Before the Commissioners appointed by Canterbury Regional Council

IN THE MATTER OF	The Resource Management Act 1991
AND	
IN THE MATTER OF	60 water permit applications to take and use water, 30 land use consent applications and 20 discharge permit applications, for agricultural and horticultural activities

Section 42A Officer's Report

Date of Hearing: 21 September 2009

Report of CARL ROBERT HANSON

INTRODUCTION

Background

1. This report forms part of Environment Canterbury's audit of the assessment of environmental effects (AEE) provided by the applicants in support of resource consent applications to take and use water in the upper Waitaki catchment for agricultural and horticultural activities.

2. This report will provide the decision-maker with information and advice related to the actual and potential cumulative effects of the proposed activities on groundwater quality.

Qualifications

3. My full name is Carl Robert Hanson. I am employed by the Canterbury Regional Council as a Groundwater Quality Scientist, a position I have held since June 2001. Prior to that I was employed as a consulting groundwater scientist in Dunedin and in the USA. I hold 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.

4. I have worked as a groundwater scientist since 1990, specialising in the fate and transport of contaminants in soil and groundwater. My 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.

5. In previous jobs, I was involved in a number of field trials and other investigations into the environmental fate and transport of pesticides and other agricultural chemicals in soils and groundwater. I was also involved with investigations of soil and groundwater contamination on numerous industrial sites in the United States and New Zealand, ranging from small scale industries to large-scale "Superfund" sites in the US.

Scope of Report

6. This report is prepared under the provisions of section 42A of the Resource Management Act 1991 (RMA). This section allows a Council officer or Council-appointed consultant to provide a report to the decision-makers on a resource consent application made to the Council, and allows the decision-makers to consider the report at the hearing. Section 41(4) of the RMA allows the decision-makers to request and receive from any person who makes a report under section 42A "any information or advice that is relevant and reasonably necessary to determine the application".

7. This report forms part of a suite of section 42A reports prepared by Environment Canterbury for the above consent applications. All reports should be read together to gain a complete understanding of the audit of the resource consent applications. Full details of the consent applications are provided in Report 1.

8. This report is an audit of information provided to Environment Canterbury by Mackenzie Water Research Limited (MWRL). The information was provided in a set of reports, including a "Summary Report" and a series of technical background reports, which together comprise an assessment of cumulative water quality effects from the proposed irrigation. I will refer to this set of reports as the "Cumulative Effects Assessment" or "the assessment".

9. My audit addresses information contained in the Summary Report and some of the technical background reports. The issues I will cover include:

   (i) assessment methodology - nitrate loading to groundwater

   (ii) assessment methodology - nitrate concentrations in groundwater

   (iii) existing nitrate-N concentrations in groundwater

   (iv) lack of information to support assessment conclusions

   (v) phosphorus in groundwater

   (vi) microbiological contaminants in groundwater

   (vii) monitoring

   (viii) mitigation

10. The full reference for the Summary Report (GHD 2009a) is as follows:

    GHD 2009a. Cumulative Water Quality Effects of Nutrients from Agricultural Intensification in the Upper Waitaki Catchment. Summary Report & Appendices. August 2009.

11. My audit also addresses information in some of the technical background report, in particular, the "Groundwater Report" (GHD 2009b):

> GHD 2009b. Cumulative Water Quality Effects of Nutrients from Agricultural Intensification in the Upper Waitaki Catchment. Groundwater Report. Draft and Confidential. May 2009.

12. I note that the Groundwater Report has been updated and finalised, and I received a copy of that final report on Monday 24 August 2009, but I was not able to include it in this audit. I apologise if some of the questions or concerns that I raise in this audit are addressed in that later version.

13. Other technical background reports that my audit refers to include the following:

> AgResearch 2008a Upper Waitaki Farm Systems and Nutrient Assessment: Stage 2 [sic] Pasture growth literature review. May 2008.
>
> AgResearch 2008b Upper Waitaki Farm Systems and Nutrient Assessment: Stage 2 Pasture and ryecorn growth modelling. May 2008.
>
> AgResearch 2008c Upper Waitaki Farm Systems and Nutrient Assessment: Stage 3 Base case nutrient assessments. August 2008.
>
> AgResearch 2009 Upper Waitaki Farm Systems and Nutrient Assessment: Stage 4 Irrigated nutrient assessments. July 2009.
>
> Aqualinc 2008 Irrigation and drainage modelling of the Upper Waitaki Basin. August 2008.

AUDIT REPORT

Summary of Cumulative Effects Assessment

14. The Cumulative Effects Assessment predicts the effects of irrigating an additional 26,255 hectares of agricultural land in the Upper Waitaki Basin. According to the Summary Report (Table 14, page 45), 8,850 hectares of land within the basin are currently irrigated, so the additional irrigation would bring the total irrigated area to 35,105 hectares.

15. The assessment concludes (Summary Report, Section 10, page 83) that with appropriate mitigation measures, the combined total of 35,105 hectares of irrigation and associated farming operations "can proceed in a manner that will not induce significant adverse ecological or water quality effects".

Summary of audit conclusions regarding groundwater quality

16. In my opinion, the Cumulative Effects Assessment has not demonstrated that the additional irrigation can proceed without significant adverse effects. The assessment methodology does not account for all of the potential adverse effects, and the assessment has not provided sufficient detail or raw data to allow an audit of the conclusions.

Summary of assessment methodology - nitrate

17. With respect to groundwater quality, the assessment focuses on nitrate. The objectives of the assessment are to predict nitrogen loadings to groundwater and surface water, and to predict nitrate concentrations in groundwater.

18. The assessment makes these predictions on a sub-catchment basis. It defines ten groundwater sub-catchments within the Upper Waitaki Basin. Groundwater recharge and nutrient loadings are calculated for each sub-catchment, and discharges to surface water are calculated from these inputs. Where possible, calculated values are compared to measured values to check the accuracy of the predictions. For example, the MODFLOW groundwater model is calibrated against measured groundwater levels, and predicted groundwater nitrate nitrogen (nitrate-N) concentrations are compared with measured concentrations in groundwater samples.

19. In the model, discharges take place at nodes, or point locations, generally at the down-gradient end of the sub-catchment. This is where, in the model, the groundwater flow and the nitrate-N loadings are added to the surface water bodies. In a few cases, discharges are calculated for stream reaches within sub-catchments as well as at the node at the down-gradient end of the sub-catchment.

20. Nitrate-N concentrations in groundwater are calculated from the nitrogen loading and groundwater recharge. The assessment of soil nitrogen leaching losses is audited by Dr Brent Clothier in section 42A report 4b. All nitrogen that leaches from the soil into groundwater is assumed by the assessment to be in the form of nitrate-N.

21. The values derived by the assessment methodology are steady-state, long-term averages. They do not account for seasonal variations or long-term changes, nor do they account for spatial variability within sub-catchments.

22. Nitrate-N concentrations in groundwater are compared to two thresholds. The first is an "indicative guideline" of 1 mg/L, chosen to characterise water quality under extensive dryland farming (Summary Report, section 6.3). The second is the New Zealand drinking-water standard of 11.3 mg/L (Ministry of Health, 2008).

Comments on assessment methodology - nitrate loading

23. One of the objectives of the assessment was to predict nitrate-N loadings to surface water. It does this by calculating average values at the scale of a sub-catchment. In my opinion, this is a reasonable method of making these predictions.

24. The average values calculated for each sub-catchment are probably acceptable for predicting nitrate-N loadings to surface water. It is true that nitrate-N loadings to *groundwater* within the catchment will not be uniform. They will vary from one location to another, and they will vary over time. However, discharge of groundwater to surface water will occur over a relatively small area at the down-gradient end of the catchment. By the time groundwater from various parts of the sub-catchment reach this discharge location, there will have been sufficient mixing and dispersion to smooth out spatial and temporal variations in nitrate-N concentrations. As a result, the nitrate-N loading rate in the discharge area will be relatively uniform over time, and it will generally equal the long-term average loading rate.

25. In some cases, groundwater discharges to stream reaches within the sub-catchment, but the assessment takes account of this, at least to some degree, by calculating groundwater discharges at these reaches.

26. The shortfall in this methodology is that it does not account for variations in stream flow at the discharge nodes. While groundwater discharge at the node may be relatively constant through the year, surface flows vary considerably. It may be that on average, surface flow rates appear sufficient to dilute nitrate-N loadings to acceptable levels. However, in periods of low flow, when the surface flow is dominated by groundwater discharge, nitrate-N concentrations could be similar to the groundwater concentrations listed in Table 17 of the Summary Report. Many of these concentrations are considerably greater than 1 mg/L, and this could cause unacceptable water quality effects in surface water. The assessment provides no comment on this issue.

Comments on assessment methodology - nitrate-N concentrations in groundwater

27. In terms of groundwater nitrate-N concentrations, sub-catchment averages are not adequate for evaluating the risk that concentrations will exceed the New Zealand drinking-water standard of 11.3 mg/L. Nitrate-N concentrations in groundwater can vary considerably over time and from one location to another. When averaged across a sub-catchment, concentrations may appear low, but this does not rule out the possibility that in some locations within the sub-catchment, in some years, concentrations may exceed acceptable levels.

28. Beneath the Canterbury Plains, the average nitrate-N concentration in shallow groundwater (groundwater recharged primarily by land surface drainage rather than by losses from rivers) is on the order of 5 to 6 mg/L (Environment Canterbury unpublished data). This concentration is considerably lower than the drinking-water standard. However, there are many locations across the Plains where average concentrations are higher than this, and in some locations average concentrations do exceed 11.3 mg/L.

29. Moreover, seasonal peak concentrations greater than 11.3 mg/L are common in shallow groundwater across most of the Plains, particularly after wet winters (Hanson, 2002; Hanson and Abraham, 2009; Environment Canterbury unpublished data). In the latest of Environment Canterbury's annual, region-wide groundwater quality surveys, conducted in the spring of 2008, the samples from 35 of the 302 wells surveyed had nitrate-N concentrations greater than 11.3 mg/L (Abraham and Hanson, 2009). These peak concentrations may only persist for a few months at a time, but since the drinking-water standard is based on the health risk from short-term exposure (Ministry of Health, 2008), these short-term exceedences are important.

30. Nitrate-N concentrations observed in groundwater in the Upper Waitaki Basin (see discussion below) have been much lower than the concentrations observed beneath the Canterbury Plains, and it is unlikely that current concentrations anywhere in the basin approach the drinking-water standard at any time of year. However, Table 17 on page 52 of the Summary Report lists predicted long-term average concentrations up to 8.7 mg/L (for the Willow Burn sub-catchment under Scenario 4). If such average concentrations did develop, then it is likely that concentrations at some locations within that sub-catchment would exceed the drinking-water standard on some occasions. Such exceedences would be most likely down-gradient of large

irrigated areas, such as those proposed in the Willow Burn, Wairepo, Ahuriri, and Pukaki sub-catchments. Furthermore, the section 42A report by Dr Clothier (report 4b) indicates that the nitrogen loading estimates in the assessment could significantly under-estimate the potential loadings. If that is the case, the nitrate-N concentrations in groundwater could be significantly higher than the assessment predicts.

Existing nitrate-N concentrations in groundwater

31. The Summary Report (section 4.4.2, page 23) reports that water quality information was available for 119 wells in the Upper Waitaki Basin, and it shows a map of the locations of these wells in Appendix DD. However, no details are provided regarding who collected these samples or how or when they were collected. Appendix A of the Summary Report (under the section labelled *Groundwater – Data Collection*) says that a "data collection survey" was completed "over a couple of days in early 2008", and that the survey involved sampling bores for water chemistry. It is not clear whether any of the data from the 119 wells mentioned in the Summary Report came from this survey.

32. The Summary Report states that nitrate-N concentrations were less than 1 mg/L in 98% of the 119 wells sampled. Without more details about how the samples were collected, the data from them must be treated with caution, but the findings are consistent with Environment Canterbury data. Environment Canterbury staff have collected samples from 35 wells in the Upper Waitaki Basin, and the nitrate-N concentrations exceeded 1 mg/L in samples from only two of those wells. The highest concentration recorded was 1.3 mg/L. The distribution of the wells sampled is by no means uniform across the basin, and it is possible that higher concentrations exist in groundwater in some locations that have not yet been sampled, but in my opinion, concentrations much greater than 1 mg/L are likely to be rare and localised.

33. I accept the assessment's use of 1 mg/L as a threshold value for existing groundwater concentrations under extensive dryland farming (Summary Report, section 4.4.3, page 23). It is possible that actual concentrations are even lower than 1 mg/L in many locations, but there are not enough data available to set a more precise threshold value.

Lack of information to support assessment conclusions

34. Leaving aside the shortcomings in its methodology, the assessment does not provide enough information to support its conclusions. The conclusions presented cannot be traced back to the raw data. Calculations are described only in general terms, and it is not possible to evaluate the details of the methods used to calculate groundwater flow rates, nutrient loadings to groundwater, or the effects of the denitrification multipliers used. Without such supporting information, it is impossible for me to audit the assessment and agree with its conclusions. Therefore, it is my opinion that the assessment has not demonstrated that the additional irrigation can proceed without inducing "significant adverse ecological or water quality effects".

35. The following paragraphs list pieces of information which, in my opinion, are critical to the derivation of the assessment's conclusion, but which I have not found in the Summary Report or any of the associated technical background reports. In my

opinion, the conclusions of the assessment cannot be justified without this information.

36. ***the area of each land use in each sub-catchment*** – The total nitrate-N loading to groundwater in each sub-catchment (shown in Table 7 on page 24 of the Summary Report) must have been calculated by identifying the land uses within the sub-catchment, determining the area of land covered by each land use, and multiplying the area by the nitrate-N loss rate for that land use. A general map of land uses across the entire Upper Waitaki Catchment is included in Appendix I to the Summary Report, but I cannot find a breakdown of these land use areas by sub-catchment in any of the assessment reports.

37. ***details of how the AgResearch model results were incorporated into the calculations of sub-catchment nitrate-N loading*** – Following on from the previous paragraph, nitrate-N loss rates for different land uses are listed in Appendix F of the Summary Report, but it is not clear where the AgResearch (2008a-c; 2009) modelling results fit into this list, or just what is actually done with those modelling results. In the Stage 4 report (AgResearch 2009), Table 1 lists nitrogen loss rates for 29 farm types, but these farm types are not shown on the land use map in Appendix I. It is not at all clear how these values were used in the calculations of sub-catchment nutrient losses.

38. ***for each sub-catchment, the areas of all combinations of irrigation, rainfall, and soil pore-available water (PAW) for which Aqualinc (2008) modelled soil drainage rates*** – Aqualinc (2008) calculated soil drainage rates for different combinations of irrigation, rainfall, and soil pore-available water (PAW). These values are shown in Tables 3 and 4 of the Aqualinc (2008) report, and they are reproduced in Tables 4 and 5 of the Groundwater Report (though the bottom half of Table 5 has used the wrong values from the Aqualinc report). In order to convert these values to groundwater recharge rates on a sub-catchment basis, there must be a table showing the land area of each irrigation/rainfall/PAW combination in each catchment. I cannot find this information. The soil infiltration rates in the Aqualinc report appear to be generally reasonable to me, but I cannot confirm that the sub-catchment recharge rates were calculated correctly, and I cannot assess the sensitivity of the assessment results to changes in the modelled drainage values.

39. ***river losses to groundwater for each sub-catchment, and details of how these values were incorporated into calculations of groundwater flow rates*** – The Groundwater Report shows maps of stream gain and loss zones in Figures 7 and 8, and the report text (Section 7.1.3) discusses recharge from stream leakage in general terms. However, it is not clear how these gains and losses are incorporated into the groundwater budgets for each sub-catchment. The stream gain and loss zones are not explicitly assigned to different sub-catchments, and there are no tables that explicitly account for inputs to groundwater from surface water. The mass balance flow charts in Appendix CC of the Summary Report provide groundwater discharge rates for some stream reaches, but the details of just where these reaches are, and how these discharges are manifested, are not at all clear. In addition, the Groundwater report (Section 6.1.3) states that the ZONE BUDGET module of MODFLOW was used to simulate discharge volumes into or out of sub-catchments, but again, it is not at all clear how this was done. It is impossible to confirm the groundwater budget calculations without explicit detail of the inputs and outputs to the budget.

40. ***the areas that contribute highland recharge to each sub-catchment*** – I found the discussion of highland recharge (Groundwater Report, Section 7.1.10) very

confusing. It appears from the report text that 30% of the rainfall in the highlands up-gradient of each groundwater sub-catchment was added to the groundwater budget, but I cannot find the areas used to calculate these recharge volumes to be listed or mapped in any of the assessment reports. In addition, it appears that 20% of the highland recharge is apportioned to deep, regional groundwater flow, but I cannot find an explicit accounting of what happens to this regional flow.

41. ***regional flow*** – I was also confused by the discussion of deep, regional groundwater flow. It is not clear to me where this regional flow comes from, where it goes, or how it is involved in groundwater nitrate concentrations and discharges to surface water. Section 5.2 of the Groundwater Report mentions "advective mixing of local and regional flow", and Section 5.2.2 states that nitrate-N leached from the soil is apportioned between "local base flow" and "regional groundwater". It appears that regional groundwater bypasses discharge nodes and flows directly into Lake Benmore. For most catchments – in fact, any catchments that do not border Lake Benmore directly – I find it difficult to believe that there is a significant component of groundwater flow that discharges directly to the lake. However, without a clear description of how the regional flow works, and without an explicit accounting of the inputs to and outputs from regional flow for each sub-catchment, I cannot evaluate the significance of this issue.

42. ***A full accounting of the water budgets for each sub-catchment*** – The preceding paragraphs list separate aspects of a common issue. There is no explicit accounting of the water budget for each sub-catchment. I could not find anywhere in the reports a full accounting that lists, for each sub-catchment, all of the groundwater inputs and all of the groundwater discharges, and that clearly explains how each of those values was derived. Without this accounting, I cannot assess the calculations made or verify the assessment's conclusions.

43. ***details of the calculations of nitrate attenuation at river margins*** – Section 4.3.1 of the Summary Report discusses denitrification, and it says that an "attenuation multiplier" was used to simulate the effects of denitrification where groundwater discharges to surface water. The report includes a map (Figure 7) showing areas of expected denitrification, primarily along stream margins. However, the details of these calculations are not explicit. In addition, I have concerns about extrapolating information on surface soils to subsurface saturated groundwater processes. In my opinion, there will be very little denitrification along most of the stream reaches shown in Figure 7. The groundwater discharging through these stream margins will be well oxygenated, and flow rates are likely to be high, so there will be little opportunity for denitrification to occur. However, without explicit details of the denitrification calculations, I cannot assess how much difference the attenuation factors make to the assessment's conclusions.

Phosphorus

44. Phosphorus in groundwater is virtually ignored by the Cumulative Effects Assessment. I agree that there are no drinking-water standards or other guideline values for phosphorus in groundwater, so the groundwater phosphorus concentrations themselves are probably not important in themselves. However, it is not clear whether groundwater provides a pathway for phosphorus to enter surface water. The assessment appears to assume that groundwater discharges are not a source of phosphorus in surface water. The reports (for example, the Summary Report, Section 4.3) discuss phosphorus losses from farms, but it is not clear how the phosphorus is lost or what happens to it.

45. Appendix B of the Summary Report states that "*the main mechanism for P loss in the catchment was assumed to be overland or shallow interflow in the hydrologically connected areas*". This is a common assumption about phosphorus transport, and in my opinion, a reasonable one for the Upper Waitaki Basin. Phosphorus tends to adsorb to soil particles rather than move with soil water and groundwater, especially in well drained, well aerated soils like those that dominate the Upper Waitaki Basin. However, there is a conflict here between the transport mechanisms for nitrogen and phosphorus, and the assessment does not resolve this conflict, but rather seems to sidestep it. The assessment assumes that nitrogen reaches surface water via soil drainage and groundwater flow. In fact, according to Appendix B of the Summary Report, "*all excess soil moisture* [in the soil moisture modelling] *is assumed to drain through to the underlying substrata*", and "*surface runoff and lateral water movement are not determined*". Again, these are reasonable assumptions, because the soils are well drained and nearly level, so I would expect surface runoff to be minimal. But the assessment does not make clear where overland flow and phosphorus transport are dominant, and where soil drainage and nitrate transport are dominant.

46. Adding to the confusion about phosphorus transport mechanisms, Appendices B and C of the Summary Report acknowledge that relatively high concentrations of phosphorus were found in some groundwater samples, suggesting that some of the phosphorus loss may be via groundwater. However, the assessment does not follow up on this issue. At any rate, the calculations of phosphorus loading to surface water are not clear. [I note also that Appendix C lists analytical results for both dissolved reactive phosphorus and total phosphorus in groundwater samples, but there is no discussion of the differences between these two parameters; in reality, they are not interchangeable.]

47. Regarding measured phosphorus concentrations in groundwater in the Upper Waitaki Basin, I agree with the assessment that some relatively high concentrations have been measured. Environment Canterbury has tested dissolved reactive phosphorus in groundwater samples from 30 wells in the basin between 2007 and 2009 (Hanson, Abraham and Evans, 2008; Abraham and Hanson, 2008). Concentrations in samples from 29 of these wells ranged from 0.002 mg/L to 0.032 mg/L, and the 30^{th} well had a concentration of 0.18 mg/L. In total, samples from eight wells had concentrations higher than 0.010 mg/L.

48. Section 4.5.2 of the Summary Report contains the following statement: "*The original assumption that all phosphorus lost from the land will be captured in the downstream sub-catchment node has led to an over estimation of the expected concentrations of phosphorus in the streams compared to observed concentrations*." It is not clear to me where the "original assumption" was made, or indeed what this statement means at all, and I do not know whether groundwater is involved in this process.

49. In summary, I found the discussion of phosphorus transport mechanisms to be very sketchy and difficult to follow, and I cannot audit the assessment's conclusions about phosphorus.

Microbiological contaminants

50. Microbiological contaminants (bacteria and viruses) were not included in the Cumulative Effects Assessment. In my opinion, this is reasonable. Bacteria and viruses only survive in groundwater for periods of a few days to a few months, so

they cannot accumulate. However, they may be an issue for some individual proposed irrigation areas or group of adjacent proposed irrigation areas, particularly where a community water supply well or drinking-water supply well is located immediately down-gradient of a proposed irrigation area.

Monitoring

51. Section 7.1.2 of the Summary Report, including a map in figure 16 on page 68 of that report, proposes 39 locations for wells to be monitored. These include 28 existing wells and 11 new wells that would be installed, presumably, specifically for groundwater quality monitoring.

52. In my opinion, this number of monitoring points would not nearly be sufficient to monitor the effects of the proposed development. I have not yet considered the degree of monitoring that would be required, but I point out that the Upper Waitaki Basin has very complex geology and hydrogeology which is only very poorly understood. Over 100 wells may be required to monitor the full effects of the irrigation, and the locations of these wells would need to be considered carefully, with wells both up-gradient and down-gradient of irrigated areas, an additional wells in areas distant from any irrigation. The Cumulative Effects Assessment provides virtually no justificaton for its proposed monitoring scheme.

Mitigation

53. Section 5.3 of the Summary Report identifies three groundwater catchments where on-farm nutrient mitigation will be required to avoid adverse water quality and/or ecological effects. These are the Ohau River and Pukaki sub-catchments, where groundwater nitrate-N concentrations are predicted to rise from below 1 mg/L to above 1 mg/L, and the Wairepo Creek sub-catchment, where increases in nitrate-N concentrations could cause adverse effects in the down-gradient surface water bodies of Kellands Pond and the Wairepo Arm of Lake Ruataniwha.

54. Section 8 of the Summary report discusses a variety of mitigation measures that could be put in place. To my knowledge, no specific site nutrient mitigation proposals have yet been provided by any of the applicants involved in this hearing, so I am uncertain of the legal standing of the mitigation suggestions in the Summary Report.

55. Regardless of the legal status of the suggested mitigation, it is my opinion that the assessment has not demonstrated that the outlined mitigation approach would indeed be effective. The assessment has not attached numbers to any of the suggested mitigation measures to quantify the reduction in nitrate leaching loss that the measures would accomplish. 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.

56. Moreover, it is my understanding from conversations with and training courses from developers of OVERSEER, the model used by AgResearch (2008b, 2008c, 2009) to predict nitrogen losses from farms, that OVERSEER assumes that farms are already following best management practices with regard to nutrient management. I am therefore sceptical that the mitigation measures suggested in the Summary Report will achieve substantial further reductions in on-farm nutrient losses. At any rate, it is my opinion that the efficacy of the proposed mitigation measures must be

demonstrated in a far more detailed and quantitative manner than what is presented in the assessment reports.

CONCLUSIONS

57. In summary, the Cumulative Effects Assessment provided by MWRL has not demonstrated that the additional irrigation can proceed without causing “significant adverse ecological or water quality effects”, as concluded by the Summary Report. The assessment methodology does not allow for assessment of potential effects on surface water quality at times of low flow, and the associated reports do not provide sufficient detail to allow confirmation of the assessment's conclusions.

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