultural values, and issues in the Upper Waitaki.

14.25 The CIA lists "*values and the associated impacts*" on cultural values relating to the waters and landscapes of the Upper Waitaki, and provides recommendations, including priorities for areas to be protected or rehabilitated, adverse effects to be avoided in relation to waahi tapu, mahinga kai, quality and quantity of water. The CIA also identified information gaps including the absence of key technical reports, as previously mentioned.

14.26 Chapter 5 of the CIA lists 27 sets of values and then details the nature of impact that each value may be subject to by the proposed expanded irrigation activity for the Upper Waitaki.

14.27 Chapter 6.5 of the CIA, "Going Forward – Ngāi Tahu Expectations", stresses the need for site specific discussions, and the expectation that the issues raised in the CIA would become the focus of direct discussions between Ngāi Tahu, MWRL and landowners.

Buddy Mikaere- Peer Review of CIA

14.28 The applicant group MWRL commissioned Mr Buddy Mikaere to undertake a peer review of the CIA. The peer review was designed to assist both the individual applicants and the applicant group to understand the cultural values and identify actions to avoid, remedy or mitigate adverse effects on the cultural issues.

14.29 Mr Buddy Mikaere, is a Principal of Buddy Mikaere Associates, a consultancy specialising in tangata whenua consultation and cultural issues arising from development applications under the RMA. We accept that Mr Mikaere has the cultural expertise to advise MWRL and individual applicants on the appropriateness of the measures designed to address the issues raised by Ngāi Tahu regarding the potential effects on cultural values of the irrigation proposals.

14.30 The Mikaere 'Peer Review" (May 2009) of the CIA was attached to his primary evidence which he presented in support of the individual applicants that he represented namely Southdown Holdings Ltd, Five Rivers Ltd, Williamson Holdings Ltd and Killermont Station, as well as Lilybank Station.

14.31 The principal objective of Mr Mikaere's evidence of October 2009 was to show how the cultural issues that had been raised by the submissions of Te Runanga o Ngāi Tahu and Ngāi Tahu Mamoe Fisher People Inc in opposing the applications for irrigation in the Mackenzie Basin had been addressed by the individual applicants he was representing. In this objective he submitted that he was strongly guided by the outcomes of the Peer Review he had produced on the CIA for MWRL.

14.32 Mr Mikaere was asked what discussions the applicant and Ngāi Tahu had engaged in following the release of the CIA to clarify or achieve a detailed understanding of the cultural issues. At that time (October 2009) Mr Mikaere commented that he was unaware of such a meeting occurring.

Environmental Issues

14.33 Mr Mikaere opined that the issues identified in the CIA document described as cultural are in his view generic in scope, i.e.; they are environmental issues that one would expect to find associated with an irrigation application. While there is obviously a cultural and heritage component to these matters his belief was that the approach taken by the applicant is applicable regardless of the cultural or ethnic links of opposing submitters.

14.34 In the exercise of his work Mr Mikaere drew on the relevant statutory provisions and planning documents that have been instrumental in establishing the Ngāi Tahu position on the use of freshwater in the Mackenzie Basin. He also noted the Ngāi Tahu Settlement Act (1998), the iwi resource management plan Te Whakatau Kaupapa (1990) and the Ngāi Tahu Freshwater Policy (2000) have close correspondence with the issues and values outlined in the CIA.

14.35 In his 7 October, 2009 evidence Mr Mikaere examined the CIA, TRONT submission and the submission of the Mamoe Fishers, the WCWARP and S42A Officers Report in the context of the applicants he was representing. For example he concluded that the issues raised in opposition to the proposed extension of irrigation in the Mackenzie Basin are not applicable to the Lilybank application. He also concluded that the issues that were relevant had been comprehensively addressed in the proposed consent conditions and FEMP.

14.36 Mr Mikaere expressed confidence in the MWRL water quality study and the efficacy of the mitigation measures in the FEMP's to comprehensively address the issues raised by Ngāi Tahu, issues which he considered to be principally environmental in nature.

Kaitiakitanga

14.37 Mr Mikaere stated that commissioning of the CIA recognised and provided for the relationship of Ngāi Tahu with their ancestral lands and waters. That regard for kaitiakitanga principles (s7(a) RMA) were addressed through the CIA process, attention to relevant Ngāi Tahu policy documents, and on site discussions with Ngāi Tahu representatives. The insertion into relevant consent conditions and implementation of the FEMP's which allows use of water resource without impinging on cultural values held by Ngāi Tahu addresses s8 of the RMA.

14.38 Mr Mikaere gave additional evidence on the 15th October in regard the Southdown Holdings Ltd, Five Rivers Ltd, Williamson Holdings Ltd and Killermont Station applications. He considered that on reviewing the evidence of Dr Bright, Mr McIndoe, Dr Ryder, Dr Goldsmith and Dr Robson, that through a combination of design features, avoidance, remedial and mitigation measures the applications for the four properties will not have an adverse effect on the Mackenzie Basin environment and catchment, and therefore no adverse effects on cultural values and related concerns.

14.39 Mr Mikaere further highlights the importance of individual property discussions with Ngāi Tahu around the implementation of the FEMP's (Farm Environmental Management Plans) as the means of giving practical effect to the protection and recognition of cultural values and issues. The CIA also recommended addressing further information needs of Ngāi Tahu on a property by property basis as a means to avoid, remedy or mitigate the adverse effects of existing and new irrigation.

Submitters' Views

14.40 On Monday 25th January 2010, Ngāi Tahu presented evidence through four witnesses with a gallery of tribal members present in support, cultural protocols marked the occasion appropriately.

David Higgins

14.41 David Higgins, Upoko (Leader) of Te Runanga o Moeraki and a tribal elder spoke about the cultural associations that Kai Tahu Whānui (note the 'k' is used interchangeably in the Kai Tahu/Ngāi Tahu dialect) with Te Manahuna (Mackenzie Basin), whakapapa and origins of the Waitaha, Kati Mamoe and Kai Tahu, contemporary tribal structure and role of Kaitiaki Papatipu Runanga in the catchment. He also spoke about Māori archaeological sites in the Upper Waitaki, the heke (trek) of Te Maiharoa and his followers into the site of Te Ao Mārama to protest the Crown asserting ownership of the "interior".

14.42 Mr Higgins told us about the trails and custom of mahika kai (mahinga kai) and chronicled an account of activity in the last 30 years by the hāpu (extended whānau) to maintain the ahi ka roa (keeping the home fires burning) in the interior. The Ngāi Tahu evidence included a series of maps and images depicting the seasonal cycle of mahinga kai, occupation sites, trails, place names, statutory acknowledgements and images of ancestors who played an important role in Te Manahuna (Mackenzie Basin).

Paul Horgan

14.43 Mr Paul Horgan had been employed by Te Runanga o Ngāi Tahu as Environmental Advisor for the previous 3.5 years. Mr Horgan has experience in law and resource management with several years experience in environmental law, policy analysis and planning related matters. Mr Horgan told us about the extensive involvement of Ngāi Tahu since 2002 to engage in the suite of applications in the Waitaki catchment. He said that he had been involved in the Upper Waitaki consent applications since he commenced working for Te Runanga o Ngāi Tahu and that the applicant group did not begin to actively engage with Ngāi Tahu until late 2008 and during 2009.

14.44 Mr Horgan reiterated that the CIA was completed without the benefit of much of the relevant technical information that MWRL were still preparing at the time. The result was that Ngāi Tahu had been required to expend considerable amount of time getting up to

speed with the cultural implications of the applications. In addition Mr Horgan told us that Ngāi Tahu representatives had visited many high country stations where the owners were seeking consent including Lilybank, Godley Peaks, Glenmore, Ōhau Downs, Glen Eyrie Downs, Killermont, Simons Hill and Simons Pass an exercise involving three separate hikoi.

Scale and Intensification

14.45 Mr Horgan said that Ngāi Tahu concerns were with the sheer scale of some of the applications, and as a result had adopted two focal points against which to assess the applications. The two sites being the Ahuriri Delta and Haldon Arm of Lake Benmore, sites identified for enhancement of mahinga kai. Ngāi Tahu does not want to see new irrigation that will degrade existing habitats and deny opportunities for enhancements in the Ahuriri Delta and Haldon Arm. Mr Horgan told us that the level of uncertainty around the effects and the potential scale of the impacts meant they were unable to support any cultural compensation proposal and in that context they are opposed to the large scale applications upstream of the Ahuriri Delta and Haldon Arm.

14.46 Mr Horgan submitted that Ngāi Tahu had modified their original opposition to all applications to the effect that generally small scale low intensity and replacement applications would not be opposed, with the proviso that such applicants carry out riparian plantings and fencing, and undertake not to significantly intensify their farming activities.

Periphyton and Nutrient Loss

14.47 Mr Horgan was critical of the applicants' proposed 25% increase in periphyton biomass threshold, stating that it is simplistic and arbitrary to assume that a 25% increase in periphyton is sustainable. Mr Horgan was concerned that if the periphyton biomass increased disproportionately, that this is likely to degrade water and habitat quality and impact on biodiversity and mahinga kai values.

14.48 Mr Horgan was critical of the lack of effort by the applicants to provide a coherent analysis of the behaviour and function of the Upper Waitaki groundwater system. Mr Horgan also cited the lack of evidence about the capacity of the Mackenzie Basin soils to support intensive agriculture, the permeability of the Basins soils would result in rapid nutrient losses to groundwater and downstream waterways.

Adaptive Management

14.49 Mr Horgan outlined Ngāi Tahu doubt about the veracity of the 'adaptive management regime that Mr Whata proposed would apply in the Mackenzie Basin. The principal concern being that an essential prerequisite for any adaptive management regime is:

(a) there is a clear understanding of the state of the existing environment; and

(b) that a staged development is applied, e.g.; development occurs in 10% increments.

14.50 Mr Horgan told us that if the state of the environment is not clear before development commences, that establishing a chain of causation between an increase in nutrient loads and irrigation related activities is also likely to be problematic.

14.51 In addition Mr Horgan told us that a significant issue for the applicants' adaptive management regime is the ability to implement remedial action in the event that unsustainable nutrient loads are detected. Simply reducing the annual allocation of water for the subsequent season as proposed in the evidence of John Kyle for Southdown, Williamson Holdings, Five Rivers and Killermont Station would not be sufficient to address degraded water problems and the lag effect of accumulated nutrient levels migrating through the gravels and into the groundwater.

Ahuriri Water Conservation Order

14.52 In respect of the Ahuriri Water Conservation Order, Mr Horgan requested on behalf of Ngāi Tahu that the applicants provide an assessment of the water quality clause of the Ahuriri Water Conservation Order in their right of reply, noting that the applicants' Water Quality Study acknowledged that "….*further development of irrigation areas has the potential to reduce in stream habitat quality*…".

Conclusion

14.53 Mr Horgan concluded by telling us that Ngāi Tahu had taken a balanced approach in assessing the cultural effects of each proposal on its own merits, and considered that many of the smaller scale proposals and those for renewal consents do not pose a risk to cultural values. In contrast, Mr Horgan told us that Ngāi Tahu were alarmed about the scale and intensity of the larger proposals such as Southdown, Five Rivers, Killermont, Simons Hill, Simons Pass and the two Rosehip applications. Mr Horgan urged that given the patchy nature of the science presented in the proposals that a precautionary approach be adopted, he stated that the 'suck and see' approach that the applicants are seeking is cavalier and inconsistent with the special relationship that Ngāi Tahu hold with the Upper Waitaki.

Ms Robertson

14.54 Ms Diana Robertson then appeared for Te Runanga o Ngāi Tahu, an ecologist working for Boffa Miskell, with qualifications in ecology and horticultural science (Lincoln) and practising as a professional ecologist since 1990. Her work experience includes assessments of terrestrial and wetland values and effects of Project Aqua, and subsequently the North Bank Tunnel, Hunter Downs Irrigation and wider catchment evidence for the Waitaki Regional Plan. Ms Robertson states that her work on various Waitaki projects involved working closely with members of Te Runanga o Ngāi Tahu and the three kaitiaki Runanga and as a result gained a greater appreciation of Ngāi Tahu associations with the Waitaki and as a result the interface between ecological and cultural values.

14.55 Though not a water quality expert, Ms Robertson stated she has a high level of experience in interpreting reports and evidence of hydrogeological, hydrological, water chemistry and aquatic ecological experts in order to assess ecological effects. In her evidence she listed the applicant and submitter reports she had reviewed. Her brief from Ngāi Tahu was to prepare evidence on the ecological effects of the Upper Waitaki irrigation consent applications on the Ahuriri Delta and Haldon Arm at Lake Benmore, and to advise on the likely effects on the ecology of the mahinga kai sites.

Mahinga kai

14.56 Ms Robertson contended that the assessment provided by the applicants was insufficient to determine the likely effects of the proposed irrigation on the mahinga kai enhancement sites, Ahuriri Delta, Haldon Arm and Lower Tekapo. In her opinion, based on the additional information provided by some of the submitter experts (Meridian, DoC), there is a significant risk of adverse effects on the water quality at the Ahuriri Delta and Haldon Arm. In her opinion, this will likely have an adverse impact on the restoration potential, mahinga kai and ecological values present at these sites.

Ahuriri Delta

14.57 Ms Robertson discussed the values of the Ahuriri Delta, noting the waterways had relatively steady flows and listed the range of native and exotic flora and fauna present in the delta. She further described the presence of the longfin eel in the delta, and the associated threats and opportunities to enhance this key mahinga kai species. Enhancement opportunities rest principally in increased native wetland and riparian vegetation habitat and use.

14.58 The key threat in her view was a reduction in water quality that would promote conditions for the proliferation of existing and new aquatic weed species and algae. The habitat and food supply for longfin eel would be altered she claimed, and algae growth would create potential toxicity issues. Both the harvesting, experience and likelihood of capture would be compromised if the habitat and ecosystem changes predicted by MEL experts occurred.

Haldon Arm

14.59 Ms Robertson discussed the mahinga kai values associated with the Haldon Arm. The long fin eel inhabits the Haldon Arm and at points upstream, which provides a strategic location for the trapping of mature long fins to transfer below the Waitaki Dam. This downstream transfer process facilitates their onward migration to the sea , bypassing the destructive turbines of the hydro dams and allowing the eels to complete their lifecycle through spawning at sea.

Lower Tekapo River

14.60 The braided river habitat in the Lower Tekapo River is host to the threatened braided river birds, also found here are the Waitaki lowland and bignose galaxias. Enhancement opportunities in the Haldon Arm and Lower Tekapo would include increasing native wetland and riparian vegetation habitat and use. In her view the principal threat to increasing native wetland habitat is the change to water quality.

Conclusion

14.61 Ms Robertson's review expressed a lack of confidence in the assessment of effects and identifies that there is a significant risk of much greater ecological impact than that stated by the applicants. The evaluation of the merits of the WQS is dealt with in detail elsewhere in this decision so is not taken any further in this cultural values section.

Ms Waaka-Home

14.62 Ms Mandy Waaka-Home presented her evidence on behalf of her hāpu Ngāti Huirapa and with the unconditional support of Te Runanga o Arowhenua, Te Runanga o Waihao, Te Runanga o Moeraki and Te Runanga o Ngāi Tahu. Ms Waaka-Home recounted the strong whakapapa connection of her and her direct forbears to the Waitaki catchment and the inherited responsibility she had of being a kaitiaki to the Waitaki catchment. Ms Waaka-Home noted that while the traditional principles of being a kaitiaki remain intact, it has been necessary to evolve the function of being a kaitiaki in order to cope with the increasingly intense demands that are being placed on the natural resources.

14.63 Ms Waaka-Home told us the role of a kaitiaki today is increasingly focused on restoring and rehabilitating degraded mahika kai sites, assessing proposed developments and preparing cultural impact assessments, making submissions, presenting evidence on consent and plan processes, and engaging with agencies such as DoC, F&G and councils.

Aspirations

14.64 The principal scope of evidence presented by Ms Waaka-Home focused on the aspirations of Ngāi Tahu in the Waitaki catchment and the significance of the longfin eel (tuna), and the reasons why the Ahuriri Arm is a focus for restoration, and the strategic importance of the Haldon Arm and Lower Tekapo for the tuna restoration objectives.

14.65 The principal driver for the 'aspirations' was described as the need to preserve and enhance the relationship with the ancestral river. It requires active engagement and interaction, to retain and pass on matauranga (knowledge) to successive generations through customary mahinga kai practice and taking a pride in the duty of kaitiaki.

Tuna Stocks

14.66 The immense importance of the tuna to whānau and hāpu of Ngāi Tahu was related to us, both as a symbol of spiritual importance and for its physical sustenance of the people. The

dual impact of hydro dams blocking migration or destruction of tuna by the hydro turbines combined with the effect of commercial eeling being the main cause in the decline in tuna stocks.

14.67 Ms Waaka-Homes told us the Ahuriri Arm was identified by Ngāi Tahu as a tangible area to restore tuna and as an exclusive fishery area because of;

(a) Traditional use by the ancestors and in memory of the prophet Te Maiharoa who chose to occupy this area in protest at Crown assertion of ownership of the interior;

(b) Ecologically diverse and ideal habitat for juvenile and adult tuna, including slow moving meandering riffles, wetlands and pools;

(c) Close proximity to the Omārama Stream, which is considered ideal for elver and into which elver are released as part of the trap and transfer programme;

(d) Potential to enhance the area by removal of crack willow, and replanting of suitable native species such as raupō (bulrush), harakeke (flax) and podocarp.

(e) The Ahuriri has a Water Conservation Order which provides safeguards in water quality and quantity;

(f) The Ahuriri is an ideal harvest point before tuna enter Te Ao Mārama (Lake Benmore);

(g) The ability for Ngāi Tahu to gain exclusive access to Ben Omar Station.

14.68 Ms Waaka-Home told us about the strategic importance of the Haldon Arm and Lower Tekapo for the trap and transfer of adult eel to below the Waitaki Dam and hence provides safe passage to the sea and migration to the breeding grounds in the mid Pacific.

14.69 Ms Waaka-Home told us of her concerns at the potential impact of the irrigation proposals on water quality and the effect algae bloom may have on tuna. She told us that years of personal observation show that tuna chase good water quality and habitat rich in suitable food resources such as larvae.

Food Source

14.70 From her people's point of view water should be clean enough to eat from; it is offensive to gather food from areas in a polluted or degraded state, particularly degraded by effluent. From past experiences, tuna living in nutrient rich habitat become unfit for harvesting because they smell and taste like tutae (effluent). Ms Waaka told us she would be embarrassed to feed manuhiri (guests) at her marae, tuna that tastes like cow tutae (dung).

14.71 Ms Waaka-Home expressed a lack of confidence in the FEMP's, monitoring programmes and consent reviews to address issues and protect the cultural relationship with ancestral waters and taonga.

Conclusion

14.72 In her conclusion Ms Waaka-Home said that while the Ngāi Tahu evidence for this hearing is focused on the Upper Waitaki, the health and vitality of the Upper catchment is essential to sustaining the health of Lower Waitaki downstream reaches. She also stated that the cultural implications of the large scale operations cannot be overstated as an enormous amount of time and energy had been expended by Ngāi Tahu on restoration objectives. While they have been marginalised by historical developments, they expressed confidence in their restoration aspirations, and asked that cultural values be seriously considered.

Other Submitters

14.73 Ngāi Tahu Mamoe Fisher People Inc submission was focused around Crown process and proprietary issues rather than issues specific to the applications before this hearing, matters that are beyond the scope of this hearing to address. The Ngāi Tahu Mamoe Fisher People Inc did not appear or provide evidence.

Officers Reports

14.74 In the Introductory section (Report 1) of the S42A Officers Report, Ms Claire Penman identified the "Ngāi Tahu Claims Settlement Act 1998" and three iwi resource management plans as relevant documents to be considered. A summary of submissions indicated that Ngāi Tahu – Mamoe Fisher People Inc and Te Runanga o Ngāi Tahu were opposed to all applications on the issues of catchment wide cumulative effects, mixing of waters, kaitiakitanga, customary rights, protection of mahinga kai sites, cultural impact, Treaty of Waitangi and wetlands loss.

14.75 In the S42A Officers Reports for the individual applications the commentary on tangata whenua values used a generic comment in the assessments for each of the individual applications that in each case "the applicant had not provided an assessment of the proposed activity on cultural values".

14.76 The reporting officers also identified the relevant affected Papatipu Runanga and whether they or Te Runanga o Ngāi Tahu had been served notice of each particular application, and which of them had made submissions and broadly on what issues. The S42A Officers concluded that until the Ngāi Tahu evidence on the cultural issues had been heard they were unable to determine that the actual and potential effect on cultural values would be minor.

14.77 In February, 2010 the S42A Reporting Officers presented their Addendum Reports to deal with matters that had arisen during the course of the hearing and on which they were able to offer further comment in addition to the material contained in their original S42A reports. These reports were presented to the hearing in the week following Ngāi Tahu presenting their evidence.

14.78 Reporting Officer Claire Penman in response to the question "does the evidence of Ngāi Tahu cause her to change any assessment of the issues", gave the response that the cumulative issue remains outstanding, and that due to uncertainty around the GHD Water Quality Study and the FERA and FEMP's being incomplete meant it was premature to make conclusive assessments. This was a consistent position of all S42A addendums.

Applicants Right of Reply

Mr Whata

14.79 In his right of reply Mr Whata acknowledged that the main concerns of Ngāi Tahu concentrated around the effects that new irrigation that may have in degrading existing habitats, which may deny opportunities to undertake enhancements. He reiterated that the applicants have agreed to the full scale of MWRL conditions that include FEMP's designed to meet the appropriate water quality standards. He considered that these steps will be significant and ensure that these activities will not adversely affect the resources that Ngāi Tahu is concerned about.

14.80 Mr Whata in response to Mr Horgan's evidence opposing the Southdown Holdings Ltd, Five Rivers and Killermont applications because of the potential to degrade the Ahuriri Delta, stated that the northern half of Glen Eyrie and Ōhau Downs do not drain into the Ahuriri Delta. He restated his confidence in the analysis that MWRL have undertaken, which has not identified the Ahuriri Delta as being affected by cumulative nutrient loading. Mr Whata also noted the applicants have committed to both the "lockstep approach" (regarding flow of groundwater) and ongoing monitoring of the Ahuriri Delta. The expectation being that

applicants will share this responsibility with other applicants given this is a cumulative issue.

14.81 Mr Whata in his right of reply did not specifically address the request by Ngāi Tahu (Mr Horgan) that that the applicants provide an assessment of the water quality clause of the Ahuriri Water Conservation Order in their right of reply. Mr Whata made a general response to cultural issues by a restatement of his confidence in the MWRL case to mitigate adverse effects.

14.82 The efficacy of the applicant's mitigation measures and conditions to address water quality issues referred to by Mr Whata are subject to greater and appropriate scrutiny elsewhere in this decision and will not be repeated here.

Mr Mikaere

14.83 April 2010, Buddy Mikaere provided supplementary evidence for MWRL (tabled) in response to points raised in the evidence of David Higgins, Di Robertson, Paul Horgan and Mandy Waaka-Home on behalf of Te Runanga o Ngāi Tahu.

14.84 In the supplementary evidence Mr Mikaere addressed Ngāi Tahu criticism of the consultation process and raised a counter argument regarding the lack of property specific information in the CIA and TRONT original submissions, which made it difficult for the applicants to address the cultural issues. He then submitted that a general approach was required by the applicants in respect of each property to determine what the specific issues were and what the appropriate avoidance, mitigation and remedial options should be.

14.85 He further stated that there was a need for the applicants to form a collective approach on the issues prior to engaging in any meaningful discussions with TRONT so that those discussions could have some focus. Mr Mikaere noted that efforts were made to consult with TRONT and Ngāi Tahu representatives centering around site visits to the applicant properties, a matter that was reported on by both parties during the course of the hearing.

14.86 Mr Mikaere then suggested that the detailed knowledge of the properties visited by Ngāi Tahu representatives was limited to waterways and there had been no identification of mahinga kai or wāhi tapu on any of the applicant properties. Mr Mikaere therefore felt motivated to question what the usefulness of an extended period of consultation might serve.

14.87 In his supplementary evidence Mr Mikaere belaboured the efforts that the applicants had to endure to identify the issues in an "information vacuum". However as previously discussed there was an absence of key technical information when the CIA was prepared, and subsequently there has been uncertainty expressed by Ngāi Tahu whether the applicant groups WQS and FEMP's would avoid, remedy or mitigate adverse effects on mahinga kai values.

Our Conclusions on Tangata Whenua Values

14.88 The evidence on cultural matters provided by Mr Mikaere for the applicant and Ngāi Tahu witnesses in response reach different conclusions. Mr Mikaere asserted that the cultural interest can be addressed through the FEMP's, which is underpinned by the WQS and associated mitigation measures, whereas Ngāi Tahu remained unconvinced in the applicants capacity to address subcatchment, cumulative water quality and quantity issues arising from the proposed expansion of irrigable lands and large scale intensification.

14.89 It is clear that Ngāi Tahu are the kaitiaki for Te Manahuna (Mackenzie Basin), with specific responsibilities apportioned to the local Papatipu Runanga. The nature and extent of kaitiakitanga is something that only tangata whenua can determine according to place and context of the relationship they traditionally hold according to customs. Having particular regard to kaitiakitanga in this context means paying special regard to the views of Ngāi Tahu about the appropriate manner in which natural and physical resources should be husbanded.

14.90 On this basis, our task is to make an assessment of the impacts on cultural values and focus on:

(a) The breadth of the ethic of kaitiakitanga as tangata whenua understand it in those locations affected by the proposal.

(b) The breadth of the relationship of tangata whenua to the particular resources and how that relationship may be affected.

14.91 History records that the Ngāi Tahu interest in Te Manahuna (Mackenzie Basin) is significantly changed as result of the effects of hydro electric development and the consequent modification of traditional mahika kai habitats. Ngāi Tahu have raised the issue of mahinga kai loss over many years in RMA processes and articulated through their own iwi resource management plans, water policy and Treaty Settlement processes. This reflects an intergenerational struggle to achieve outcomes that are positive for mahinga kai and customary practices.

14.92 The principal objective of the Ngāi Tahu approach to the irrigation proposals was to protect the potential to restore mahinga kai resources and related cultural activities in the Ahuriri Delta, Lower Tekapo River and Haldon arm of Lake Benmore. Ngāi Tahu engaged in on farm visits and consultation, and in the process narrowed their scope to the large scale and intensive proposals that were of immediate and greatest concern to them. However the Ngāi Tahu assessment of the applicants' WQS against cultural considerations through the CIA process was limited due to the absence of key technical reports at the time the CIA was prepared.

14.93 The applicant's case is dependent on the efficacy of the WQS and avoiding any change in the trophic status of the receiving environments including the Ahuriri and Haldon Arms of Lake Benmore. The applicant through MWRL and Mr Mikaere focused mitigation measures for cultural matters on the individual properties, and expressed strong confidence in the efficacy of that approach to limit adverse effects on water quality to an acceptable level.

14.94 The problem with the effects based focus and the adherence to the FEMPS and on farm mitigation is that it assumes the applicant's evidence was complete and accurate. This approach narrows the extent of the relationship of Ngāi Tahu to their natural resources and ignores the cultural dimension that extends beyond the individual farms to the waterways and places of mahinga kai in the catchment.

14.95 Our approach to the proposed activities at a broad level has been to assess the evidence on the assimilative capacity of the Ahuriri and Haldon Arms of Lake Benmore to receive the extra nutrients that the proposed irrigation activities will generate. The case around the efficacy of the applicants WQS is discussed elsewhere in this decision. Suffice it to say that in terms of recognising values of tangata whenua, it is deficient in that it gives us no certainty that its conclusions are correct.

14.96 The confidence Mr Mikaere placed in the ability of the proposed MWRL measures to avoid adverse effects on Ngāi Tahu cultural values may have been premature. We are inclined to this view given the lack of clarity around the effectiveness of the WQS and supporting hydrology, water quality and nutrient management evidence of MWRL to predict the effects of the irrigation proposals.

14.97 We do not share Mr Mikaere's confidence on this issue and consider that even with very considerable mitigation measures proposed, the large scale intensification activities will contribute nutrients into the Ahuriri Delta and Ahuriri Arm of Lake Benmore. Given the negative position we have on the efficacy of the WQS to address the cumulative effects of all proposals, we therefore find that the effects on tangata whenua cultural and spiritual values will be more than minor. In particular, we consider that the effects on the areas identified for mahinga kai restoration will compromise the aspirations of Ngāi Tahu if granted in total.

15 ECONOMIC EFFECTS

15.1 Mr John Kyle for MWRL appended to his evidence a copy of an Economic Impact Assessment (EIA), "Upper Waitaki-Mackenzie Irrigation Economic Impact Assessment", April 2009. The EIA was prepared by Butcher Partners Ltd in association with MacFarlane Rural Business. The EIA is one of a number of MWRL research projects that underpin the economic cost benefit assumptions of the applicant's case for irrigation in the Mackenzie Basin. [26]

15.2 The EIA report makes it clear that it is not a cost benefit analysis, and hence not a complete measure of efficiency as per (section 7(b) of the RMA. The aim of the analysis was primarily to assess the typical average impacts of switches from dryland farming to irrigated farming in the Mackenzie Basin, and does not attempt to assess the impacts of any individual scheme.

15.3 A farmer's decision to proceed with an irrigation project implies that they expect a net benefit from the project from a market perspective. The EIA also notes that a net benefit to Meridian Energy or any other user of the water is a separate consideration which does not directly affect farmers, and hence a farmer's commercial wish to undertake irrigation is not necessarily indicative of a project which is efficient from an overall perspective.

15.4 The Basins economy is based on income[27] from agriculture (38%) and tourism (27%). There was 6% growth in the period from 2001-06, which is considerably slower than the national average of 15% during the same period; the fastest growth in the Basin occurring in the construction and service industries.

Scenario

15.5 The direct economic impacts of various sorts of farming were estimated on the basis of farm budgets for the following scenarios;

(a) 7,500 Ha dry land merino farm; and

(b) 250 Ha stand-alone irrigated farms undertaking irrigated mixed cropping and finishing, dairy support and dairy production; and

(c) 7,500 Ha dry land merino farm with 500 Ha being irrigated and integrated into the total farm management plan.

15.6 The farm budgets were prepared by Mr Hugh Eaton of Macfarlane Rural Business and based on desktop research rather than farm surveys.

15.7 The total economic impacts in the Mackenzie Basin of the various forms of farming were estimated by developing an appropriate economic model and incorporating into this the farm expenditure patterns provided by Mr Eaton and information on where expenditure is likely to occur. We note the report reflects a number of assumptions about prices, productivity, costs, and recognises that expectations about these vary over time.

15.8 The EIA report comments that impacts will only occur if farmers perceive the irrigation development to be commercially viable and that the study is not an analysis of commercial viability. Further the Report states that the initial indications are that the marginal rates of return to dairy support (5.2%), dairy production (6.1%) and partial irrigation (6.1%) are below recent (2009) borrowing rates. For the investment to be commercially viable, farmers are going to need considerable equity and are going to have to accept even lower

[26] The report was qualified by the rider that the Mackenzie Basin is not a standard geographic area used by Statistics New Zealand, and for that reason statistics are generated from best available sources, but are approximate only.
[27] District income is the total income earned by land, labour and capital.

rates of return on their equity than the interest rate on debt, but acceptance of such low returns on equity has been a long-standing feature of New Zealand agriculture.

15.9 We do not analyse the cost benefit details of the EIA report as there were further calculations submitted by Mr Butcher during the hearing as he responded to questions raised by Mr Harris (Meridian Energy).

Expert Witnesses

15.10 We heard from two expert witnesses who provided evidence on the economic effects of the proposed irrigation for the applicants (MWRL) and a submitter (Meridian Energy), their experience and qualifications are as follows;

Mr Geoffrey Butcher

15.11 Mr Butcher holds an MA in Economics from Canterbury University, and has held positions in the Institute of Economic Research, Tongan Ministry of Finance and has been a consulting economist in the private sector since 1987. He has appeared before hearings of council, commissioners and the Environment Court on Resource Management matters. He has prepared economic impact assessments on numerous schemes including several in Central Otago, Downlands, Rangitata, Opuha, Hunter Downs and Central Plains. Mr Butcher also produced a report for MAF 2002 entitled "Role of Central Government in Community Water Projects". Mr Butcher prepared and presented evidence for MWRL.

Mr Simon Harris

15.12 Mr Harris has a Bachelor in Agricultural Science (Hons) from Lincoln University and is a member of the New Zealand Agriculture and Resource Economics Society and practised for fifteen years as a consultant specialising in environmental and resource economics and business analysis. He has undertaken economic impact and cost benefit assessments of proposed water resource allocation and management regimes including modelling and reporting impacts at the farm, district, regional and national level.

Mr Simon Harris, Meridian Energy

15.13 Mr Simon Harris, Meridian Energy, in preparing his evidence reviewed the MWRL research projects that inform the economic, social and agricultural assessments of the irrigation proposals. In respect of the EIA report he concluded that the general methodology and parameter assumptions are generally appropriate and the results credible from that point. However he advised us (October 2009) that he had three issues with the EIA as presented and these related to:

(a) Farm systems and land use mixes adopted in the EIA are not consistent with those adopted in the water quality modelling for the GHD Cumulative Water Quality Assessment or with the applicant's intentions. He contended that the two assessments (EIA & GHD) are reporting quite different irrigation development scenarios and therefore cannot be used in the same decision framework.

(b) He said the value of costs assumed on and off the farm were quite low, that the $200 / ha adopted in the EIA Report are somewhat lower for example than the Glasson Potts Fowler report of 2004 which used a figure of $350/ha within a range of $0-$590/ha. Mr Harris considered that establishing electricity delivery infrastructure to the Mackenzie is potentially so significant and variable that a sensitivity testing of up to $500 / ha is needed. The adoption of low costs for these areas of expenditure would have the effect of inflating the returns at the farm gate and the regional value added calculation as reported in the EIA.

(c) The assumed dairy price used in the modelling is 5% higher than that which would normally be assumed using the best practice methodology discussed in the EIA report.

Scope of economic assessment

15.14 Mr Harris submitted that when assessing a resource consent application, a useful framework is set out in the MAF Technical Paper 2002/13[28] which includes consideration of the effects of community irrigation schemes on:

(a) Commercial viability;

(b) Economic contribution; and

(c) Social impact

15.15 The above framework is equally appropriate for the assessment of individual and grouped consents in the Mackenzie situation.

15.16 He believed it would have been appropriate for MWRL to present evidence that includes consideration or analysis of the total economic impact, commercial viability, water affordability and overall efficiency to allow the hearing to fully evaluate them against the relevant economic tests in section 5 & 7 of the RMA.

15.17 He believed that consideration of the total economic impact would require an expansion of the EIA report to include impacts beyond the study area of the Mackenzie Basin, and other potential uses of the water.

15.18 Mr Harris discussed his own test of water affordability by recalculating the farm budgets with an off farm water delivery charge of $500 / Ha / annum, which he said would consume the profit of all irrigated models other than dairying. The assumptions around potential water costs should be reported explicitly and sensitivity tested in order to consider affordability of the land use development proposal.

15.19 Mr Harris told us that efficiency is best reported in a benefit cost format, such as net change in farm profit, lost electricity generation, increased generation costs, lost recreation revenue while other aspects are only able to be qualitatively described such as water quality, landscape values and community strengthening.

15.20 He told us that a simple agricultural analysis of land use mix in Scenario 1 in the EIA[29] results in an aggregate Net Present Value of $75.4m, to which he applied an 8% discount rate consistent with the current discount rate used by central government in its analysis of the welfare change of impacts of projects. He told us that the authors of the EIA report indicate that the marginal returns from development were below the costs of borrowing money.

15.21 Mr Harris told us his scope of the economic assessment was a simple analysis and does not address potential cost issues in off farm water provision, nor the opportunity cost of water for irrigation. This analysis, he concluded, indicates the applicants proposals as presented in the EIA report are not an efficient use of resources in their own merit, let alone if it comes at some external costs to the detriment of other society values such as landscape character.

[28] Ford, S J; Butcher, G; Taylor Baines (Dec 2002): Economic and Social Assessment of Community Irrigation Projects. MAF Technical Paper No: 2002/13.

[29] Scenario 1, 20% of land went into dairying, 20% into dairy support, 60% went into partial irrigation of larger farms.
Scenario 2, 33% went into partial irrigation of extensive farms, with the balance being split between dairy support (44%) and dairy production (56%).
The stand-alone fully irrigate cropping and finishing farm in either scenario because of the poor financial returns indicated in the farm modelling.

GHD Cumulative WQS

15.22 Mr Harris told us that the models used in the AgResearch and MWRL nutrient research are not consistent with those used by the experienced MacFarlane Rural Business consultants in the EIA commissioned by the applicants. Mr Harris reiterated his confidence in the highly experienced consultants and the appropriate and credible models used in the EIA, and the review of the underlying assumptions by Mr MacFarlane. He said he would have had greater confidence in the MWRL research if it had adopted the assumptions arising from the EIA.

Mitigation

15.23 Mr Harris said he could not see where the applicants had modelled the mitigation options, including significant capital cost, operating expenditure, skill requirement and management focus required to meet the best practice standards espoused.

15.24 He told us the applicants are proposing essentially that they be granted the rights to all remaining assimilative capacity of the Mackenzie Basin. Existing landholders he believes have a right to believe they can intensify their properties given there is some headroom in respect of assimilative capacity. The way these property rights are altered, allocated and potentially transferred has important implications for economic efficiency that do not appear to be have been addressed by the applicants.

15.25 Mr Harris considered that the complexity and costs of managing and supporting a nutrient cap system will be significant in cash, time and skills and the proposed mitigations are far from proven at a farm level or at a policy level.

Mr Butcher - Rebuttal (MWRL)

15.26 Mr Butcher told us he was asked by MWRL to prepare and present rebuttal evidence (October 2009) in response to questions Mr Harris (Meridian Energy) had raised over the impacts in the EIA report on the grounds that;

(a) The land use mix used was only loosely based on the land uses revealed in a GHD survey of potential irrigators and instead presented on a basis of a more intensive land use

(b) The irrigation costs were less than what Mr Harris would have expected to see in the Mackenzie Basin

(c) The Dairy prices used were not based on a 7 year average, and although the impacts on the results of using a 7 year average were footnoted, the executive summary tables did not reflect the 7 year average

15.27 Mr Butcher said that at the time the EIA report was written the GHD survey results were not finalised, and he was unable to use identical land uses to GHD. This was because the budgets produced by Mr Eaton were not exactly the same as the land uses revealed by the survey and had not modelled stabled dairying. For his rebuttal Mr Butcher had recalculated his primary evidence on the impacts of irrigation of 25,000 Ha, based on three land use mixes and the 7 year average price of milk which is more consistent with the GHD survey results. The GHD survey results expand beyond Mackenzie Basin to include the Mackenzie, Waitaki and Waimate Districts, which is consistent with the WCWARP Policy 11(c). He told us that the multipliers for this expanded geographic area are significantly higher than in the EIA report because the combined districts have a much greater degree of self sufficiency than does the Mackenzie District alone.

15.28 The findings using the revised land use mix, 7 year average price of milk and GHD survey result in lower total economic impacts as outlined in Table 1 of his rebuttal evidence.

15.29 Mr Butcher advised us that the extension of the analysis to the broader geographic area of Waimate, Waitaki and Mackenzie Districts yields considerably larger off-farm impacts

partly because of meat processing in Waitaki District generates further impacts. He estimated that with the wider geographic approach the irrigation of 25,000 ha in the Mackenzie Basin will increase total added value to $53 million per year, associated with this will be an additional $24 million per year gross household income and an additional 470 jobs, as evident in Table 2 of his rebuttal evidence.

15.30 Mr Butcher also recalculated his capital cost figures in response to Mr Harris (Meridian Energy) suggesting that it would have been appropriate to have undertaken sensitivity testing using a higher irrigation cost per hectare using a figure as high as $500 / Ha, which is $300 higher than had been assumed in Mr Eaton's budgets.

15.31 Mr Butcher advised that he had considered the effects of the higher figure and reported that the value added on farm profitability would decline by $7.5 million, with consequential impacts on farm profitability but no change to on-farm employment or household income. Value added off-farm would rise, as would employment or household income. His calculations suggested that a net off-farm impact of a $7.5 million increase in operating costs that would be split between electricity and scheme maintenance (including household income of $2.0 million) as well as providing 40 jobs.

Mr Harris - Reply

15.32 Mr Harris in his addendum (November 2009) said that he was satisfied that Mr Butcher in his rebuttal had answered most areas of concern except for one area, and that was the inconsistency between the pasture growth rates used in different sets of evidence and the difficulty it creates in assessing the overall impacts and efficiency of the applications.

Mr Butcher - Reply

15.33 Mr Butcher presented evidence in reply (April 2010) to questions previously raised by commissioners and other parties during the hearing. On the matter of why no overall cost-benefit analysis was carried out for the project Mr Butcher contended that the costs and benefits related to the market can be debated at length and the uncertainty is reflected in the different profitability for intensive sheep and beef farming assumed by himself and Mr Copeland. That in the end there is a commercial decision to make, and that those investing their money have the greatest incentive to undertake the best possible financial analysis of market costs and benefits. If there are mitigation measures which have a financial cost, and if the applicants proceed with construction, then it could be assumed the benefits outweigh the costs.

15.34 Mr Butcher said it was his understanding that the applicants view is that the decision by the Waitaki Catchment Water Allocation Board to allocate water to irrigation provides a prima facie case that use of water is an efficient use of resources from a comprehensive (market and non-market) perspective.

15.35 Mr Butcher submitted that provided the costs of mitigation are met by the applicants, then that will be reflected in the final decision of the applicants to invest. These costs, he told us, do not need to be established at this stage, and therefore the applicants do not see the need for a full cost benefit analysis.

15.36 Mr Butcher submitted that it was his understanding that there are no other potential users and no other obvious parties who will be affected by uncertainty, the one proviso being the $8/25^{th}$ of the water that is not allocated to irrigation or not subject to this hearing. It was his understanding that provision had been made for this factor. He considered Meridian Energy will be affected if and when they lose water, but the mere possibility it might happen will have cost them little.

Lack of Sensitivity Analysis

15.37 Mr Butcher said he confined himself to the sensitivity of economic impacts to changes in the costs of irrigation itself, and did not look at a range of other parameter values as his primary objective was to provide indicative values of economic impacts.

Variation in Financial performance

15.38 Mr Butcher gave an example of the significant variance in the estimates between himself and Mr Copeland on Net Profit per hectare for intensive sheep and beef farming, which ranged from $458 to $48 per Ha. He explained some of the variances that contributed to the difference which were plausible, and gave further credence to the applicants reluctance to undertake a full cost benefit analysis; preferring to leave commercial efficiency to be defined by investors. As a consequence, he focused on social and environmental impacts only.

Cost of WQ analysis compared to Net Benefits of Project

15.39 Mr Butcher responded to a panel query whether the MWL Water Quality Study (WQS) would have benefited from better resourcing, particularly given the large scale implications and potential benefits from irrigation for the applicants. He told us that the net benefit per year would need to be summed over future years and discounted to a net Present Value to get the total investor benefits, then multiplied by the probability of success in applying for the resource consents and adjusted for risk preference.

15.40 If the net present value of investor benefits was for example $50m and the probability of success in getting resource consents is say, 30% then the investors would not be prepared to spend more than $17m in trying to get resource consents. In fact, he opined, if the investors were risk averse, then they would not be prepared to spend nearly as much as this. In this context, investing more than $1m on WQS, which is only part of the costs of obtaining resource consents, is a moderately significant sum.

Conclusion on economic effects

15.41 The EIA report was one of many reports prepared on behalf of MWRL to inform and assist the group and individual applicant's to complete their irrigation proposals for the Mackenzie Basin. There was a lack of correspondence between some elements of the MWRL reports that reduced the coherency of the economic impacts, this issue was satisfactorily addressed during the hearing.

15.42 The potential for assimilative capacity of lakes and rivers in the Mackenzie Basin to be altered, allocated and potentially transferred through this hearing has important implications for economic efficiency that have not been addressed by the applicants.

15.43 The complexity and costs in managing and supporting a nutrient cap system will be significant in cost, time and skills. Given our uncertainty that the WQS has adequately assessed the water quality issues of the proposed irrigation, we are equally uncertain that the total economic costs and benefits of the irrigation proposals have been appropriately identified and assessed.

15.44 The applicants approach to assessing commercial efficiency was focused on the social and economic impacts of the irrigation proposals, and they purposely chose not to extend the assessment to a full on-farm off-farm cost benefit analysis. The basis for this being that the many potential variables and subjectivity of assumptions did not justify this option.

15.45 Instead we were informed the applicant's approach was to recognise that where a commercial decision is to be made it will be made on the basis of best estimates of likely outcomes.

15.46 We consider that the applicant's approach to assessing economic impacts or benefits of the irrigation proposal was useful. It enabled us to have a level of understanding about the economic benefits that would result if all consents were granted. It seemed to us it did take into account at an appropriate level the costs of implementing the consents and, in particular, it had some regard to the costs of putting in place the mitigation measures.

15.47 In the end we noted that there was a useful level of agreement between economic experts around the approach, process, and content of the various views expressed to us.

15.48 Overall, we considered we had sufficient material to recognise the real economic benefits that could accrue from the grants of the applications before us. While accepting the economic benefits only one of the issues for us to consider, we can and do record our view that we accepted the economic benefits of irrigation as put forward by MWRL on behalf of all of the applicants.

15.49 For the sake of clarity we note that we did receive evidence from others in relation to economic benefits. However, we do consider this material to be site-specific and, where we have considered it appropriate to do so, we have recorded that material within Part B of our decisions.

16 ISSUES FOR PART B DECISIONS

16.1 This part of our decision provides a discussion on a range of issues that are common to many different proposals. This includes our approach to determining the status of activities, requirements for additional consents, stockwater consents, replacement consents, priority, derogation, and the number of decisions per proposal. We have also outlined the approach we have applied to formulating conditions of consent for those applications that are granted.

16.2 The reason for including this information in Part A is to demonstrate consistency in our approach and avoid repetition of the same issues in multiple Part B decisions. The separate Part B decisions should be read in combination the following comments and findings.

Determining the status of the activities

16.3 Under the RMA, we are required to determine the status of the activity in order to ensure that the correct statutory tests are applied. This has not always been a straightforward exercise due to the number of plans involved and the changes that have occurred since many of the applications were first lodged.

16.4 In summary, the status of a particular activity will depend on the following key issues, each of which is discussed further below:

(a) Whether the application is listed in Schedule 2 of the Resource Management (Waitaki Catchment) Amendment Act 2004 ("the Waitaki Act");

(b) The nature of the activity;

(c) The date on which the application was lodged; and

(d) The status of other applications that form part of the same proposal.

Step 1 – The Waitaki Act

16.5 In accordance with s88A of the RMA, the usual approach for determining the status of the activity is that it is based on the relevant rules that existed at the time that the applications were lodged. This applies even if those rules have since changed.

However for many of the current applications, this approach is altered by the Waitaki Act. Schedule 2 of the Waitaki Act lists a number of consent applications to which the Act applies, including many of the applications now before us. Section 31 of the Waitaki Act states that for all of those applications, s88A of the RMA does not apply .

16.6 The effect of this is that the status of those applications listed in Schedule 2 of the Waitaki Act must be determined by the relevant provisions of the now operative plans, being the NRRP and the WCWARP. This applies even though those plans were not in force at the time the applications were lodged.

16.7 For activities not listed in the schedule, the relevant plan will be the TRP, the PNRRP or the WCWARP, depending on the date on the nature of the activity and the date on which the applications is lodged. This is discussed further below.

Step 2 - Nature of the activity and date of lodgement

16.8 The next step in determining the status of the activity is to identify the nature of the activity that is proposed. There are three broad categories of activities that we are considering:

(a) Activities in or under the beds of lakes and rivers pursuant to **section 13** of the RMA;

(b) The diversion, damming, taking and use surface water pursuant to **section 14** of the RMA; and

(c) The discharge of contaminants to the environment pursuant to **section 15** of the RMA.

16.9 Dealing first with those applications listed in Schedule 2, the status of activities to disturb the bed or discharge contaminants under s13 and 15 of the RMA respectively will be determined by the operative NRRP. Activities to divert, dam, take and use water under section 14 of the RMA will be determined under the WCWARP.

16.10 In relation to those applications not listed in the Waitaki Act, the status of the activity will depend first on the date of lodgement and second on the nature of the activity. If lodged before July 2004 (when the PNRRP was notified), the TRP is the relevant plan. If lodged after July 2004, the relevant plan for determining status is as follows:

(a) S13 and 15 activities – Both the TRP and the PNRRP; and

(b) S14 activities – the WCWARP[30]

16.11 The process for determining the status of the activity is illustrated in **Figure 1** below.

[30] This is on the basis that all s14 applications that are not listed in Schedule 2 were either lodged before July 2004 (when the TRP applied) of after September 2005 (when the WCWARP was operative). We have adopted September 2005 as the operative date for the WCWARP, even though appeals were subsequently lodged to the High Court. This decision is based on the wording of section 27 of the Waitaki Act and the fact that the appeals only related to certain parts of the WCWARP, not the WCWARP as a whole.

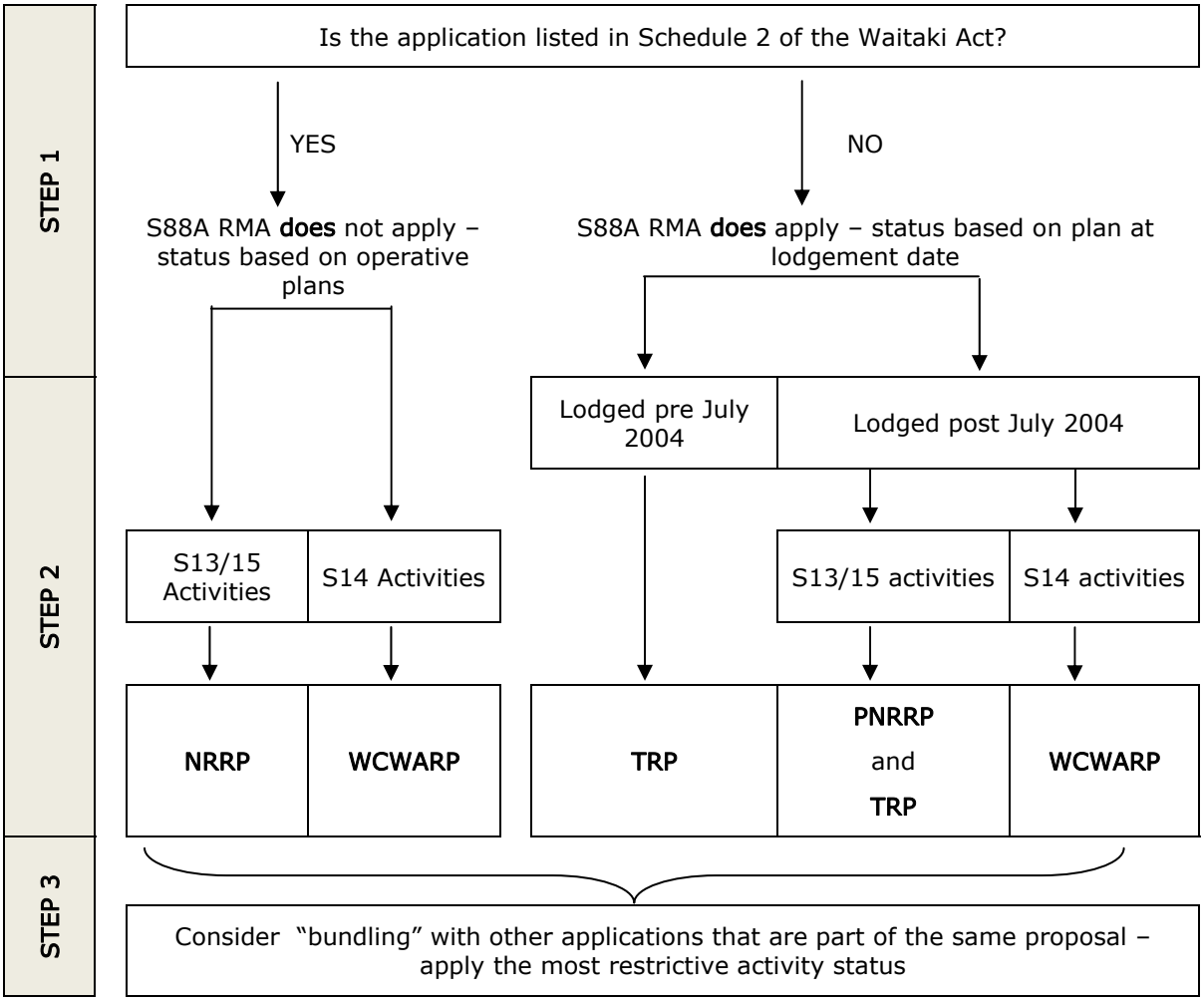


Figure 1 *– Process for determining status of activities*

Step 3 – Other related applications – "Bundling"

16.12 The final step to consider is whether there are any other applications that form part of the same proposal and that should be "bundled" together for the purpose of determining the status of the activity.

16.13 Various witnesses and legal counsel discussed the issue of bundling on behalf of the applicants that they represented. We have considered those views and taken them into account when making our findings on this issue.

16.14 Where multiple applications make up a single proposal, the starting point for determining the overall status of the proposal is that stated in *Southpark Corporation Limited and Anor v Auckland City Council* [31]:

> *"... it has been established and accepted that in general there is no scope for hybrid planning status for a proposal, and the more stringent classification applies to the whole."*

[31] A111/00 at para 8

16.15 The Court in *Darby* then considered a range of other case law that has discussed the issue of bundling consents, mainly in the context of notification, and summarises the position on this issue as follows:[32] at paragraph 33:

> *"In many cases it will be appropriate for a consent authority to consider a proposal in the round, because failure to do so would mean artificially splitting it up without considering the interrelating issue that relate to the overall judgment requiring to be made in the circumstances, and to determining whether or not the Act's purpose will be suitably served. However, if a particular consent that is sought is plainly limited in its scope and nature, and the effects of exercising the consent would not overlap or have consequential or flow on effects in relation to effects stemming from the exercise of any other consent required for the proposal, then the application for that consent may be adjudged individually on its merits."*

16.16 The principle emerging from the above is that where multiple consents for one proposal overlap to such an extent that they cannot be realistically or properly separated, the consent authority should adopt a holistic approach and assess the proposal on the basis of the most stringent classification. The intended purpose of bundling consents in this manner is to ensure that an overall judgment can be brought to bear as to whether the proposal is in accordance with the purpose of the RMA.

16.17 Whether it is appropriate to bundle consents in a particular case will depend on the relationship and linkage between the activities for which consent is being sought. Where separate applications are clearly part of the same proposal **and** the effects of the activities overlap, all applications should be assessed against the more stringent classification.

16.18 We have applied this approach when determining the status of activities in our Part B decisions. In some circumstances this has led to us assessing an entire proposal as non-complying even though parts of it may be discretionary activities when considered in isolation. In others circumstance we have formed the view that although the activities are part of the same proposal, the effects do not overlap and activity status can be determined independently. The critical factor in making this decision is whether the environmental effects of the various activities overlap.

Comparison to Officer Approach

16.19 For completeness, we have compared our approach to that adopted by the reporting officers in the various s42A reports prepared.

16.20 In relation to the general approach to determining the status of the activities under the relevant plans, our approach is generally consistent with the reporting officers. The main difference is in relation to applications under s13 and 15 that are listed in the Schedule 2 Waitaki Act. Notwithstanding their listing in that Act, the reporting officers applied s88A and assessed those activities under the plan that existed at the time. We have preferred to apply the clear and unambiguous wording of the Act and assess those activities under the current plans as if s88A does not apply.

16.21 The other area where our approach differs is in relation to the issue of bundling. For the most part, the reporting officers had very little discussion on bundling and simply noted that no applications had been bundled and the status for each application had been determined independently[33]. There is no explanation as to why this approach was adopted.

16.22 Dr Freeman did offer one approach to bundling, where he suggests that all applications should be considered as non-complying activities due to the significant risk of cumulative effects[34]. We have rejected this approach on the basis that the applications comprise many separate and distinct proposals, albeit with related cumulative effects. We consider that it would therefore be inappropriate to bundle in the manner suggested by Dr Freeman.

[32] C069/07 at para 33
[33] S42A Report 1 by Claire Penman, para 53
[34] S42A Report 4F, Mike Freeman, para 97

Requirements for Additional Consents

Land use consents

16.23 An issue arose during the course of the hearing, primarily in response to submissions from Meridian Energy Limited (Meridian) as to the need for resource consents to use land pursuant to Section 9 RMA. The proposition was that a land use consent is required under Chapter 4 PNRRP to use water for irrigation that may result in contaminants entering the groundwater or surface-water.

16.24 This bought into consideration Section 91 RMA. In summary form, Section 91 RMA provides that a consent authority may determine not to proceed with the notification or hearing of an application for a resource consent if it considers on reasonable grounds that other consents under the RMA are required in respect of the proposal to which the application relates and it is appropriate for the purpose of better understanding the nature of the proposal that applications for any one or more of those other resource consents be made before proceeding further.

16.25 The first issue was whether or not consent was actually required under the PNRRP rules. We received advice and analysis on this issue from the consent investigating officers in their s42A reports, Mr Gimblett (planning consultant for Meridian Energy Limited) and Mr Kyle (the planning consultant for MWRL). It is fair to say that the PNRRP rules that existed at the time were far from clear and gave rise to some confusing issues of interpretation and application.

16.26 The S42A introductory report from Ms Claire Penman provides a helpful discussion of this issue. Although she did not completely dismiss the application of the relevant PNRRP rules, she formed the view that it was unnecessary to require the applicant group to seek any additional land use consents. The key reason for this was that she considered we already had sufficient information for us to hear and determine these applications without any further applications being made. Secondly, she expressed the view (at least as we understood it) that there was no certainty in terms of how the rules she referred to would be affected as the PNRRP continued through its own hearing process.

16.27 After considering the advice of the consent investigating officer and the views expressed by Mr Kyle and Mr Gimblett we largely accepted the views expressed by Ms Penman. We formed the view that even if land use consent was required under Chapter 4 of the PNRRP, applications for those consents would not provide a better understanding of the nature of the proposals before us at this hearing. We think we have more than adequate evidence to understand the nature of the proposal, particularly where we are considering the impacts on water quality.

16.28 For this reason, we considered that there was no real benefit in requiring additional consent applications to be made. Furthermore, this would have created even further delay in this already long delayed process.

16.29 In any event, what has occurred since the hearing is the NRRP has now become operative. We have sought advice in relation to the fate of the previous rules from Council consent investigating officers and have been advised that Rule WQL20 is the new rule for land use resulting in nitrate/nitrogen discharges.

16.30 Rule WQL20 provides for the use of land for pastoral grazing as a permitted activity, subject to compliance with conditions. We note that there is considerable commonality between the matters covered by the conditions and the water quality issues we are considering as part of these applications. If the conditions cannot be complied with, consent is required as a restricted discretionary activity.

16.31 In considering Rule WQL20, we think it may be the case that some of the applicants before us may require resource consent under this Rule for their activities. However that it is not for us to determine. We are issuing consents pursuant to sections 13, 14 and 15 of the RMA. If it happens to be the case that additional consents are required for land use under section 9, then our decisions do not avoid the obligation of a landowner or occupier to obtain any such necessary land use consent required by the now operative NRRP.

Discharge consents "called in" by the Minister

16.32 This issue is largely traversed in many of our Minutes, notably our 8th Minute of 6 November 2009 and our 17th Minute of 10 February 2010.

16.33 In summary form, we formed the view as we expressed it in our 8th Minute that what became known as the "effluent applications" from the related applicant group should be before us as we had reached a view that the effluent resource consents form part of the overall proposal in relation to the water takes that were before us. Also, we considered we needed information relating to the effluent applications so that we could make a decision taking into account all of the effects of the proposal. We considered this was in line with sound and accepted resource management process.

16.34 The relevant applicant group proceeded with their effluent resource consents. Those consents were "called-in" by the Minister for the Environment on 27 January 2010. The details of the relevant applications and consents are provided within our 15th Minute.

16.35 In our 17th Minute of 10 February 2010, after taking into account the Minister's exercise of his "call-in" powers, we heard from all parties and determined that we should proceed and determine the applicants' water applications for reasons set out within that Minute.

16.36 To complete the "story", we were told by the applicants as at 25 March 2010 that they had withdrawn their effluent applications from the "call-in" Board of Enquiry process. We were asked by the applicant group to continue and determine the water take applications and we did so.

16.37 The only other point worth mention is that we were aware that the applicant group held certificates of compliance for various activities from district councils covering various parts of the overall farming proposal. We were aware that some of those certificates of compliance became the subject of judicial review proceedings.

16.38 In the round, the results of those proceedings did not prevent us from being able to reach the determinations that we have. We considered we had sufficient information before us to make the determinations requested of us by the applicant group.

Consents for works in canals

16.39 Some applicants before us seek to undertake works in the hydro-canals within the catchment to use and construct a structure for the purpose of taking or diverting water.

16.40 In this circumstance the issue emerged as to whether or not a consent was required in terms of Section 13 RMA, which places restriction on certain uses of beds of lakes and rivers.

16.41 Noting the obvious, that we are here dealing with a canal and not a lake or river, the question is, is a Section 13 consent required for the activity we have described above?

16.42 We have concluded it is not, primarily on the basis of the definition of a river as provided in Section 2(1) RMA, namely the interpretation and application section.

16.43 Under the RMA, a river is defined as follows:

> *"River means a continually or intermittently flowing body of freshwater; and includes a stream and modified water course; but does not include any artificial water course (including an irrigation canal, water supply race, canal for the supply of water for electricity power generation, and farm drainage canal)."*

16.44 Given this definition, we do not consider that a consent under Section 13 RMA is required for works in hydro canals.

Diversion consents

16.45 For many of the applications to install intake structures in the bed of a river a temporary diversion of water will be required to minimise the work required in flowing water. This raises the issue of whether a separate consent is required for the diversion. All of the proposed diversion are over a short length, temporary in nature and return water to the same watercourse that it was originally part of.

16.46 Under the WCWARP, small diversions of water are permitted where the effects are minor. However under Rule 1, this only applies where the diversion is less than 10 cubic metres per day per property at a rate not exceeding 5 litres per second. For all of the applications where this is an issue, the diversions exceed these limits and therefore requires consent under the WCWARP.

16.47 In many cases the applicants have not applied for a separate consent for the diversion. However based on the information contained within the applications and presented at the hearings, we consider that the diversion is implicit in the applications to disturb the bed and that we have sufficient information to understand the potential effects of the activity. Furthermore, we consider that no person would be prejudiced by us considering the diversion as part of the existing applications and that there is no good reason to require the applicants to make separate applications for these activity.

16.48 For the above reasons, in the Part B decisions where this issue arises, we have considered the diversion as a component part of the activity being applied for. We have therefore assessed the effects of the diversion and evaluated it against the relevant planning instruments as part of our overall consideration of the proposal. This is consistent with the pragmatic approach adopted by the High Court in similar circumstances, which confirmed that we are able to consider granting consent to an activity even though consent has not been specifically sought[35].

Stockwater

16.49 We faced a range of different approaches to stockwater from the applicant group.

16.50 Some applicants sought stockwater be included within their applications to take water while others relied on Section 14 RMA to take water for reasonable needs of animals for drinking water and for themselves for the same purpose.

16.51 Turning first to Section 14 RMA. Section 14(3) RMA provides an exception to Section 14(1) RMA enabling a person to take, use, dam or divert freshwater if it is taken or used for an individual's reasonable domestic needs or the reasonable needs of an individual's animals for drinking water and the taking or use does not, or is not likely to, have an adverse effect on the environment.

16.52 The fact that the RMA provides for the taking of water for an individual's domestic needs and the needs of an individual's animals is recognised within Annex 1 of the WCWARP, this annex provided the decision and principal reasons for adopting the plan's provisions.

16.53 Paragraph 75 of Annex 1 makes it clear that the WCWARP cannot and is not intended to regulate the exercise of the rights conferred by Section 14(3). Those rights exist independent of the WCWARP; and that is how we have approached the matter.

16.54 Where an applicant does not seek stockwater be included within their take application and have relied upon their Section 14(3) RMA rights, then that is a matter that we leave to the Council. It can consider and determine whether or not the applicant's activities in relation to stockwater and drinking water come within the exception to Section 14 RMA.

16.55 In the instance where the application makes it clear that stockwater is part of the application then we have included stockwater in both our assessment and the relevant

[35] *Queenstown Lakes District Council v Hawthorn Estate Ltd & Ors* (HC, Christchurch, CIV-2004-485-1441, CIV-2004-485-1445, 17 December 2004, Fogarty J) at para 55

conditions. In short, this means the volume of water allocated is both for the purpose of stockwater and also for irrigation.

16.56 We do note the existence of Policy 24 WCWARP. This allows consent holders:

> *"to take water for domestic stock drinking water uses and for processing and storage of perishable produce when rivers or lakes are at or below minimum flows or levels provided the amount does not exceed 250 litres per person per day based on the population being supplied at the time, plus actual stock drinking water requirements, ..."*

16.57 We read this Policy as applying in the circumstance where rivers or lakes are at or below minimum flows or levels and the policy is directed at confirming and refining rights to take water for domestic stock drinking water and processing and storage of perishable produce.

16.58 Mr Chapman, legal counsel for UWAG, addressed us on stockwater. We note our approach is consistent with his submissions on the point of stockwater.

16.59 Specifically, what we have not enquired into is whether or not the taking or use does not or is not likely to have an adverse effect on the environment. We have left this to Environment Canterbury to determine.

16.60 We do note that in some instances the applicants had been taking water for drinking needs of animals and they had been using a conveyance system to convey that water, which in our view was certainly not neither effective nor efficient. Combined with a lack of appropriate metering, the result may have been that the amount of water taken far exceeded the needs of an animal for drinking water; and a great deal of the water was used for the purpose of actually providing a means of conveying water.

16.61 However, we make it clear that we did not enquire into that, nor did we receive any evidence to substantiate the Section 14 rights. We did not receive any comment from officers suggesting that the claims made by the various applicants in reliance on those rights were unreasonable. We have simply left this matter for full review and investigation by Environment Canterbury, if it wishes to do so.

Approach to 'Replacement' Consents

16.62 Our approach to replacement consents was firstly to consider how the WCWARP dealt with replacement consents.

16.63 Policy 28 is the relevant WCWARP policy on replacement of existing consents. That Policy provides that in considering whether to grant or refuse applications for replacement consents the authority will:

(a) Consider whether all reasonable attempts to meet the efficiency expectations of the plan have been undertaken;

(b) Recognise the value of the investment of the existing consent holder; and

(c) Maintain the inclusion of the consent if granted in any allocation limits and priority bands on the waterbody concerned.

16.64 The explanation to this policy provides that there is no right of renewal of a resource consent. The explanation notes consideration of the efficiency of the use of water being used under the existing consent is critical to ensure that the efficiency expectations of the WCWARP are implemented. The Policy provides for maintaining an existing consent in the same allocation limit and priority band when it is replaced. It also provides for recognition of the value of the applicant's investment when an application for replacement is considered.

16.65 Section 124 RMA covers the circumstance of exercising a resource consent while applying for a new consent. Provided a consent holder applies for a new consent for the same

activity and the application is made at least six months before the expiry of the existing consent, then the holder may continue to operate under the existing consent until a new consent is granted and all appeals determined or a new consent is declined and all appeals are determined.

16.66 We also take the point that Section 124 RMA does not authorise the original activity to go beyond what is sanctioned by the original consent in the meantime.

16.67 This point is relevant to some of the applications before us, as some applications held a resource consent to take a certain volume of water, but had only applied a lesser volume to land for irrigation purposes. Thus, we were called upon to determine the extent and scope of the Section 124 RMA "protection" or "right".

16.68 In that case the approach we took was to evaluate the effect of the water take on the relevant waterbody. Secondly, we needed to evaluate the effect of applying only part of the volume of water taken on the land. We took the view then that while the original resource consent may have provided consent to take and apply the full volume of water, the fact that only part of that total volume had been applied influenced our assessment and understanding of the effects of the original resource consent on the environment in contrast with what was now being sought.

16.69 The main relevance of an existing consent is that it establishes the receiving environment against which effects are to be assessed. For this to occur, the activity must have been lawfully established. In determining the receiving environment we have taken into account the fact that in some instances only part of a consent has been exercised. We focused on that part of a consent that had been exercised to help us better understand the receiving environment against which effects for the new consent are to be assessed.

16.70 The fact that an applicant seeks a 'replacement consent' does in no way remove the need to assess the continuing and future effects of a proposal and consider whether they are appropriate. The point that a party holds an existing consent is no guarantee that a new consent will issue.

16.71 There are specific considerations relevant to replacement consents in the RMA. They are found at Section 104(2A), which requires us to have regard to the investment of the existing consent holder when considering an application affected by Section 124. This only applies to applications lodged after 10 August 2005. However this is a circumstance that is reflected in Policy 28 WCWARP in any event and we have taken it into account as appropriate.

16.72 In summary, there emerged competing considerations for applications involving replacement consents. These considerations included the fact of the applicant's investment, whether all reasonable attempts to meet the efficiency expectations of the plan had been undertaken by the applicant, whether the effects on the environment of a grant of consent were acceptable, and how consistent or otherwise the application was in terms of supporting the scheme and purpose of the relevant plans? The scale and significance of each of these circumstances is clearly influenced by the context of each application and needs to be considered and weighed by us on a case-by-case basis.

Priority

16.73 Given the number of applications involved, a relevant issue to consider is which applications should be given priority when considering whether or not to grant consent.

General principles

16.74 In relation to the current applications, priority is primarily relevant to applications to divert, take and use water under s14 of the RMA. We consider that priority is relevant in respect of two key issues, each of which is discussed further below:

(a) The allocation limits in the WCWARP; and

(b) Assessment of cumulative effects, particularly water quality and landscape.

16.75 On 8 April 2008 Commissioner Skelton issued a decision confirming the relevant priority order for these applications. This overturned his earlier decision and confirmed that for applications in process prior to the WCWARP becoming operative, priority should be based the date on which the application was first ready for notification, irrespective of any re-notification under the WCWARP.

16.76 During the course of the hearing, we asked for comment from the Council regarding the law on priority. In a memorandum from Ms Dysart dated 19 April 2010, we were advised that the most recent decision of the Court of appeal was that priority should be determined by the "first to file" test rather than the "first ready for notification" test[36]. However leave had been granted to appeal that decision to the Supreme Court. Ms Dysart also noted that the Courts have left it open to conclude that in other circumstances other tests may be appropriate.

16.77 On this basis, we consider that there were two available alternatives on which to determine priority – the date on which a complete application was filed or the date on which the application was ready for notification. We have preferred the latter approach and retained the priority order established by Commissioner Skelton, as set out in the s42A Reports[37].

16.78 The key reason for this is that this is the order on which the applications were presented to us and that it seemed inappropriate and unnecessary to change the order at this late stage. Furthermore, based on the conclusions we have reached in this decision and our Part B decisions to follow, priority is not a significant determinant on whether or not consent has been granted.

16.79 For the sake of clarity, we have attached the priority order we have followed for s14 applications at **Appendix B** to this decision. We note that there is one change to the established order where it was agreed between Haldon Station Limited and Southdown Holdings Limited[38] that the application by Haldon Station Limited should have higher priority. We have amended the priority list to reflect this agreement.

16.80 Sections 124A, 124B and 124C were introduced by the Resource Management Amendment Act 2005 and took effect on 9 August 2008. These sections give priority to applications for 'replacement' consents relying on s124. However as all application before us were lodged before 9 August 2008, these sections are not relevant and do not alter the priority order.

Allocation limits

16.81 As discussed earlier in this decision, Rule 6 and Table 5 of the WCWARP contain annual allocation limits for different activities. Overall, a limit of 275 M/m^3 of water is allocated for agricultural and horticultural activities upstream of the Waitaki Dam. Individual limits are also set upstream of each glacial lake outlet, including Lake Tekapo, Lake Pūkaki and Lake Ōhau.

16.82 Based on the evidence provided to us, we are satisfied that the combined allocation of all applications before us remains less than the total allocation of $275M/m^3$. This was not in contention at the hearing. The overall priority of all applications in relation to this total limit is therefore not an issue.

16.83 However we note that sub-limits are breached for the following locations:

(a) Upstream of Lake Pūkaki outlet; and

(b) Upstream of Lake Ōhau outlet.

[36] *Central Plains Water Trust v Synlait Limited* [2009] NZCA 609
[37] Report 3, Attachment 2 by Maria Bartlett
[38] Formerly Williamson Holdings Limited

16.84 For the area upstream of Lake Pūkaki, the total allocation limit is 8M/m^3. However if all applications are granted, the total allocation will be approximately 30M/m^3. The priority order for consideration of applications in this area is Simons Hills Station Limited (CRC062842), followed by Simons Pass Station Limited (CRC062867), then Glentanner Station Limited (CRC071362).

16.85 For the area upstream of Lake Ōhau, the total allocation limit is 12M/m3. However if all applications are granted, the total allocation will be approximately 24M/m3. The priority order for consideration of applications in this area is Southdown Holdings Ltd (CRC040835), followed by Five Rivers Limited (CRC061154).

16.86 For the above applications, priority is more important as it can have an impact on the status of the activities being considered. We have commented further on this as relevant in our Part B decisions.

Assessment of cumulative effects

16.87 The second area where priority is relevant is in relation to consideration of cumulative effects, particularly water quality and landscape. This applies irrespective of whether an allocation limit is breached for a particular area.

16.88 All parties accepted that due to the interconnected nature of the environment, the potential effects of the activities cannot be considered in isolation. To do this would ignore the very real potential for cumulative effects. In other words, whilst granting consent to one application alone may not adversely affect water quality or landscape values, when considered in combination with multiple other applications for similar activities, the effects may be significant.

16.89 To address this issue of cumulative effects in relation to water quality, the applicants combined to prepare the WQS and to demonstrate that the standard set up by the WQS can be achieved. Mr Whata told us the applicants have accepted a need to work together to meet the WQS thresholds rather than on a 'first come, first served' basis'. In other words, Mr Whata submitted that priority was not relevant as the combined approach demonstrated that all applications could be granted without adverse effects on water quality. However Mr Whata went on to note that if we were not minded to adopt the WQS or the combined approach then the 'first come, first serve' approach will need to be adopted.

16.90 As discussed above, we have rejected the applicant's evidence on the cumulative effects in terms of water quality and the impacts of the same on the receiving waters of the lakes. We therefore have no option but to retreat to and apply the standard approach to priorities, namely each application must be determined in the priority order as set out in Appendix B. We have adopted the same approach for consideration of cumulative landscape effects.

16.91 In practical terms, this means that when considering the first application, we must assess potential effects based on the state of the existing environment. However each subsequent application must take into account the environment as it may be modified by any higher priority activities that have been granted consent.

16.92 Thus, on the assumption that a first-in-time application is granted it may be that when the adverse effects of that activity are considered cumulatively with a subsequent application, those cumulative effects may be regarded as more than the receiving environment can absorb. That, of course, is a matter of assessment of whatever evidence we have available to us. However, that is the course we must now follow given the rejection by us of the applicants' proposition and supporting evidence around cumulative effects in terms of water quality and landscape values.

16.93 Notwithstanding the above, our decisions on cumulative water quality effects were governed in the main by the location of the applicant's property within the catchment. As noted in #9.145-9.146 we came to the view that any significant increase in nutrient load in either Ahuriri or Wairepo catchments could result in their trophic states increasing to mesotrophic and eutrophic, respectively. We record here that by significant increase we

mean greater than 5% of the new nitrogen load predicted by the applicants to be lost from the irrigated pasture.

16.94 For those applications where the predicted nitrogen loss was less than 5% of the new predicted nitrogen load we have applied our discretion whether to grant or decline, taking other factors into account such as the proximity of streams and rivers, the sustainability of the farming operation, as well as the priority issues discussed above.

16.95 For those properties draining to the Haldon Arm we determined (#9.147) that the sum of sum predicted nutrient losses would result in a no more than minor increase to the trophic state of that Arm. Thus there were no cumulative water quality issues to concern us with respect to the Haldon Arm of Lake Benmore. However we did consider that MWRL had underestimated the likely environmental effects on streams and rivers, and these effects were the focus for our water quality effects assessment for properties in the Haldon Arm catchment and are discussed in individual Part B decisions.

Derogation

16.96 The matter of non-derogation has its genesis in relation to allocation of water within the High Court declaration decision of *Aoraki Water Trust and Others v Meridian Energy Limited*[39]. The Court there held where a resource was fully allocated to a permit holder a consent authority could not lawfully grant another party a permit to use the same resource unless specifically empowered to do so by statute because to do so would derogate from the existing holder's rights.

16.97 In particular, the Court noted in its decision at paragraph 55:

> "*There is nothing in Section 104 to 104B or elsewhere in the Act* [RMA] *that would authorise CRC* [Canterbury Regional Council] *to grant Aoraki a water permit for Lake Tekapo if the grant would have the effect of reducing the amount of water available to satisfy the terms of Meridian's consents.*"

16.98 The High Court decision is specifically referred to by way of footnote on page 52 of the WCWARP. It is also referred to on page 14 in the document entitled, "Waitaki Catchment Water Allocation Regional Plan Section 32 Report".

16.99 Thus, resource consent for additional water for any activity within the Upper Waitaki catchment cannot be granted unless existing consent holder Meridian agrees to the derogation of their consents. As a matter of law, we accept we cannot grant a consent unless there is a derogation approval provided by Meridian.

16.100 We were told from the participants in this hearing that there is an agreement with the Mackenzie Irrigation Company Limited (MIC) for Meridian to give its derogation approval to the allocation of water to members of MIC who hold shares for new agricultural and horticultural activities, subject to various conditions. For those applicants seeking to replace an activity previously authorised by a resource consent the practice to date is that Meridian has been providing a derogation approval on a case-by-case basis.

16.101 We know and understand Meridian has provided that derogation approval to the various applicants before us on certain conditions. We see the issue of those conditions as being a matter between Meridian and the applicants. However, in the instance of grants of consents we are agreeable that the Meridian conditions for providing derogation approval be included as resource consent conditions because this reflects the basis upon which Meridian gave its derogation approval. That is, both Meridian and the relevant applicant promoted those conditions to us by agreement for inclusion if we determined to grant consent. We are prepared on that basis to accept that we will include those conditions and any other conditions we think necessary, provided all conditions are appropriate for resource management purpose.

[39] [2005] NZRMA 251 (Chisholm and Harrison JJ).

16.102 If there is any error or omission in that regard, this part of our decision can be relied upon to the effect that in giving a grant of consent to an applicant before us where that applicant requires Meridian derogation approval and that approval has been given on the understanding that the Meridian conditions would be included within the granted conditions, then we agree that those Meridian conditions be incorporated into the grant of consent.

16.103 In terms of whether derogation approval has in fact been granted we have been reliant upon the consent investigating officers and the applicants themselves for confirmation as to that fact. Our current understanding is that all applications before us that require derogation approval have received that approval. We therefore do not provide any further discussion on the issue of derogation in our Part B decisions.

Duration / Term

16.104 The grant or otherwise of applications to take and use water are bound up with derogation approval provided by Meridian.

16.105 Each derogation approval for new applicants is covered by the Mackenzie Irrigation Company (MIC) agreement for new applicants. One of the requirements for new applicants is that those applicants seek an expiry term of 30 April 2025, which is the expiry date of Meridian's consents for the Waitaki Hydro Electric Power Scheme.

16.106 Therefore given the terms upon which the derogation approval was granted and the terms upon which the application was sought the only issue we saw was whether or not a term of consent with an expiry date earlier than 30 April 2025 was appropriate having regard to relevant resource management issues. Where this is the case we adopt that approach, which is explained in the relevant Part B decision.

16.107 In every other instance where there were no factors suggesting or requiring an earlier expiry date, we have adopted the requirement put forward by Meridian in terms of its derogation approval, as we consider we have no option but to do so. The applicant group accepted the requirement that the term of the consents expire on 30 April 2025 in any event and did not seek longer terms.

16.108 Where the application is a renewal, the same Meridian restriction does not apply. However, we think that there is some benefit for future decision-makers in having a uniform date of expiry; so we have adopted 30 April 2025 as a common expiry date throughout.

Approach to Conditions

16.109 The hearings were adjourned on the basis that all participants would through a structured process meet and do one of two things. Either they would agree to a condition set for all applications or, failing reaching agreement, they would provide condition sets and detail to us their differing position on those condition sets and explaining to us why their position should be preferred over others providing cogent reasons.

16.110 Understandably, given the complexity of the issues before us coupled with the number of applications, this process took a very long period of time to complete. Indeed, the hearings concluded on 29 April 2010. We were not provided with the condition sets until late January 2011. This added further delay to the decision making process.

16.111 Unfortunately, the condition sets do not record agreement between the parties and also they do not record in detail the competing positions between the participants with their reasons as requested. Thus, we have adopted the "normal" approach to conditions and rather than having the benefit of agreements we have had to determine what conditions are appropriate for ourselves.

16.112 In terms of our approach to conditions we record that we are well alive to the point that Meridian has provided its derogation approval on the basis that the conditions they have set forward are included within the ultimate condition set we impose. Meridian has made

it clear that their derogation approval is provided subject to those conditions being included in the grant of consent.

Number of decisions per proposal

16.113 In relation to our Part B decisions, the general approach we have adopted to is try and issue a single decision for each separate proposal. This decision will often cover multiple consents that are part of a single proposal. For example, many proposals involve an application to take and use water for irrigation along with a related application to disturb the bed to install an intake structure.

16.114 In some circumstances, it has not been practical to issue a single decision for one proposal due to the complexity of the issues involved and the amount of evidence presented. In these circumstances, to make our decisions easier to read and understand we have provided separate decisions for discrete aspects of the proposal.

16.115 Irrespective of the number of decisions for a single proposal, we have made a separate finding for each separate application as to whether consent is granted or declined. In some cases, this has meant that the take and use application has been declined, but the related application to disturb the bed has been granted. We recognise that one is of little value without the other, but consider that this approach is consistent with our responsibilities under the RMA and may help to simplify matters going forward.

17 CONCLUSION

17.1 Our overall conclusions on the catchment-wide issues are summarised in the Executive Summary at the start of this Decision and are not repeated here. The key conclusions following each main section of the Decision should be referred to for further details.

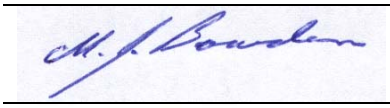
17.2 Finally, we reiterate that Part A is only one component of our overall decision and should be read in combination with the relevant Part B decisions to understand our findings on specific applications and proposals.

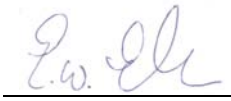
DECISION DATED AT CHRISTCHURCH THIS 22ND DAY OF NOVEMBER 2011

Signed by

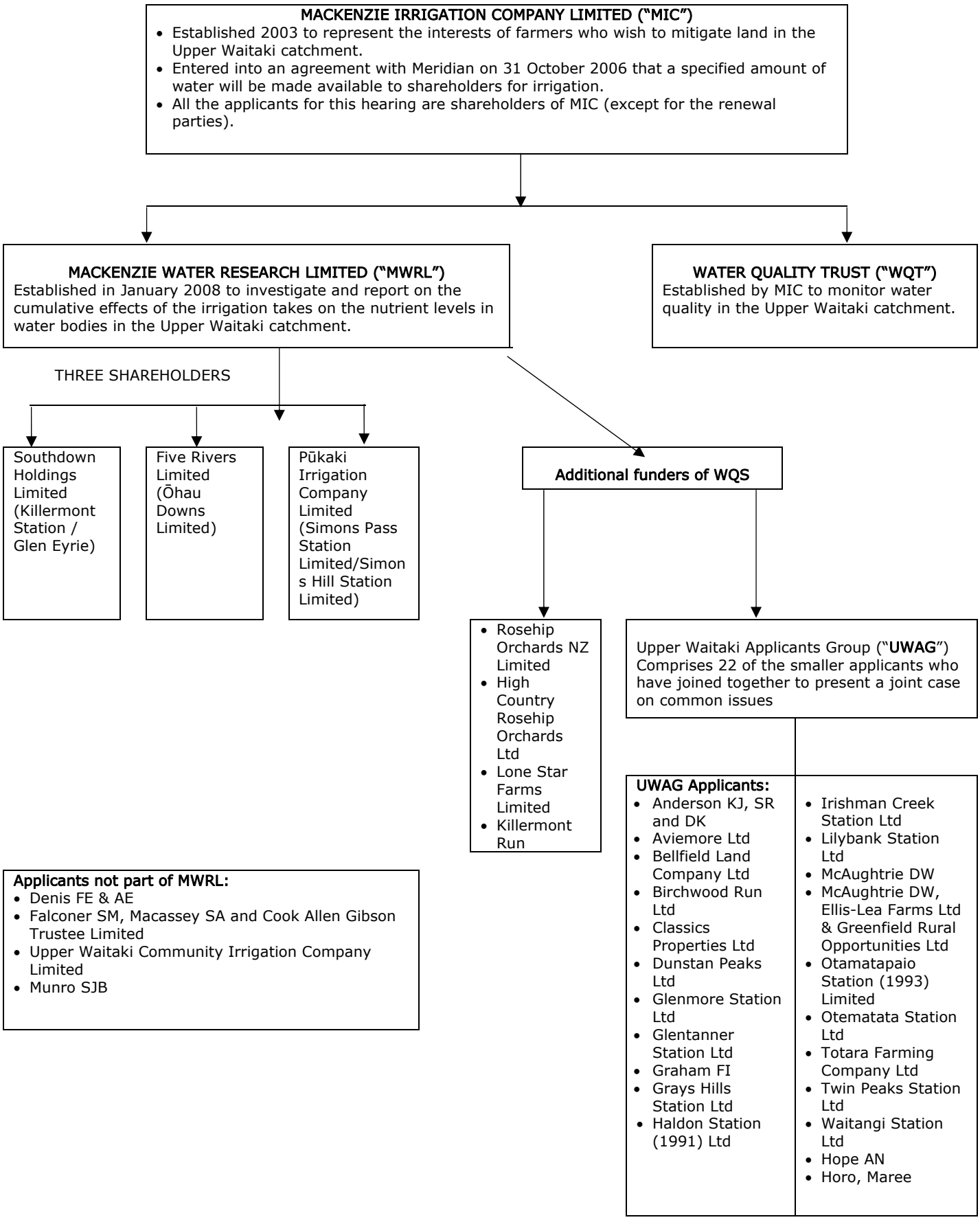
Paul Rogers 

Dr James Cooke 

Michael Bowden 

Edward Ellison 

APPENDIX A: Structure of organisations involved with the applications



APPENDIX B: Priority Order of Applications to Divert, Take and Use Water

No.	Ref.	Applicant	Notifiable date
1	CRC011845	Irishman Creek Station Limited	13 Feb 2002
2	CRC020355	Otematata Station Limited	26 Feb 2002
3	CRC011361	Dunstan Peaks Limited	19 Jul 2002
4	CRC031175	Lone Star Farms Limited	4 Feb 2003
5	CRC012047	Otamatapaio Station (1993) Limited	4 Mar 2003
6	CRC030944	Waitangi Station Limited	23 Apr 2003
7	CRC012017	Messrs K J & D K & Mrs S R Anderson	20 Jun 2003
8	CRC012019	Messrs K J & D K & Mrs S R Anderson	20 Jun 2003
10	CRC020584	Totara Farming Co Limited	30 Sep 2003
11	CRC040180	Killermont Station Ltd – Frosty Gully	3 Dec 2003
12	CRC041331	Killermont Station Ltd – Pebbly block	22 Dec 2003
13	CRC041777	Killermont Station Ltd - Woolshed	27 Feb 2004
14	CRC042561	Haldon Station (1991) Limited	24 May 2004[40]
15	CRC041788	Southdown Holdings Limited	27 Feb 2004
16	CRC991473	Mr D W McAughtrie, Greenfield Rural Opportunities Limited & Ellis-Lea Farms (2000) Limited	29 Oct 2004
17	CRC001128	Upper Waitaki Community Irrigation Company	5 Nov 2004
18	CRC011940	Mr D W McAughtrie	10 Nov 2004
19	CRC011987	Bellfield Land Company Limited	15 Nov 2004
20	CRC012291	Birchwood Run Limited	21 Dec 2004
21	CRC041798	Killermont Station Ltd – Mānuka Creek	3 Mar 2005
22	CRC041031	Aviemore Limited	15 Mar 2005
23	CRC042661	Grays Hills Station Limited	15 Mar 2005
24	CRC040835	Southdown Holdings Limited	21 Mar 2005
25	CRC041033	Otematata Station Limited	21 Mar 2005
26	CRC042011	M Horo	24 Mar 2005
27	CRC042015	M Horo	24 Mar 2005
28	CRC042017	M Horo	24 Mar 2005

[40] This application has been moved ahead of CRC041788 in the priority order by virtue of agreement between the two applicants

29	CRC042018	M Horo	24 Mar 2005
30	CRC042020	M Horo	24 Mar 2005
31	CRC042022	M Horo	24 Mar 2005
32	CRC042025	M Horo	24 Mar 2005
33	CRC041542	Mr A N Hope	30 Mar 2005
34	CRC041543	Mr A N Hope	30 Mar 2005
35	CRC060253	Mrs Falconer, Mr Macassey & Cook Allan Gibson Trustee Co Ltd	26 Jul 2005
36	CRC052501	Glenmore Station Limited	15 Aug 2005
37	CRC052502	Glenmore Station Limited	15 Aug 2005
38	CRC061154	Five Rivers Limited	6 Oct 2005
39	CRC060938	Mr S J B Munro	19 Dec 2005
40	CRC062842	Simons Hill Station Limited	14 Feb 2006
41	CRC062867	Simons Pass Station Limited	14 Feb 2006
42	CRC063106	Classic Properties Limited	7 Mar 2006
43	CRC063564	Twin Peaks Station Limited	7 Apr 2006
44	CRC070406	Classic Properties Limited	10 Aug 2006
45	CRC071649	Bellfield Land Company Limited	01 Dec 2006
46	CRC071786	Lilybank Station Holdings Limited	14 Dec 2006
47	CRC072118	Rosehip Orchards NZ Limited	22 Jan 2007
48	CRC072233	High Country Rosehip Orchards Limited	29 Jan 2007
49	CRC071362	Glentanner Station Limited	7 Feb 2007
50	CRC072363	Mr F I Graham	7 Feb 2007
51	CRC073115	Southdown Holdings Limited	1 May 2007
52	CRC082269	Haldon Station Limited	25 Feb 2008
53	CRC083609	Glentanner Station Limited	7 May 2008
54	CRC082304	Simons Hill Station Limited	4 Jun 2008
55	CRC082311	Simons Pass Station Limited	4 Jun 2008
56	CRC083692	Aviemore Limited	22 Oct 2008