IN THE MATTER OF	**the Resource Management Act 1991**
AND	
IN THE MATTER OF	**applications by Central Plains Water Limited (CPW) for Water Permit to divert and take water from the Waimakariri and Rakaia Rivers**

Supplementary Evidence of Dr Adrian Selwyn Meredith

INTRODUCTION

1. My full name is **Adrian Selwyn Meredith**, and I am employed by the Canterbury Regional Council as a Christchurch based water quality scientist. My qualifications, experience, and areas of responsibility are set out in my primary statement of evidence prepared and circulated in advance of this hearing.

2. This supplementary brief of evidence has been prepared in response to:
   - Supplementary evidence prepared by witnesses for the applicant, notably Drs Greg Burrell and Richard Allibone.
   - Evidence presented by submitters to the applications
   - In response to the content and response to questioning of witnesses to this hearing

   This supplementary evidence will provide further information and advice related to three areas of the applications, notably effects on:

   Waimakariri River flow and quality issues

   Issues relating to proposed controls on screening of water intakes

   Issues related to the proposed Waianiwaniwa Reservoir

   Such evidence is within my area of expertise. In forming the opinions I have expressed in this evidence, I have relied in part upon the evidence of other witnesses who are giving evidence for the Canterbury Regional Council, namely: Shirley Hayward, and Philip Grove of CRC, and Al McKerchar and Maurice Duncan of NIWA.

3. I also provide a brief 'executive summary' of the key conclusions I have reached, and how they differ from those reached by evidence for the Central Plains Water Scheme (CPW).

SUMMARY

Waimakariri River Flow and quality issues

4. I comment on the apparent disagreements and confusion over hydrological modelling assessments, and conclusions drawn for flows in the Waimakariri River. I also discuss the limitations of habitat modelling and interpretation.

5. I comment on the supplementary evidence of Dr Burrell on habitat modelling of the Waimakariri River

6. I provide further information on activities in the lower Waimakariri River that confound interpretation of water quality data and effects. In particular, the lower end of the Waimakariri River supports a number of gravel abstraction operators who have historically, and at present, abstract gravel directly from the flowing channels of the river. These widespread activities are known to produce turbid discharge plumes that visibly extend at least 2 to 3 kilometres beyond gravel abstraction points. Such activities confound the water quality data collected by NIWA at the SH1 bridge site, and confound the data interpretation by a number of witnesses.

Intake Screening

7. I further elaborate on the purpose and content of the recent (2007) NIWA/ECan Fish Screen Good Practice Guidelines, referred to by a number of witnesses; I clarify the status and weight that should be placed upon those guidelines.

8. I comment on the context of several recent resource consent intake screening processes and/or decisions that have proposed or adopted management plan approaches to fish screening requirements. I discuss why I consider they are unique, and/or are not comparable or directly applicable to the CPWES situation.

9. I provide further information on alternative fish screening or repulsion technologies (as at RDR) and their applicability to CPWES.

10. In taking into account the above points, I comment on the necessity to specify clear objectives and intent for fish screening or exclusion at water intakes for the CPWES.

Waianiwaniwa Reservoir

11. I provide further information on the lake level changes experienced at Lake Opuha (reservoir) in the nine years since commissioning, as visited by the commissioners, and comment on the consequences of unlimited or unmanaged level variations.

12. I discuss some results of annual monitoring reports for Opuha Dam, and trends or indications that some water quality conditions have not improved over time. The consequences of this to the Waianiwaniwa Dam situation are discussed.

13. I discuss the monitoring and water quality management consent conditions at Opuha, which resulted from a review of consents following water quality deterioration at Opuha Dam. I comment on their applicability to the proposed Waianiwaniwa Dam.

14. I review the supplementary information on further mitigations for Canterbury Mudfish populations in Waianiwaniwa Valley by Dr Richard Allibone.

15. I comment on further features of the mudfish populations.

Evidence in full:

Waimakariri River Flow and quality issues

16. The central issue around sustainability of the proposed abstractions from the Waimakariri River is effects of resulting flow regimes on provision of river habitat and 'useable' water conditions. A wide range of submitters have given evidence as to the flow requirements for a range of ecological, recreational, and amenity values. These show that for many of the features or values of the river, habitat or useable water area increases linearly with increasing flow, particularly in relation to river width, but also depth, velocity, and habitat variability. The most beneficial or useable flows are generally in the 60 to 80 cumec range, but corresponding reductions in quality or useability also occur in the more highly affected affected 40 to 60 cumec range.

17. The hydrological modelling presented can be confusing when various modelling statistics are presented that encompass various combinations of habitat features. Arguments can be raised relative to model portrayal of mean depth, mean width, total wetted width, weighted useable are (WUA), or habitat suitability indices (HSI). These can be used selectively to illustrate changes variously increasing, decreasing, or not changing with increases or decreases in flow.

18. Furthermore, while habitat modelling is a useful tool to illustrate the magnitude of possible changes, as with most models, it relies on basic assumptions, such as that while important factors such as depth and velocity change, all other habitat features remain equal or qualitatively unchanged. Dr Burrell (section 2.3 in 'Response to requests for further information' in December 2007) also notes that *"… there are inherent uncertainties to hydrological modelling, and therefore there can be uncertain outcomes for biological communities"*. Therefore, the results of hydrological modelling are only indicative and should be treated cautiously in determining absolute likely effects. In particular, model outcomes that predict "steepest linear increases with flow" may be more important indicators than findings of gradual or no change.

19. Correspondingly, information has been provided that "...small reduction in mean depth with reduced flow is the reason why instream habitat for many species changes little with flow (Burrell, in Golders 2007b). However, a corresponding large decrease in total wetted channel width of around 90 metres (a 28% reduction) occurs over the same range 85 to 41 cumecs. Dr John Hayes (submitter for Fish and Game) calculated that loss of invertebrate habitat will be as high as 19-26% during some months (para 2.13 of his evidence). Dr Dean Olsen also concluded that the CPW scheme alone (i.e. not accounting for cumulative effects) is expected to reduce the available habitat for the important invertebrate *Deleatidium* by up to 20% in several months of the year.

20. Whether these invertebrate habitat losses will translate to effects on fish and bird populations depends on whether food is limiting. The applicant has provided no information to help determine this. In the absence of such information I support the conclusions of Drs Olsen, Hayes and Hughey regarding the likely overall

negative effect of reduced food production on braided river fish and bird populations as a result of sustained reduced flows.

21. On the basis of the uncertainties of the hydrological modelling, CPWES offered mitigation in terms of further alterations to abstractions occurring around small freshes (Tipler 2007). Further, flow control scenarios were considered in the evidence of De Joux (for Fish and Game) and have subsequently been commented on in supplementary evidence provided by Golders (Burrell).

22. Dr Burrell argues that benefits of different regimes are minimal because he considers habitat unlikely to be limiting, and effects to be largely driven by flood frequency and accrual (interflood) period. His analysis presents median or average condition, which changes little in the different scenarios. However, in dry summers (non average conditions) magnitude of changes may be much greater. The further analysis presented by Burrell is therefore simplistic and adds little to further consideration of mitigatory flow regimes.

23. These are also the Water Conservation Order process developed a more complicated series of flow controls for the Rakaia River, and is correspondingly less controversial than the proposed Waimakariri abstraction. It is also notable that the subsequent proposed Ministry for the Environment National Environmental Standard (NES) on Ecological Flows and Water Levels (March 2008) proposes default controls that include both minimum flow controls and allocation controls (caps) that functionally limit abstraction blocks. This latter function is missing from existing Waimakariri River Regional Plan controls, and is the main element of additional flow mitigations being debated.

24. Given the debate over the various modelling outcomes, and high values of the Waimakariri River, I consider further flow regime controls on the significant CPWES abstractions are warranted to protect the river values and resources. All of the features inherent in the Rakaia WCO controls could appropriately be implemented on Waimakariri River consents. However, (as proposed in the draft NES) allocation controls such as a higher minimum flow on B class water and a B class allocation limit are most effective/appropriate.

25. In addition, controls over cessation of abstraction for periods of 12-24 hours on floods and freshes would also be of most benefit to river habitat conditions. I agree with the evidence of Dr John Hayes, that durations of at least 12-24 hours are necessary to be effective in achieving riverbed flushing or disturbance.

<u>Water quality</u>

26. The lower end of the Waimakariri River supports a number of gravel abstraction operators who have historically, and at present, abstract gravel directly from the flowing channels of the river by hydraulic excavator. This activity is unique to the Waimakariri River in Canterbury, and results from the difficulty in conducting gravel abstraction activities in the narrow ‘Wrights Cut’ reach of the Waimakariri River. These widespread activities are known to produce turbid discharge plumes that visibly extend at least 2 to 3 kilometres beyond gravel abstraction points (G Slaughter, Fulton Hogan) and can often extend down below the SH1 monitoring site.

27. I consider these activities confound the extensive water quality data set (1989 to present) collected by NIWA at the SH1 bridge site, and subsequently used by CPWES and submitter witnesses. I consider this data cannot be used to indicate whether waters become clearer, or more turbid as waters flow down the plains.

28. In particular, the highly scattered graphical data presented by Dr John Hayes may be partly explained by this confounding activity.

29. I would expect Waimakariri River waters to become successively clearer down the plains under low flows as transported fine sediments increasingly find lower bed velocity areas to settle, or reach thresholds to settle on the bed. My own observations are of river gravels becoming increasingly covered with fine coatings of silt over long accrual periods at low flows. The NIWA water quality data cannot therefore be used to either refute or support this contention, as the suspended solids, turbidity, and clarity determinations at SH1 are confounded by significant localised disturbance activities.

30. Furthermore, the capacity for such fine silt accumulation on the bed would be increased during times of significant or maximal CPWES abstraction on decreasing hydrographs. In other words, naturally more turbid water would be subjected to lower base flows beyond the abstraction points, and therefore would lead to periods with higher silt contents to settle at low flows.

31. It is for this reason that I remain concerned not only about fine silt sedimentation on longer accrual periods, but also the prevalence and growth of silt tolerant cyanobacteria mats in the lower river under these conditions. Fine silt accumulation smothers and inhibits the growth of most common diatom and green algae communities, which have no ability to cope with such smothering. Corresponding cyanobacteria (blue-green-algae) taxa are motile (initiate movement) and so can migrate up through silt layers as it accumulates.

32. This is why such growths have been becoming increasingly apparent in recent dry years, and would be expected to further increase in prominence under high abstraction scenarios. These cyanobacterial growths are both objectionable and potentially toxic, as against the simple nuisance value of green filamentous growths modelled or referred to by other witnesses. This is a further reason why additional flow regime controls are required, such as a gap between the Class A and B blocks, and protection of the flushing power of small to medium floods and freshes, to prevent the likely increase in frequency of these toxic or nuisance growths.

Intake Screening

33. The requirement for fish screening facilities at major water abstraction intakes has increased in prominence recently (as alluded to by a number of submitters). Subsequently, a 'Fish Screening, Good Practice Guideline' has been produced by NIWA (NIWA 2007), in association with ECan, Fish and Game, Department of Conservation, and Irrigation NZ. This report, and the process leading to its production, arose as a result of widespread concern over the absence or poor performance of fish screening at intakes in Canterbury. The guideline culminated from the preparation of a published Canterbury Sports Fish Criteria (Bejakovich 2006), and Native Fish Requirements in Canterbury (Charteris 2006), and discussed by those witnesses.

34. The Good Practice Guideline identifies and lists seven logical design requirements for effective screening of intakes from rivers. The guideline reinforces the need to consider a "whole of intake design" methodology incorporating consideration of all seven criteria. These include:

(i) Location of intake as close to the river as possible

(ii) Water velocity through any screen slow enough to allow escape and prevent damage

(iii) Water velocity across the screen sufficient to sweep fish away from the screen

(iv) Provision of a suitable bypass

(v) Connectivity between the bypass and river.

(vi) Appropriate sized openings in screening material

(vii) Operation and maintenance of the facility.

35. The guideline also lists and discusses a number of examples of operational designs in Canterbury with good design features.

36. The guideline has subsequently been released, and workshopped in three meetings throughout Canterbury, and is now scoping further developments to further assist the screening issue.

37. Therefore, there is considerable information available on the necessity for, and design features for significant river intakes in Canterbury. Therefore, there is no basis to argue that fish screening requirements are either unnecessary, unreasonable, or unable to be specifically designed.

38. However, CPWES still proposes to not specify particular screening objectives, or confirm design features, but to adopt a "management plan" approach to develop such features at a future time, and to be subsequently approved by the Regional Council. Such a process does not explicitly allow for input from interested parties, such as those submitting to this application.

39. This process is also of concern because there is no surety as to the resulting screening objectives, efficiencies, or structures. Furthermore, in the application evidence, CPWES also makes passing comment on possible or favoured design approaches. Several of these design approaches are clearly inconsistent with many of the 'SEVEN DESIGN CRITERIA' above. In particular, screening proposal elements proposed to date are:

- Siting intake screens distant from the river (down stream of proposed sediment settling ponds)

- Not accepting existing low velocity criteria

- Not explicitly providing for efficient bypasses

- provide considerable problems or uncertainty for connectivity with the river.

- propose coarser screening mesh (5mm) than justified in guidelines

- Little guidance on operation and/or maintenance.

40. Therefore it is not surprising that there are concerns over the range of possible outcomes of an unconfirmed screening management plan approach. Both submitters, and ECan staff are wary of a simplistic proposal and unspecified "management plan" approach to address the important intake screening issue at hand.

41. The consent Management Plan approach is also suggested and justified as an approach adopted at a number of other major consented sites. The applicant therefore alludes to an element of 'precedent' argument in the adoption of a management plan approach. I address each of the three cases alluded to by either the applicant or submitters below.

(a) NTPL takes from Waimakariri River:

42. Ngai Tahu Properties Limited was granted consent to abstract water from the Waimakariri River at the Browns Rock (Waimakariri Irrigation Ltd) site with a range of specific screening attributes. This consent was subsequently appealed to the Environment Court, largely on the basis of the specific attributes. The resulting appeal was taken to formal court assisted mediation and resulted in a successfully mediated consent order (Appendix 1).

43. This order set out a 'management plan' approach that set aside specific design criteria, as in the seven screening criteria discussed above. The primary reason that all parties to the agreement (ECan, DOC, Fish and Game, NTPL, WIL) agreed to this approach is understood to be because there was general agreement that such a screen was unlikely to be built for many years to come.

44. This was because of a number of reasons:

- The consent conditions also allowed NTPL to abstract volumes of water through the existing consented WIL screen when spare capacity was available, so exercise of the consent to construct a screen was unlikely in the short term;

- The land that NTPL proposed to develop and irrigate was likely to be unavailable some years until existing forestry holdings were harvested;

- When finalised, the NTPL abstraction was likely to be incorporated into a new composite intake in association with WIL and other proposed abstractors and;

- Given a probable several years delay, that current technology, best-practice, and requirements were likely to have changed considerably.

45. As a result it was generally considered that it was unnecessary to commit considerable effort to refining or agreeing to a possibly redundant design. As such a management plan approach with unspecified design features was agreed with all parties, and was approved by consent order.

46. This is therefore a peculiar or unique situation that justified an alternative approach for very good reasons. I believe that it was not intended to represent or signal an alternative approach to routine intake screening applications, that avoid specifying intake objectives, criteria and design in routine applications.

(b) Hunter Downs Irrigation Scheme

47. The resource consent hearings for the Hunter Downs irrigation scheme (HDIS) on the lower Waitaki River occurred after the resolution of the NTPL consent order, and proposed a very similar 'management plan' approach to resolution to the fish screening issues. Furthermore, advice to both hearings had similar consultancy staff advising the applicants in both cases.

48. HDIS also cannot be considered routine or precedent setting on this approach for two reasons. Firstly, the NDIS process is unusual in that it was agreed to hear

the consents required in two sequential processes, to minimise to cost, and given the uncertainty of outcome of the process. Therefore, not all required resource consents, or details were required to be addressed in this first hearing.

49. Secondly, the hearing process is currently adjourned and no decisions have been made. Therefore, the proposed consent conditions (Appendix 2) are nothing more than ‘applicant proposals’ being currently considered by decision makers. They are not currently approved and have no standing.

(c) Rangitata Diversion Race Ltd (RDR)

50. The RDR has diverted over 30 cumecs of water from the Rangitata River for irrigation, for over 50 years, and has remained unscreened over that time. Upon discussion of applications to replace existing consents, the issue of screening of the intake was very contentious, and subsequently consents granted were appealed to the Environment Court by Fish and Game NZ.

51. Given that the RDR system was an existing facility, retrofitting of screening to the system was problematical, and any screening was considered a considerable benefit over the existing situation. Parties to mediation therefore agreed to a management plan approach to address the difficult existing screening issues (Appendix 3.), and as novel approaches may be required.

52. Furthermore, as a result of the particular parties to the appeal and subsequent mediation, it was agreed that screening of only elements of the salmon fishery needed to be explicitly considered. Subsequently the approval to trial a novel fish repulsion barrier has been agreed, designed, and constructed, and is to be trialled this year. This facility is described in further sections of my evidence.

53. The RDR agreement is therefore again a peculiar or unique situation, and has again arisen both as a result of an unusual situation, and as a result of detailed appeal mediation agreements.

54. None of the three case studies noted above are straight forward consenting processes for complete new irrigation schemes. As such, the process has not as yet been shown to work successfully, and therefore none should be seen as proven or successful models, or precedent setting for routine addressing of scheme intake screening systems.

(d) Alternative screening technologies

55. The RDR has (by mediation) chosen to adopt alternative (non-physical) screening technologies to give effect to their (salmon) intake screening requirements. The RDR intake has been visited by the commissioners to this hearing, and in this section of my evidence I elaborate on the layout of the screening technology, and the particular benefits and detriments of this technology.

56. An aerial photo of the RDR intake is appended as Figure 1. This shows that the alternative BAFF (Bio- Acoustic Fish Fence) screen is located within the intake channel, well downstream of the river intake, and upstream of both an access bridge across the intake channel and upstream of the ‘sandtrap’ sediment settling area. Therefore it is not ’ideally’ sited “as close as possible to the river” (Criteria 1. in NIWA guidelines), but is sited upstream of the ponded sandtrap, and is still largely adjacent to the river channel.

57. The repulsed fish are diverted down a newly constructed diversion channel that travels back to the river, and arrives at the river at a similar point to the sandtrap sluicing channel. Therefore a functioning bypass (Criteria 4.) and connectivity to the river (Criteria 5.) are addressed.

58. Further photos are appended (curtesy of the system installer/supplier) to show the placement of the 26 modular BAFF elements mounted obliquely across the intake canal on a concrete foundation on the canal bed, photographed both before and after canal filling (Figures 2, 3). The operative system appears as a line of small bubbles emerging at the surface, somewhat reminiscent of a long aquarium bubbler.

59. The BAFF technology relies on two repulsion elements: a bubble curtain, and acoustic noise 'injected' into the bubbles. The principle is that sensitive fish travelling down towards the bioacoustic curtain are deflected along the upstream edge of the curtain until they either find a gap in it, or are directed into a bypass at the channel margin. The abstracted water however freely passes through the bubble curtain. The effectiveness of the system is therefore contingent on the 'completeness' of the curtain, and the sensitivity of the fish to it.

60. BAFF systems are generally constructed in intake channels (as at the RDR) rather than in natural rivers, as the channel characteristics allow more control over achieving good 'completeness' of the repulsion curtain.

61. The sensitivity of fish species to BAFF systems varies greatly between fish species, so BAFF type systems are generally considered most suitable in areas where there are limited species present, or screening is only required for certain valued species. For example effectiveness trials conducted by the RDR supplier in UK varied between species (Figure 4). It is generally considered that active pelagic and schooling species are most sensitive, and benthic species least sensitive. Therefore, salmonids (salmon and trout) are generally considered 'sensitive, and species such as eels, lampreys and catfish 'insensitive'.

62. Therefore, the BAFF system at the RDR is designed to deflect salmonid fish (particularly salmon juveniles), but is expected to be likely to be relatively ineffective at deflecting native fish such as eels and torrent fish. As such it is considered a solution that is only likely to be effective with some elements of the river fish community (the salmon fishery).

63. The system is required to be 'effective' by consent condition, but the threshold of 'effectiveness is unspecified. Given the degree of effectiveness claimed at other overseas facilities are of the order of 80%, this would be expected to be the likely maximum effectiveness at the RDR. This is to be monitored in the first years of operation. Even if this is achieved, an ongoing loss of up to 20% of entrained salmon juveniles could be expected, and higher proportions of entrained native fish species. As stated earlier, this may be agreed at an old existing facility via mediation with one party, but this level of fish loss may be less acceptable at a new facility with a wider ranger of active submitters focussed on outcomes.

64. Additionally the BAFF suppliers also sell SPA (Specific Acoustic Array) systems. These are specific underwater speaker repulsion systems that can be sited in rivers, lakes or ocean, adjacent to intakes. They were considered for the RDR situation, but it was considered that the high energy environment of the Rangitata River was too likely to damage 'in-river' installations of speaker arrays. Fish may also be rendered less 'sensitive' if having had to travel through the very high energy Rangitata Gorge system immediately prior to encountering the repulsion

system (habituation). To a lesser extend this may also be a concern with the BAFF effectiveness.

65. The benefits and detriments of a BAFF repulsion system are then:

<u>Benefits:</u>

- Lower installation cost than physical screens

- Lower operational cost without screen cleaning requirements

- Ability to site the system closer to the river

<u>Detriments:</u>

- Unproven effectiveness in New Zealand

- Only likely to be 80% effective or less

- Specific effectiveness only with some fish species

- Possibility of 'habituation' in high energy gravel rivers

66. The novel BAFF and SPA repulsion systems are therefore not ideal systems alone for a new purpose designed intake. They may however be useful additional technology to "pre-screen" or to be used in association with other technology.

Waianiwaniwa Reservoir

67. The Opuha Dam was visited by the CPWES consent commissioners to view an operational irrigation reservoir. The degree of water level variation experienced at such dams is frequently questioned but data illustrating variation is often unavailable. I have accessed the water level data for Opuha Dam from commissioning to the present (approximately 9 years) and include it as Figure 5.

68. Water level variation is managed in the Opuha Dam consents by requiring that routine water levels are annually only drawn down by 7 vertical meters, but that the dam water level can be drawn down to its maximum extent (21 vertical meters) only once in every 20 years (5% reoccurrence). This acknowledges that annual lake level variations of 7 metres should be sustainable for maintenance of natural values but that extreme water level variations are unsustainable unless they occur very infrequently.

69. The record in Figure 5. Illustrates that extreme water level variations were generated in 2001 with water levels drawn down by 18 vertical metres. In 2006 and 2007 the water levels were drawn down by approximately 10 vertical metres, and low levels of at least this extent have been experienced again in 2008 and were observed by the CPWES commissioners.

70. This shows that while optimal water level ranges to maintain natural values can be specified, they are difficult to maintain, predict, and enforce. In the case of Opuha Dam, the natural values being managed include a stocked salmon fishery, natural trout fishery, and a range of recreational and amenity conditions.

71. The proposed Waianiwaniwa reservoir is proposed to have storage with up to a 30 vertical metre water level range, and no limit on annual or frequency of level variations. This is largely because there are no explicit natural or recreational values offered as benefits or mitigation of effects for the scheme at present.

72. If such benefits or mitigations are directly or indirectly offered or required, then further consideration of reservoir level management regimes for lake levels may be required. For example, if reservoir fisheries are promoted, either directly, or as a consequence of low effectiveness of intake fish screening, then those fish resources will need to be protected from too frequent catastrophic water level variation effects (water quality deterioration, loss of food supply, contraction of habitat area, etc.).

73. The issue of stratification (layering) of water quality in reservoirs has also been raised and continues to be dismissed by the applicant as likely to be only a transitory issue for the first couple of years following lake filling. However, this suggestion is naïve given existing evidence from New Zealand.

74. At Opuha Dam the potential for deoxygenation of bottom waters, as illustrated by the rate of oxygen loss from bottom waters is unchanged over the past 7 years of monitoring. This illustrates that the propensity to deoxygenate is not changing and that stratification and deoxygenation will probably be a reoccurring feature for the life of the dam at Opuha. This has also been found in several of the Auckland water supply dams over the past 30-40 years despite them being in protected reserve catchments with low nutrient inputs. Therefore, as at Opuha and at Auckland water supply reservoirs, ongoing control of stratification and deoxygenation is likely to be required from initial dam filling to throughout the life of the reservoir.

75. Lack of identifying or resolving of this issue effectively at Opuha resulted in at least two years of significant adverse effects including water quality issues, and emission of toxic gases. It was only resolved effectively by formal consent review requiring a suite of explicit continuous monitoring and design and operation of prescribed aeration equipment. Such conditions (to be supplied) have been achievable and effective in managing the issues since. Furthermore, their design, construction, and implementation of the aeration, monitoring and control equipment are much more cost effective if constructed "in the dry" prior to lake filling, than if subsequently retrofitted by divers.

76. I consider, implementing a suite of conditions such as those resulting from the Opuha Dam review would avoid any chance of sustained periods of deoxygenation regularly generating a wide suite of effects on water quality, ecology, and local environment at the proposed Waianiwaniwa reservoir.

Waianiwaniwa mudfish populations.

77. The other outstanding issue at the proposed reservoir site, is the significance and management of the large population of Canterbury mudfish in the valley. Considerable evidence as to the status and importance of this population has been presented in my initial evidence and submitter evidence of Ms Sjaan Charteris and Professor McIntosh. Most recently, supplementary evidence has by provided by Dr Allibone for CPWES.

78. Dr Allibone provided proposals for further mitigatory actions regarding the Waianiwaniwa mudfish populations. The most substantial of these was a proposal to generate up to 20 km of artificially constructed mudfish stream habitat

around the south eastern and north eastern margins of the proposed reservoir in designated land above the highest proposed reservoir water level. This stream is proposed to be fed by a pumped water supply from the reservoir, constructed in natural sediments, and stocked from the Waianiwaniwa River mudfish populations.

79. Ms Charteris submitting for the Department of Conservation provided additional references to show that the success of establishing translocated populations of Canterbury mudfish has been very poor in Canterbury to date despite documented instances of over 30 years of efforts. These indicate that despite considerable research on the ecology of Canterbury mudfish, the habitat requirements to establish viable self reproducing populations is poorly established. Therefore, the likely success of trying to establish artificial mudfish habitat on the scale proposed around the margins of the Waianiwaniwa reservoir is poor or at best highly risky.

80. Furthermore, managing populations on the basis of habitat maintained by pumped water supplies are also additionally risky with the hazards of potential failures of a range of engineered elements including power supplies, pumps, filters and maintenance. To be tangible mitigation they must also provide habitat surety (pumped water supply) in posterity rather than just for the duration of the resource consents.

81. Mudfish populations exist in a number of environments that could be considered somewhat artificial, including stock water races. However, these are all naturally populated habitats that are either likely to have been populated from natural populations disturbed during the historic construction of such races (including the draining of wetlands), or from recruitment via natural dispersal processes following floods or sustained high water levels.

82. As I alluded to in my earlier evidence, headwater mudfish populations (such as the Waianiwaniwa River population) are important sources of widely dispersed fry and juveniles that have historically widely repopulated suitable habitat fragments across the Canterbury plains during spring floods. Many of these plains habitat fragments are susceptible to extinction during drought and other disturbances, and may have “come and go” as they were repeatedly depopulated by droughts and repopulated by flood mechanisms.

83. Latterly, suitable stock water races have provided viable mudfish habitat in places, but only a few areas have established or sustained significant mudfish populations (O’Brien 2006a, b). Rather than illustrating the potential ease of establishing further mudfish populations in artificial habitats, these examples more clearly reinforce the importance of the headwater ‘source’ populations in offering the repeated opportunities to recolonise or establish further natural populations.

84. The proposed artificial stream habitats around the reservoir margin do not offer this recolonisation opportunity, being largely isolated from flood dispersal by stable artificially maintained stream flow regimes, and the reservoir and dam also preventing downstream dispersal onto the lower plains. If approved, successfully established and maintained, the artificial stream populations proposed by Allibone would only provide a further artificially maintained population that could only provide captive sources for translocation (in short – a Zoo type facility).

85. Furthermore, the proposal describes artificially constructed streams that would be fed from a pumped water supply fed by reservoir storage. In short, the artificial streams could only exist after the reservoir had been filled. In the intervening

period (years?) the extensive mudfish populations in Waianiwaniwa valley would have to be successfully captured, transferred, and held in captivity until such time as the proposed streams were ready for colonisation. While CPWES has previously indicated it proposed to establish a captive rearing and holding facility, the scale of a facility required to maintain the entire population numbers from the valley are enormous. It is therefore likely that only a small proportion of the valley population could be held in captivity and the vast majority are likely to perish or be lost in the reservoir (not 'protected').

86. Therefore the extensive artificial stream habitat mitigations, most recently offered in the supplementary evidence of Dr Allibone, have several unresolved issues, represent relatively poor (zoo-like) mitigation, prevent existing natural population dispersal mechanisms, and certainly do not guaranteed population 'protection'.

87. I do not consider the proposal to be in any significant way 'protection' of the extant mudfish population, or 'low risk mitigation' for what would otherwise be extensive loss of Canterbury's largest mudfish population (suggested by Professor McIntosh as possibly representing over 50% of the remaining numbers of this endangered species).

References cited.

Golder Associates, December 2007: Response to request for further information regarding ecological effects. Central Plains Water Scheme.

Golder Kingett Mitchell (2007): Central Plains Water: Effects on the Rakaia River, Fish Screening Issues and Reservoir Water Quality.

O'Brien, L, and Dunn, D. 2006a: Canterbury mudfish within Hororata township. Ichthyo-niche report. 9pp.

O'Brien, L, and Dunn, D. 2006b: Galaxiid fry survey in the Selwyn stockwater race network.. Ichthyo-niche report. 10pp.

URS, 4th December 2007: Response to Ecan s92 request regarding sediment transport in the Rakaia and Waimakariri rivers, effects on water levels of Lake Ellesmere and effects on tidal reaches. Memorandum from URS, 4th December 2007.

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Appendix 1. Ngai Tahu Properties Ltd fish screening condition (Consent CRC052033)

7. (a) *The consent holder shall install, operate and maintain a fish screen ("the Screen") across any intake it constructs as referred to in condition 1(a) and it shall be designed in accordance with the certified plans approved by the Canterbury Regional Council in accordance with condition 7(e)(ii).*

(b) *The Screen shall as far as practical prevent the entrainment, impingement and entrapment of salmonids including adults, fingerlings and fry and for the purposes of this condition this shall be achieved by installing, operating and maintaining the fish screen in accordance with the certified design plans referred to in 7(a).*

(c) *The design plans for the Screen shall be certified by: a chartered engineer with experience in the design and operation of fish screens; and either a fisheries biologist with post graduate qualifications in salmon fisheries or a fisheries biologist with internationally recognised experience in salmon fisheries research. ("the Certifiers").*

(d) *The appointment of the Certifiers by the consent holder shall be subject to the prior written approval of the Canterbury Regional Council.*

(e) *Prior to the commencement of construction:*

(i) *the consent holder shall provide to the Canterbury Regional Council:*

(A) *the certified design plans including the screen slot size, sweep velocity, approach velocity, and, if relevant, an effective by-pass which returns fish to an actively flowing braid of the Waimakariri River;*

(B) *a report from the Certifiers which certifies and explains how the certified design and operation of the Screen :*

- *demonstrate best practice in achievement of condition 7(b))*
- *take into consideration any relevant regional plan;*
- *take into consideration any regional or national guidelines in relation to fish screen design or any international guidelines that the Certifiers consider relevant.*

(ii) *the Canterbury Regional Council shall give to the consent holder written notice stating whether or not it approves of the certified design plans, within 20 working days of receipt of those plans and the Certifiers' report referred to at condition 7(e)(i)(B), and such approval shall not be unreasonably withheld.*

(f) *The consent holder shall prior to commissioning provide a certificate from a suitably qualified person confirming that construction has occurred in accordance with the design plans approved by the Canterbury Regional Council.*

(g) *Within 24 hours of the Screen becoming damaged or ineffective, the consent holder shall cease taking water and notify the Canterbury Regional Council and advise it of any remedial measures including fish salvage to be implemented. The taking of water shall not recommence until the effectiveness of the Screen has been restored in accordance with Conditions 7(a) and 7(b).*

Appendix 2. Amended draft conditions (proposed by applicant) for intake screening at Hunter Downs Irrigation Scheme application (dated 18 December 2007).

Fish Deflection Barrier / Fish Screen

11. (a) Prior to the taking of water pursuant to this consent, the consent holder shall install, operate and maintain a fish screen ("the screen") or deflection barrier across the intake designed in accordance with the certified plans approved by a person duly authorised by the Canterbury Regional Council in accordance with Condition 11(f).

(b) The screen or deflection barrier shall as far as practicable prevent the entrainment, impingement and entrapment of salmonids including adults, fingerlings and fry and for the purposes of this condition this shall be achieved by installing, operating and maintaining a fish screen or deflection barrier in accordance with the certified design plans referred to in Condition 11(c).

(c) The design plans for the screen or deflection barrier shall be certified by: a suitably qualified engineer with experience in the design and operation of fish screens and deflection barriers; and either a fisheries biologist with post-graduate qualifications in salmonid fisheries or a fisheries biologist with internationally recognised experience in salmonid fisheries research ("the Certifiers").

(d) The appointment of the Certifiers by the consent holder shall be subject to the prior written approval of the person duly authorised by the Canterbury Regional Council.

(e) Prior to the commencement of construction of the fish screen or deflection barrier, the consent holder shall provide to the Canterbury Regional Council:

(i) The certified design plans including the screen or deflection barrier slot/aperture size, sweep velocity, approach velocity and, if relevant, an effective by-pass which returns fish to an actively flowing braid of the Waitaki River;

(ii) A report from the Certifiers which certifies and explains how the certified design and operation of the screen or deflection barrier:

- Demonstrates best practice in achievement of Condition 11(b);
- Takes into consideration regional or national guidelines in relation to fish screen and/or deflection barrier design and/or any international guidelines that the Certifiers consider relevant.

(f) A person duly authorised by the Canterbury Regional Council shall give written notice to the consent holder stating whether or not it approves of the certified design plans within 20 working days of receipt of the plans and the certifiers report referred to in Condition 11(e) and such approval shall not be unreasonably withheld.

(g) The consent holder shall, prior to commissioning, provide a certificate from a suitably qualified person confirming that construction of the screen or deflection barrier has occurred in accordance with the certified design plans approved in accordance with Condition 11(f).

(h) After installation the consent holder shall commission an audit by an independent research organisation approved by the Canterbury Regional Council to determine the effectiveness of the screen or deflection barrier installed. The methodology to be adopted shall be approved by the Canterbury Regional Council. The consent holder shall provide the results of the audit to the Canterbury Regional Council within 18 months of the commissioning of the Hunter Downs Irrigation Scheme take.

(i) The fish screen or deflection barrier shall be inspected for any damage causing fish to be entrained, impinged, entrapped or pass through the screen or device, within a 24 hour period and then at least once every following 48 hours, when the flow in the Waitaki River at the Kurow Gauge (Kurow Gauge flow map ref: 140:079-088) as estimated by the Canterbury Regional Council is greater than either:

(i) 600 cubic metres per second; or

(ii) 450 cubic metres per second if consent CRC071903 (Meridian Energy Limited – North Bank Tunnel) or any subsequent replacement consent is operative.

(j) Within 24 hours of the fish screen or deflection device becoming ineffective, the consent holder shall notify the Canterbury Regional Council of the situation, any remedial measures to be implemented, and the likely timeframes for implementing those measures. The consent holder shall use its reasonable endeavours to restore the effectiveness of the fish exclusion measures in accordance with Condition11(b) as soon as possible. This consent shall not be exercised if the effectiveness of the fish screen or deflection device in accordance with Condition 11(b) has not been restored within 30 days of the fish screen or deflection device first becoming ineffective.

(k) The area(s) of the outfall(s) from the intake overflow channel(s) shall be monitored twice monthly during October to February inclusive for the first 3 years of the exercise of this consent to ensure that there is no accumulation of native fish in the vicinity of the outfall(s) from the overflow channel(s).

Appendix 3.

<u>Amend</u> Condition 4 of CRC011245 to read as follows:

4. *The consent holder shall take such measures as are appropriate to ensure that, so far as is reasonably practicable, fish are able to pass the dam and are prevented from becoming entrained in the Rangitata Diversion Race. To that end:*

(a) *The consent holder shall ensure that a fish pass over the dam be provided and maintained so the passage of fish is not significantly impeded;*

(b) *By 1 August 2009 the consent holder shall install and commission a system for the purpose of diverting fish so that they are not entrained in the Rangitata Diversion Race. The system will be installed and commissioned in accordance with consents CRC082583, CRC080840 and CRC070275;*

(c) *Within 3 years of the commencement of this consent the consent holder shall provide the consent authority with a report, prepared by a person appropriately qualified and experience in freshwater fisheries biology, detailing the extent to which the pass referred to in paragraph (a) and the fish diversion system referred to in paragraph (b) above is meeting the object of this condition and making recommendations, if such are thought by that person to be necessary, as to the way in which that object may better be met;*

(d) *At any time within the fourth year of this consent and during every fourth year thereafter the consent authority may review this condition (pursuant to s 128) for the purpose of determining what steps should be taken by the consent holder so as better to achieve the object of this condition;*

(e) *The consent holder may at any time apply to the consent authority for a change to this condition, but for the sole purpose of the better achievement of its object.*

Figure 1. Layout of constructed RDR BAFF fish repulsion system (Photo curtesy of Fish Guidence Systems UK Ltd).

The RDR BAFF

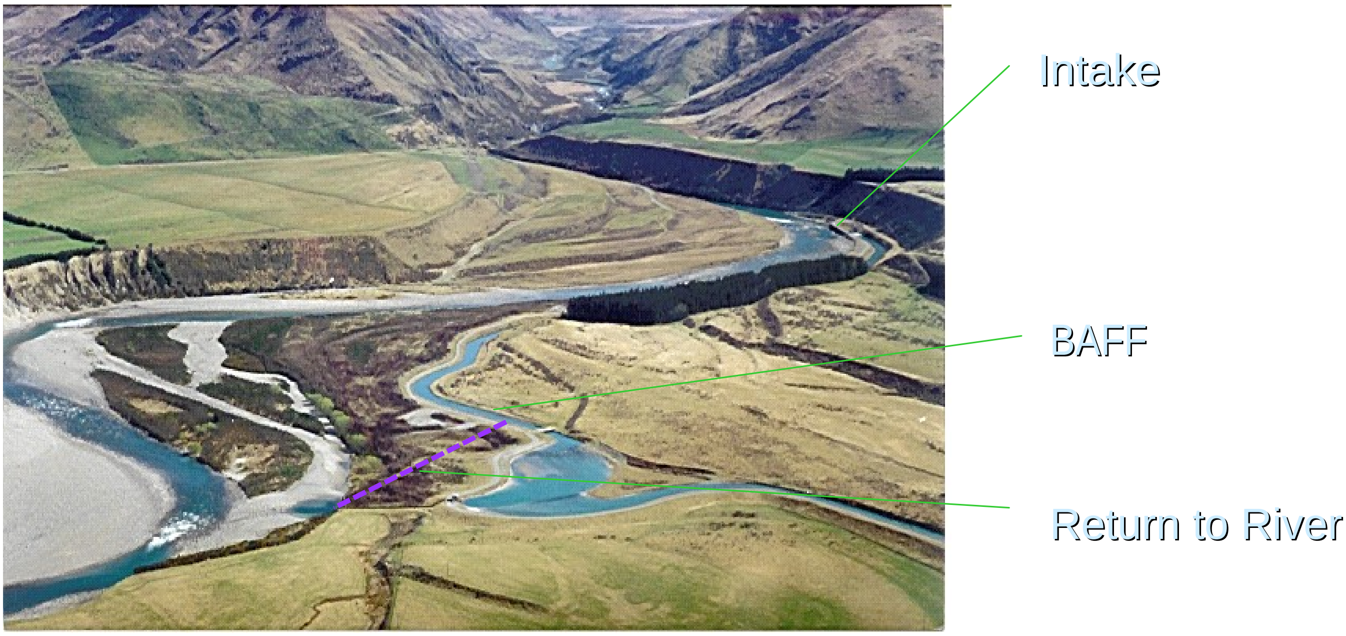

Figure 2. RDR BAFF units under construction in dry intake channel (Figure curtesy of Fish Guidence Systems UK Ltd).

The RDR BAFF

- RDR BAFF System after re-alignment
- Race drained down, before re-filling

Figure 3. Photos of RDR BAFF system in trial commissioning operation looking upstream up intake canal (Figure curtesy of Fish Guidence Systems UK Ltd).

Figure 4. Lake Opuha telemetered water levels over period since commissioning (1999 to January 2008, showing maximum and minimum control levels. (Data curtesy of ECS Ltd.)