IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	applications by Central Plains Water Trust to: Canterbury Regional Council for resource consents to take and use water from the Waimakariri and Rakaia Rivers and for all associated consents required for the construction and operation of the Central Plains Water Enhancement Scheme Selwyn District Council for resource consents to construct and operate the Central Plains Water Enhancement Scheme
AND	
IN THE MATTER OF	a notice of requirement by Central Plains Water Limited to: Selwyn District Council for the designation of land for works associated with the construction and operation of the Central Plains Water Enhancement Scheme

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SUPPLEMENTARY EVIDENCE OF GREGORY PETER BURRELL

BUDDLE FINDLAY
Barristers and Solicitors
Christchurch

Solicitor Acting: **Rachel Dunningham**
Counsel: M.C. Casey Q C
Tel 64-3-379 1747 Fax 64-3-379 5659 PO Box 322 DX WP20307 Christchurch

INTRODUCTION

1. My name is Gregory Peter Burrell. My qualifications and experience, and the basis on which I prepared this brief, are set out in my main brief of evidence prepared for this hearing (dated January 2008).

2. The purpose of this supplementary brief of evidence is to comment on the effects of the proposed revised Central Plains Water Enhancement Scheme (CPW) on the ecology of lowland streams and Lake Ellesmere/Te Waihora.

3. In preparing this supplementary brief I have relied upon:

   - Modelled groundwater levels and lowland stream flow data from Julian Weir of Aqualinc.

   - Information on the revised CPW scheme configuration and predicted effects on groundwater nitrate loading and concentrations from Cliff Tipler of URS.

4. I have also met with Mr Ned Norton and Dr Vince Bidwell regarding their review of technical evidence concerning nutrients and lowland streams. Their review report was not yet finalised at the time of preparing my supplementary evidence.

EFFECTS ON STREAM FLOWS AND HABITAT

Predicted Flow Changes

5. The stream flow data supplied by Aqualinc indicates that the revised scheme will still increase flows in lowland streams, but that the magnitude of flow increase is reduced compared with the original scheme layout. For example, Mr Weir's modelling results (Appendix E of his supplementary evidence) show the 7-day mean annual low flow (7dMALF) for the Selwyn River at Coes Ford increasing from 475 L/s under the status quo to 3,137 L/s under the original CPW scheme layout and to 2,196 L/s under the "CPW with no dam" scenario (i.e., the revised scheme). My analysis of the Aqualinc data indicates that the general distribution of effects remains the same under the revised scheme as those described in my main brief of evidence, with the greatest increases in stream flows occurring in the Selwyn and Irwell Rivers and the magnitude of flow increases diminishing with distance north and south of these rivers.

Significance of Effects

6. I discussed the benefits of increased flow to lowland streams in my evidence in reply, dated September 2008. The increases in stream flows caused by the revised scheme remain substantial (>100% increase) in waterways such as the Selwyn and Irwell Rivers and Doyleston Drain and in my opinion the beneficial effects on habitat availability will therefore remain.

7. There are numerous small drains and tributaries of the Selwyn River (e.g., Silverstream) where increased flows would significantly improve habitat availability for brown trout spawning and rearing (Taylor 2006). For other small streams with softer bed sediments, significantly increasing flows will increase habitat availability, especially for eels (e.g., Graynoth 2007). However, in my opinion, the key potential environmental benefit for lowland streams is the impact of increased flows on habitat availability in the Selwyn River, given the river's historic significance as a trout fishery and concerns that declining flows in recent years have contributed to the fishery's decline (e.g., Jellyman et al. 2003).

8. Since giving my evidence in reply in September 2008, ECan has produced a new report on instream habitat modelling results in the lower Selwyn River, which is of relevance to this hearing. The report, prepared by Brooker & Graynoth (2008), studied two reaches of the Selwyn River, upstream and downstream of Coes Ford.

9. My summary of key points of relevance from the Brooker & Graynoth (2008) report are as follows:

- Maximum Weighted Usable Area (WUA) for adult brown trout occurred at around 2.2 to 2.3 m^3/s for both sites surveyed, which is similar to the revised post-CPW 7dMALF predicted by Aqualinc. Maximum WUA was more than double the habitat available at the existing, status-quo 7dMALF (assuming a 7dMALF of 0.47 m^3/s, from the Aqualinc modelling).

- Similarly, maximum WUA for food producing habitat occurred at a flow of 2.4 and 3.2 m^3/s for the two modelling sites, which was 2 to 3 times the WUA present at the existing 7dMALF and similar to that predicted by Aqualinc post-CPW.

- Maximum WUA for brown trout spawning habitat occurred at flows of around 1 m^3/s or greater, but results were affected by high macrophyte cover present during summer fieldwork and different results might be expected if fieldwork were undertaken when macrophyte cover was low during the winter spawning period.

- The area of suitable habitat (WUA) for "clean water" diatom films more than doubled and the area available for long filamentous algae (i.e., nuisance growths) was at least halved, as flows increased from 0.47 m^3/s to 2.20 m^3/s (i.e., the status quo and revised post-CPW 7dMALF values given by Aqualinc).

- Effects on macrophyte cover were not modelled, although based on the modelled increases in water velocities, I would anticipate that habitat availability for macrophytes would follow a similar pattern to that of long filamentous algae, with up to a halving of WUA as 7dMALF increases from status quo to revised post-CPW flows. A reduction in macrophyte cover would increase the area of stony habitat available for invertebrates and fish to colonise.

- It was concluded by Brooker & Graynoth (2008) that *"Any increase in mean and minimum flows in the lower Selwyn is therefore likely to increase the average size of resident trout."*

10. In summary, based on the results of the Brooker & Graynoth (2008) report, the magnitude of flow increases predicted for the Selwyn River following the implementation of the proposed revised CPW scheme will at least double the habitat available for adult brown trout and their food, and this will result in a significant increase in the abundance and size of adult trout present, compared with the existing, status-quo situation. In my opinion, the new Brooker & Graynoth (2008) report provides the most robust evidence produced to date of the likely benefits of increased flows to the Selwyn River brown trout fishery and aquatic ecosystem health in general.

NUTRIENT EFFECTS ON LOWLAND STREAMS AND TE WAIHORA

Nutrient Enrichment

11. The impact of landuse intensification on nutrient concentrations in lowland streams and Te Waihora is a key issue of environmental concern with the CPW scheme. In his supplementary evidence, Mr Tipler has predicted that the revised CPW scheme will result in less nitrate loading to groundwater, and reduced nitrate concentrations, compared with the original scheme layout. While it is difficult to predict what the actual effect on nitrate concentrations entering a given waterway will be (see my paragraph 29 below, and Mr Tipler's supplementary evidence paragraph 83), I consider it a reasonable conclusion that reduced landuse intensification and less irrigation compared with the original application will result in reduced nitrate concentrations in streams downgradient and in Te Waihora.

12. In Section 10.5 of my main brief of evidence, I opined that increased nitrate loading to lowland streams and Te Waihora is unlikely to adversely affect aquatic ecosystems essentially due to existing nitrate concentrations already being in over-supply, and the existing biological communities being tolerant of high nitrate levels. In her supplementary evidence for ECan, Ms Hayward considered this assessment to be an oversimplification, as ECan monitoring data shows changes in nutrient concentrations over time, with the potential for nutrient limitation of periphyton and macrophytes to occur.

13. While I agree with Ms Hayward that nutrient limitation may occur in lowland streams, in my opinion, the monitoring data provided in her supplementary evidence shows that nitrates will more often than not be in abundant supply. I will now elaborate on this further, as this is an area of some contention.

14. Figures 2 to 7 of Ms Hayward's supplementary evidence show nitrate+nitrite-nitrogen (NNN) concentrations from the six Te Waihora tributaries that have a reasonably long and regular water quality monitoring record. Based on the figures in Ms Hayward's supplementary evidence, of the six tributaries regularly sampled by ECan, four (the Selwyn River, Boggy Creek, Doyleston Drain, and Harts Creek) have NNN concentrations that exceed ANZECC 2000 nutrient enrichment guidelines for at least 90% of the time. Nutrient enrichment guidelines are exceeded at least 85% of the time in Hanmer Road Drain, but only around 50% of the time in the Irwell River.

15. In my opinion, these data clearly support my conclusion that nitrate concentrations already exceed nutrient enrichment guidelines for the majority of the time in lowland tributaries of Te Waihora.

16. All of the six tributary sites show a trend of declining NNN concentrations over summer, reflecting the combined effects of reduced nitrate-rich groundwater inflows and plant uptake of nutrients over summer. This effect of low NNN concentrations over summer occurs over the longest period at the Irwell River monitoring site, as it experiences the lowest flows of all six sites monitored. A similar pattern of lower nitrate concentrations over summer has been reported elsewhere in the country (e.g., Quinn & Stroud 2002).

17. Increased irrigation and drainage to groundwater from the CPW scheme does therefore have the potential for increasing both flows and nitrate concentrations during summer, thereby reducing the likelihood of summer nutrient limitation of nuisance algae or macrophytes in lowland tributaries of Te Waihora. This could reduce the potential for natural die-back of macrophytes over summer months due to nutrient limitation, although I am sceptical that die-back currently occurs anyway (as evidenced by regular drain clearance by local authorities).

18. In my opinion this potential summer nutrient enrichment effect needs to be balanced against the significant increases in aquatic habitat that will occur in the lowland streams. In my opinion, the data I have presented indicates the potential for nutrient enrichment effects on lowland streams is small (as nutrient concentrations are already very high), whereas the potential for improved aquatic habitat due to increased flows is substantial.

Nitrate toxicity

19. The issue of nitrate toxicity in lowland streams was raised by Ms Hayward in paragraphs 16 to 21 of her supplementary evidence. Clearly, the reduced nitrate loading to lowland streams means the revised scheme will pose less of a toxicity risk to aquatic biota than previously assessed. However, I understand from Mr Norton that ECan has recently commissioned NIWA to review the current ANZECC toxicity guideline for nitrate and although I have not seen the ECan report, I understand from Mr Norton that the report recommends that the toxicity guideline be dropped from the existing concentration of 7.2 g/m^3 down to below 3 g/m^3.

20. In her supplementary evidence, Ms Hayward produced plots of nitrate concentrations in six tributaries of Te Waihora, showing how concentrations vary over time in relation to various guidelines. I have reproduced Figure 2 of Ms Hayward's evidence (Figure 1 of my evidence attached), which shows nitrate concentrations in the Selwyn River. I will focus here on the Selwyn River, because in my opinion it provides the best quality, stony habitat for stream invertebrates of the Te Waihora tributaries downgradient of the CPW scheme area. I would therefore expect that, of all the Te Waihora tributaries potentially affected by the CPW scheme, the invertebrate community of the Selwyn River would be the most sensitive to poor water quality.

21. In Figure 1 attached, I have superimposed an additional dashed line on Ms Hayward's plot, showing an assumed revised nitrate toxicity guideline of 3 g/m^3. The monitoring data indicates that nitrate concentrations exceed the revised toxicity guideline for about 85% of the time. However, ECan monitoring data from the Selwyn River shows high macroinvertebrate QMCI scores (a mean of >6; see Figure 2 of my main brief of evidence), which is slightly higher than the average QMCI score of 5.7 for 98 hill-fed lower plains streams regularly monitored by ECan (Hayward et al. 2009). My point here is that the Selwyn River sustains healthy invertebrate communities, even though the new nitrate toxicity guidelines are exceeded for the majority of the time.

22. Note that I have focussed on invertebrate monitoring data and QMCI scores to quantify stream health because:

- It is generally accepted that invertebrates are good monitors of stream health, as they are sensitive to changes in both water quality and habitat condition (e.g., Boothroyd & Stark 2000);
- The QMCI is the biological index of choice for ECan, who have stated that the QMCI is the *"most appropriate single index for setting numeric objectives for stream health."* (Hayward et al. 2009); and
- There is a general lack of quantitative fish monitoring data available.

23. I will draw on another example regarding nitrate toxicity, as I believe it is an area that needs to be looked at with some scrutiny. The second example is from the Hinds-Ashburton area, where irrigation and intensive agriculture has occurred over several decades and is associated with very high nitrate

concentrations in lowland spring-fed streams (including “drains”). I have used data from this particular area as it has the most extensive set of paired water quality and biological monitoring data I am aware of for lowland spring-fed streams in Canterbury (by paired, I mean water quality and biological monitoring data taken from the same sites).

24. Of the 27 Hinds-Ashburton stream sites sampled over two years by Meredith et al. (2006), all sites had median dissolved inorganic nitrogen (DIN)[1] concentrations exceeding 3 g/m³, with a median amongst the sites of 5.65 g/m³. This is considerably higher than the median and 80th percentile DIN concentrations of 1.5 and 3.8 g/m³ of DIN for lowland spring-fed streams in Canterbury (Hayward et al. 2009).

25. Of the 22 Hinds-Ashburton stream sites with invertebrate and water quality monitoring data, the average QMCI score was 5.08, with a range of 3.5 to 7.0 (Meredith et al. 2006). This is significantly higher than the average QMCI score of 4.5 from 58 lowland spring-fed streams in Canterbury (Hayward et al. 2009). I have reproduced Figure 2.2 from Hayward et al. (2009), showing the average QMCI score from the Hinds-Ashburton streams compared with the average for spring-fed lowland streams; the fact that the Hinds-Ashburton average is well above the 95% confidence intervals on the spring-fed plains data indicates that QMCI scores for the Hinds-Ashburton streams are significantly higher than average for Canterbury spring-fed lowland streams.

26. Again, my point here is that while median nitrate concentrations in all of the Hinds-Ashburton streams exceed the revised nitrate toxicity guideline, macroinvertebrate community health remains high overall; in fact higher than average for similar stream types in Canterbury. Thus, streams such as those in the Hinds-Ashburton area can have very high nitrate concentrations, well in excess of nitrate toxicity guidelines, but can also have high invertebrate community health relative to other similar stream types.

27. Based on the examples I have given above, it remains my opinion that the CPW scheme presents a low risk of causing nitrate toxicity in lowland streams.

Phosphorus

28. Mr Norton has indicated that he has concerns regarding the effect of the CPW scheme on phosphorus concentrations and that nutrient management techniques should address both nitrogen and phosphorus (pers Comm.). I agree with Mr Norton that CPW farmers should manage both nitrogen and phosphorus on their farms. Mitigation measures for control of phosphorus loss to surface waters were outlined in paragraphs 171 to 173 of Mr Kennedy's main brief of evidence, which included the statement that, *"Given the low land gradient and relatively low rainfall within the CPW irrigation area, surface water contamination by surface runoff will be relatively easy to mitigate."*

29. I agree with Mr Norton that mitigation measures will never be 100% effective. However, I also stand by my assertion that there is a greater ability to minimise agricultural impacts on low gradient land, such as that in the proposed CPW scheme area, than on steeper hill country. It is my opinion that there is also a greater chance of effects being minimised when farmers are part of a collective sustainability agreement, such as the Sustainability Protocol and farm plans proposed by CPW.

30. I understand that Mr Norton is also concerned that phosphorus may migrate from the CPW scheme area into groundwater and thence into lowland streams, and that this effect has been inadequately assessed to date. This is a considerable departure from the expert opinion of the soil scientist acting for CPW, Dr Glynn Francis, who has stated that the risk of phosphorus leaching to groundwater is low (paragraphs 22 to 24 of his main brief of evidence). It also differs from the opinion of ECan's groundwater quality expert, Mr Carl Hanson, who concluded that, *"The CPW scheme is unlikely to have significant adverse effects on phosphorus, pesticides, or pathogenic micro-organisms in the groundwater beneath the Central Plains."* (paragraph 14 of his evidence in chief). As such, I will reserve further comment on this matter until Mr Norton's final report is available and the relevant soil and groundwater experts have provided their response on the matter.

[1] DIN is comprised of nitrate-, nitrite- and ammonia-nitrogen. Nitrate-nitrogen comprised the majority of DIN at all sites sampled, with most nitrite-N concentrations <0.1 g/m³ and most ammonia-N concentrations <0.05 g/m³.

CONCLUDING COMMENTS

31. In summary, I agree with Ms Hayward and Mr Norton that landuse intensification and increased nutrient concentrations associated with the CPW scheme (original and revised) present a risk of increased macrophyte cover and greater periphyton biomass, with flow-on adverse effects for invertebrates and fish. However, I consider this risk to be low, and that it will be compensated by increased habitat availability for aquatic species, due to increased stream flows. Similarly, I also acknowledge that there is some risk of nitrate toxicity in lowland streams. However, the fact that existing high levels of nitrate (exceeding revised nitrate toxicity levels) in streams such as the lower Selwyn River have not resulted in loss of stream condition (as measured by QMCI scores), also suggests that the risk of adverse effects from nitrate toxicity is low. My point is that while there may be an incremental increase in nutrient concentrations, it is my opinion that the existing environment is not very sensitive to an increase in nutrient concentrations.

32. I also acknowledge, however, that given the already high nutrient concentrations in most of the Te Waihora tributaries, even a relatively small incremental increase in nutrients is considered unacceptable to stakeholders such as Fish and Game, the Department of Conservation and Ngai Tahu (as indicated in various pieces of technical evidence presented for these groups).

33. A management challenge for these lowland streams is evaluating whether the positive effects of increased flows and improved usable habitat offset the potential negative effects associated with increased nutrient concentrations. In my opinion, the data and reports I have reviewed in this brief of evidence and in earlier supplementary briefs indicate that increased stream flows will significantly increase the total area of aquatic habitat available for aquatic species in lowland tributaries of Te Waihora.

34. As I have already indicated in this supplementary evidence, the data concerning effects on surface water quality is less definitive. Mr Tipler's September 2009 supplementary evidence suggests that groundwater nitrate concentrations will increase in the order of 0.5 g/m^3 throughout the scheme area. However, Mr Tipler also states in paragraph 83 of his supplementary evidence that he does not anticipate adverse effects on lowland streams and Te Waihora because of water chemistry data indicating that the most likely

source of water in the lowland streams is associated with local drainage and not from the CPW scheme area.

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GP Burrell, September 2009

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Figures

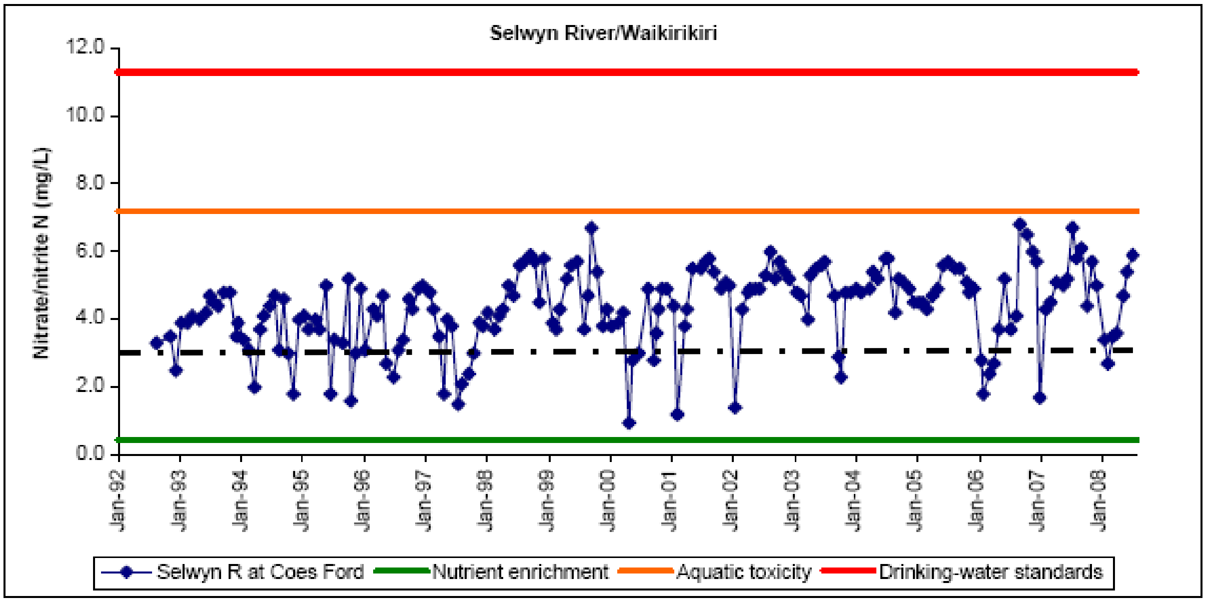

Figure 1: Nitrate/nitrite concentrations in the Selwyn River (reproduced from Ms Hayward's supplementary evidence). The thick dashed horizontal line indicates the revised nitrate toxicity level.

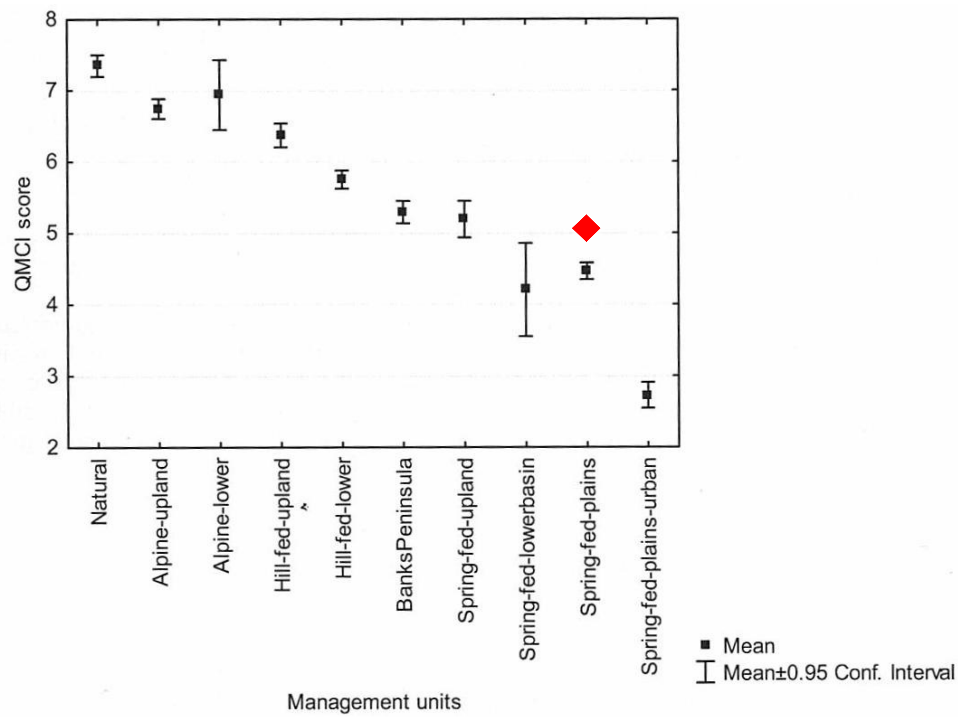

Figure 2: **Mean and 95% confidence intervals of QMCI scores for all sites sampled as part of ECan's Ecosystem Health monitoring programme since 1999 (reproduced from Hayward et al. 2009). I have added the red diamond, which indicates the mean QMCI score from 22 streams in the Ashburton-Hinds area, based on data from Meredith et al. (2006).**