Before the Commissioners appointed by
Canterbury Regional Council

IN THE MATTER OF	The Resource ManagementAct 1991
AND	
IN THE MATTER OF	Applications by the Central Plains Water Trust and Central Plains Water Ltd. To Take and Use Water for Irrigation in the Central Plains area.

Section 42A Officer' s Report

Date of Hearing: August 2008

Report of VINCENT JOHN BIDWELL

Qualifications and Experience

1. My full name is Vincent John Bidwell. I hold the qualifications of BE (Hons) (civil) and PhD (engineering) from University of Auckland. I am a member of the Institution of Professional Engineers New Zealand, the Royal Society of New Zealand, and the New Zealand Hydrological Society. I am currently employed as a Senior Research Engineer, Environmental Engineering, by Lincoln Ventures Ltd at Lincoln University.

2. I have 37 years experience in research, management, and consulting in hydrology and agricultural engineering. My specialist research, relevant to this evidence, includes time-series analysis of groundwater behaviour in Central Canterbury (1991) and application of the Eigenmodel approach to analysing groundwater resources as a contribution to the Canterbury Strategic Water Study (CSWS, 2002). I am the author of "Groundwater Management Tools: Analytical Procedure and Case Studies" (MAF Technical Paper No: 2003/6), which describes the theory and applications of the Eigenmodel approach to groundwater modelling in New Zealand. I am also an author and co-author of two practical manuals about agricultural land drainage.

3. I acknowledge that I have read the code of conduct for expert witnesses contained in the Environment Court's Practice Note dated 31 March 2005. I have complied with it when preparing my written statement of evidence and I agree to comply with it when I give oral evidence.

Scope of my evidence

4. My evidence will discuss the predictions of increased groundwater levels caused by implementation of the Central Plains Water Enhancement Scheme (CPWES), as provided by the Aqualinc groundwater model.

5. The issue of concern is the area of land likely to be affected by high groundwater levels (groundwater mounding) that cause inundation, reduction in agricultural productivity, and increased expenditure on capital works for drainage and wastewater disposal.

6. The main conclusion of my evidence is that the predictions of groundwater levels from the Aqualinc model are not reliable for the purpose of assessment of these effects.

7. In my opinion, the cause of the poor performance of the Aqualinc model is that the current version used for information to this hearing is insufficiently calibrated. As a result, the model does not simulate the full dynamic response of groundwater levels to recharge events.

   Such evidence is within my expertise.

Concern about groundwater level predictions

8. David Scott (s42A report; para. 25) drew attention to the groundwater level predictions for well L36/0092 (location shown in Figure 1). The nature of these predictions is shown in Figure 2, which is reproduced from page 19 of Julian Weir's evidence. In particular, Mr Scott refers to the under-estimation of groundwater level response during years of higher than average rainfall and he states that under-estimation of the response to the CPWES is also likely.

Evidence of Julian Weir p.18: location of well L36/0092

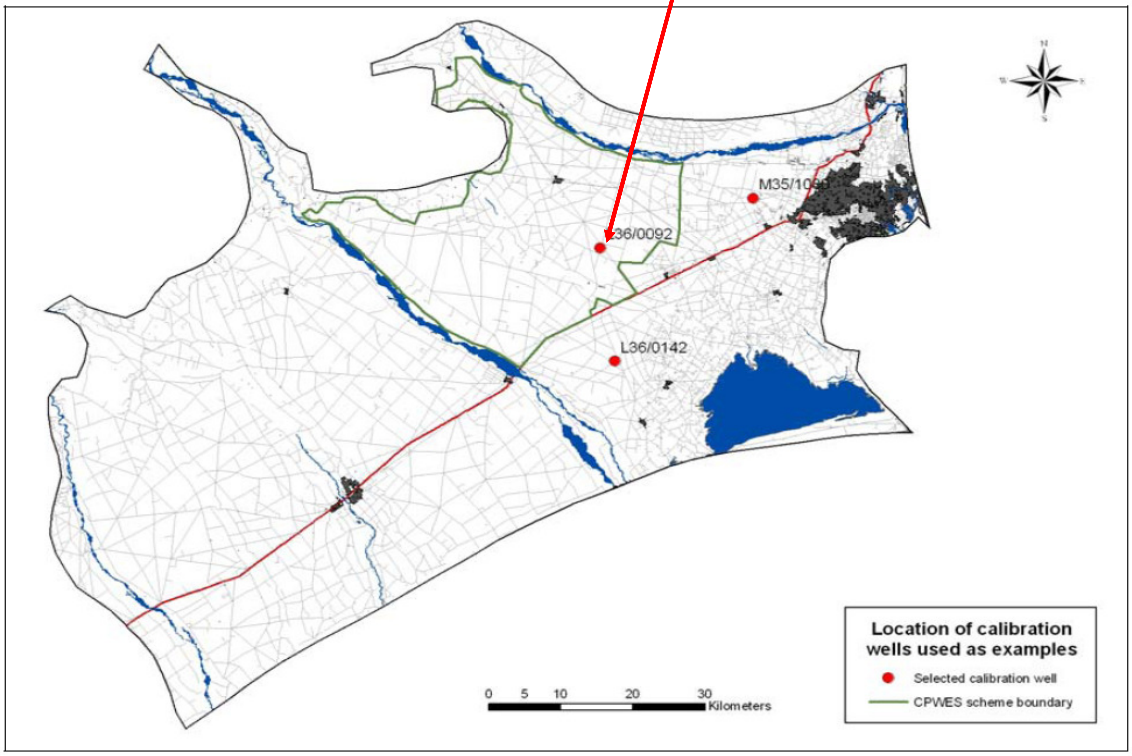

Figure 1

Evidence of Julian Weir p.19: Aqualinc model simulation L36/0092

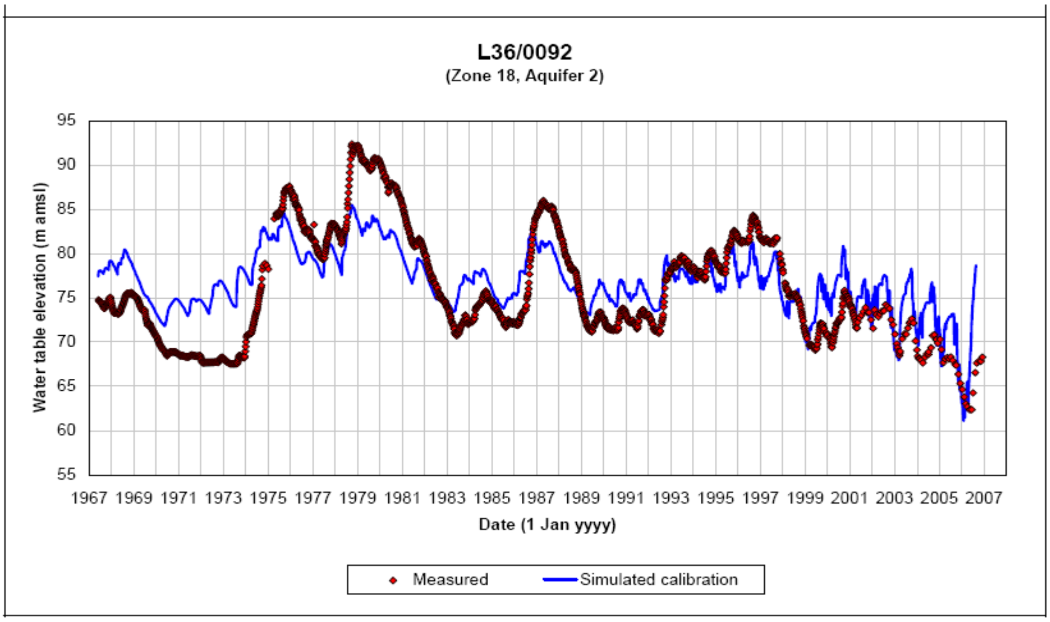

Figure 2

9. Julian Weir responded (Response to s42A officers' reports: para. 20) that this under-estimation was likely to have been a result of unaccounted recharge from the alpine foothills. Mr Weir referred to discussion of model predictions for this well in Bidwell et al. (1991) as support for his statement.

10. I put a question of clarification to Mr Weir at the end of his evidence on 7 March 2008, saying that the discussion section of Bidwell et al. (1991) had been misinterpreted and I asked Mr Weir's opinion about a comparison of the respective modelling predictions.

11. The reason for putting this question was that the model predictions in Bidwell et al. (1991), shown in Figure 3, do represent the full range of groundwater level rise following the high rainfall years of 1977-78. The under-prediction of 1987-89 was ascribed by the authors to recharge from the Selwyn River which had the highest monthly flow on record in August 1986.

Model prediction of groundwater level for well L36/0092
from Bidwell et al. (1991)

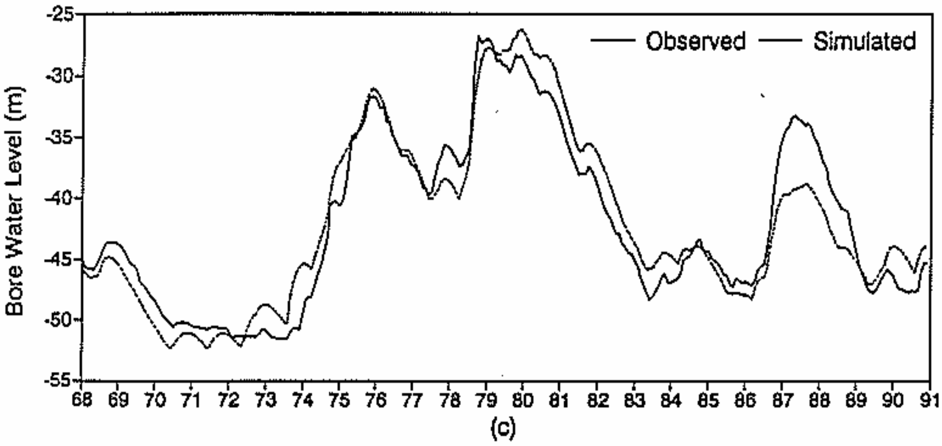

FIG. 4—The (a) water level and recharge series, (b) (1, 1, 2) simulation, and (c) (2, 1, 1) simulation, for monthly data January 1968–December 1990.

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Figure 3

Achievable groundwater level prediction

12. The modelling method demonstrated in Figure 3 has been further developed into what is now called the Eigenmodel approach (MAF, 2003). An Eigenmodel prediction for well L35/0092 is shown in Figure 4, based on land surface recharge data provided by David Scott. Figure 5 shows a comparison between the Aqualinc model and the Eigenmodel.

13. The Eigenmodel results demonstrate a strong dynamic relationship between land surface recharge and time-variation of groundwater level. The Eigenmodel is based on the mathematics of groundwater flow, so this relationship is not just a statistical correlation. The relationship is strongest during the period of high groundwater levels of the late 1970's when natural soil-water drainage dominates any other recharge

source or abstraction effects. This time period is also the critical historical test event for consideration of groundwater mounding.

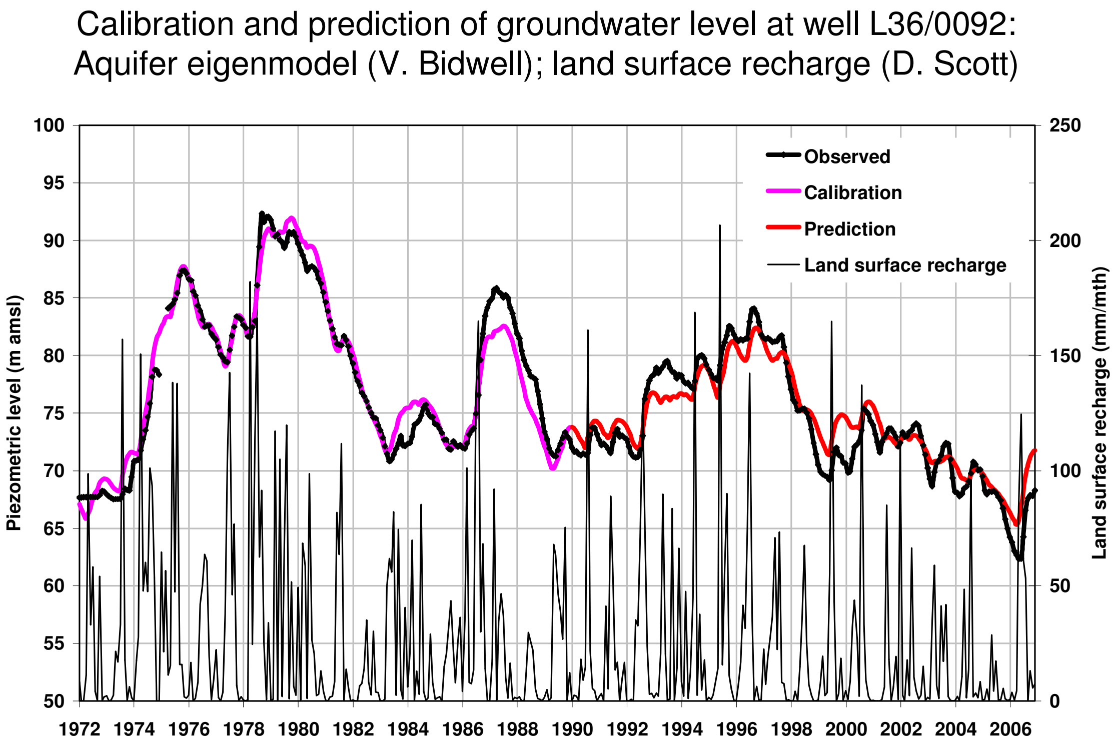

Figure 4

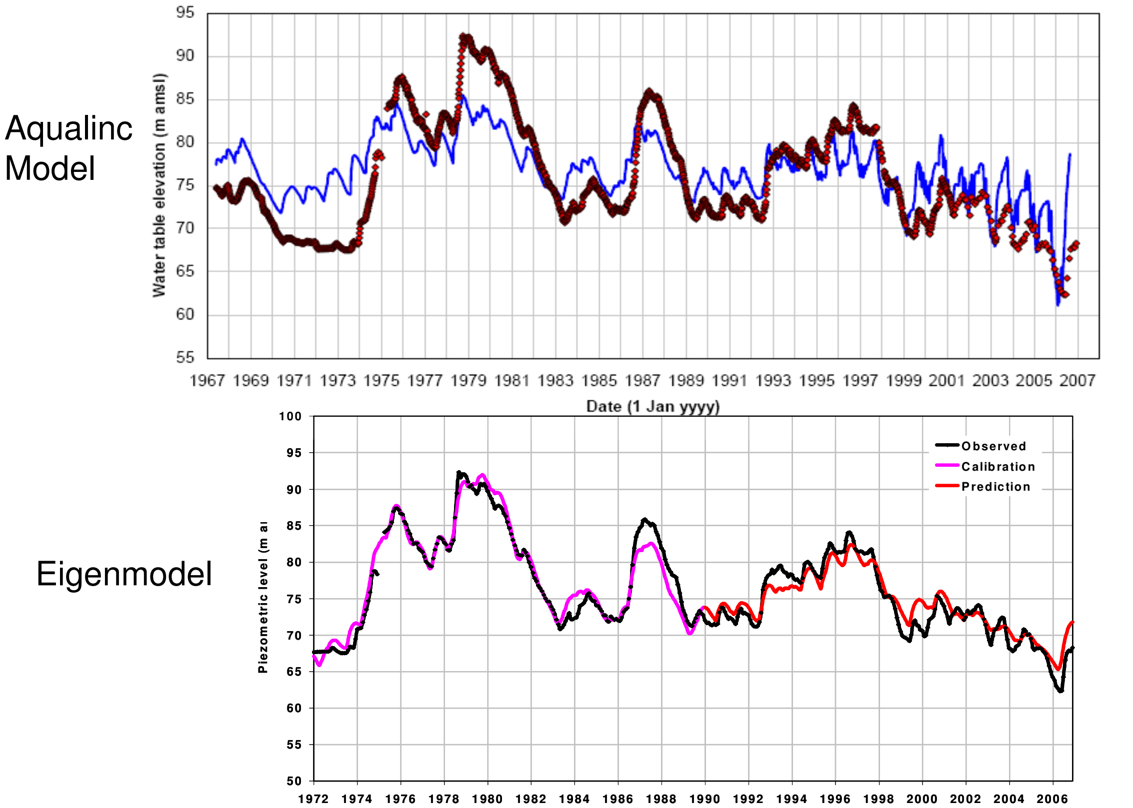

Figure 5

14. The model results shown in Figure 5 indicate that the Aqualinc model, in the form presented as evidence, does not predict the full range of groundwater levels caused by time-variation in land surface recharge. In my opinion, the Aqualinc model is insufficiently calibrated for this purpose.

Occurrence of under-prediction of groundwater levels

15. Soil-water drainage from the proposed CPWES would be a significant increase in land surface recharge on the scheme area. The Aqualinc model under-prediction of groundwater level effects from natural land surface recharge means that the model will also under-predict the groundwater mounding likely to be caused by CPWES.

16. Figure 6 shows the Aqualinc model prediction of groundwater level increase at well L36/0092 due to CPWES. However, this increase is relative to pre-CPWES model

Evidence of Julian Weir, Appendix E, p.103: effects of "Status quo" and CPWES irrigation regimes on groundwater levels for 1967-2006

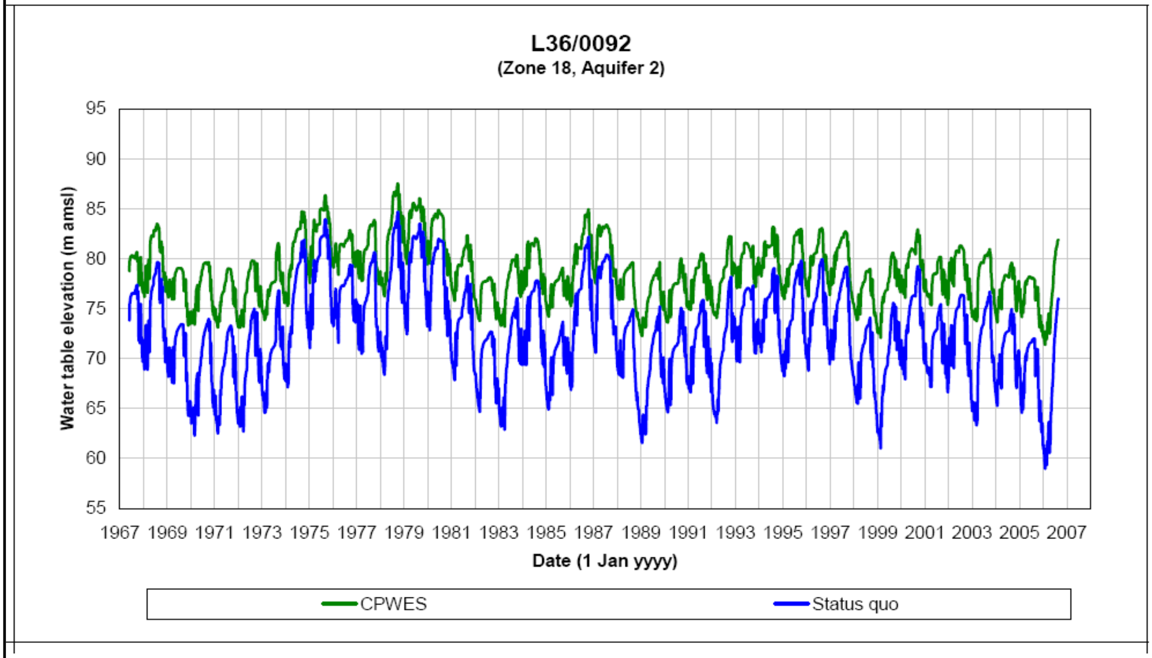

Figure 6

predictions. The observed groundwater levels are not shown.

17. Figure 7 compares the record of observations shown in Figure 2 with the Aqualinc model predictions of post-CPWES groundwater level predictions in Figure 6. It is clear that the predicted level of CPWES groundwater mounding during the 1978 climate scenario is approximately 5 m lower than the historical observed value for that year. Yet it is reasonable to expect that had CPWES been in operation the groundwater levels in 1978 would have been even higher than the historically observed values.

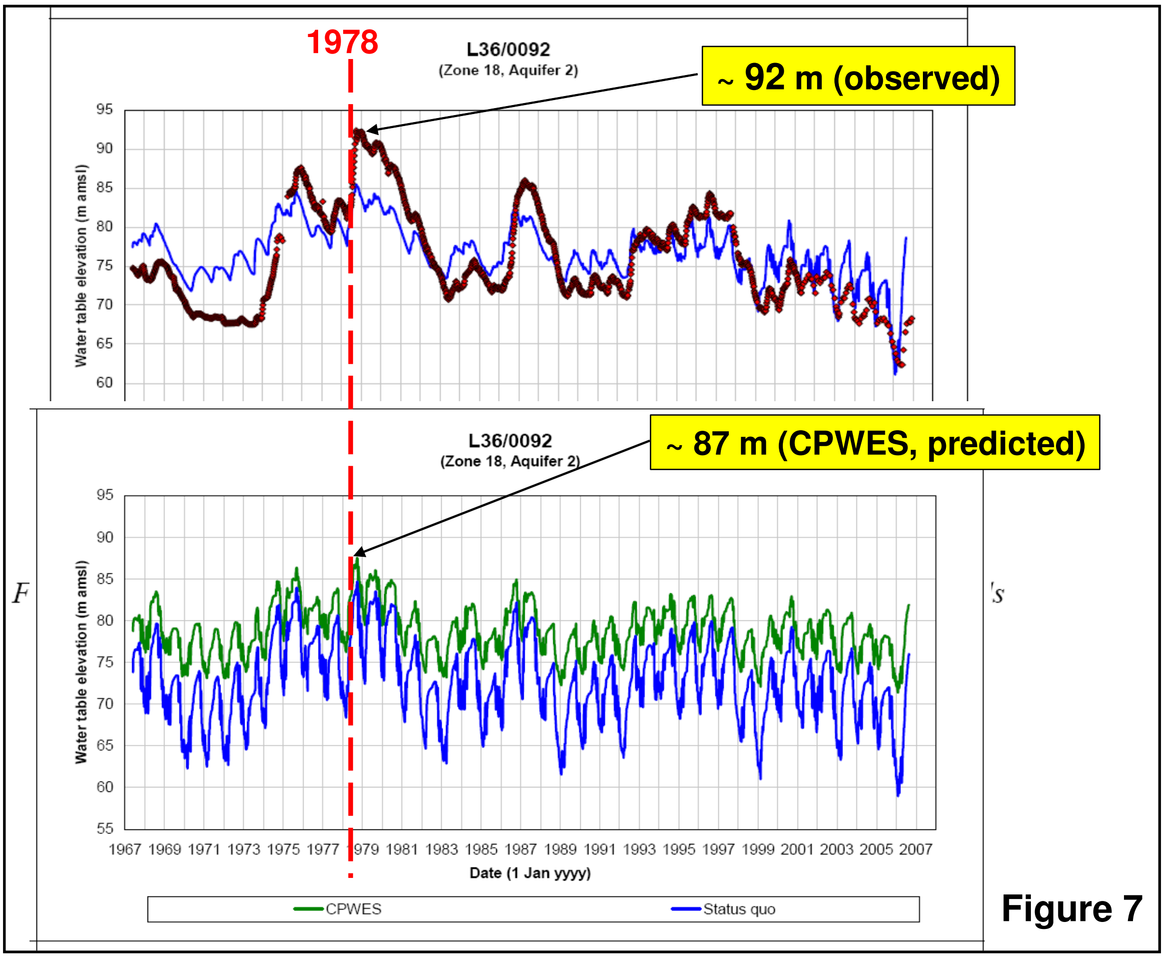

Figure 7

18. The general performance of the Aqualinc model for transient groundwater level prediction has been summarised by Julian Weir in Figure 5 of his evidence (p. 20), in the form of residuals. Residuals are model prediction errors. These results are reproduced as my Figure 8. A dashed line is added to show that approximately 22% of all the residuals are negative by more than two metres. These negative residuals are caused by predictions of groundwater level that are less than the observed values.

19. The magnitudes of these residuals are significantly large in relation to the precision required for assessing groundwater levels in relation to land surface levels for the purpose of drainage works. The corresponding errors for predictions of the effects of CPWES are likely to be even larger because land surface recharge, which is the controlling input, would be larger under the CPWES scenario.

20. The evidence of Mr Weir does not provide the locations to which specific residual values apply, and therefore it is not possible to assess the reliability of groundwater level predictions for any particular area.

Consequences of under-prediction of groundwater levels

21. The "Effects on Groundwater Levels" described in Mr Weir's evidence (para. 136ff) are based on the transient model predictions provided in his Appendix E. These model predictions are not compared with the observation records. For the purpose of predicting absolute groundwater levels caused by groundwater mounding, these model

predictions are unreliable. The magnitude of relative increase in groundwater level is also likely to be under-predicted.

Evidence of Julian Weir, p. 20

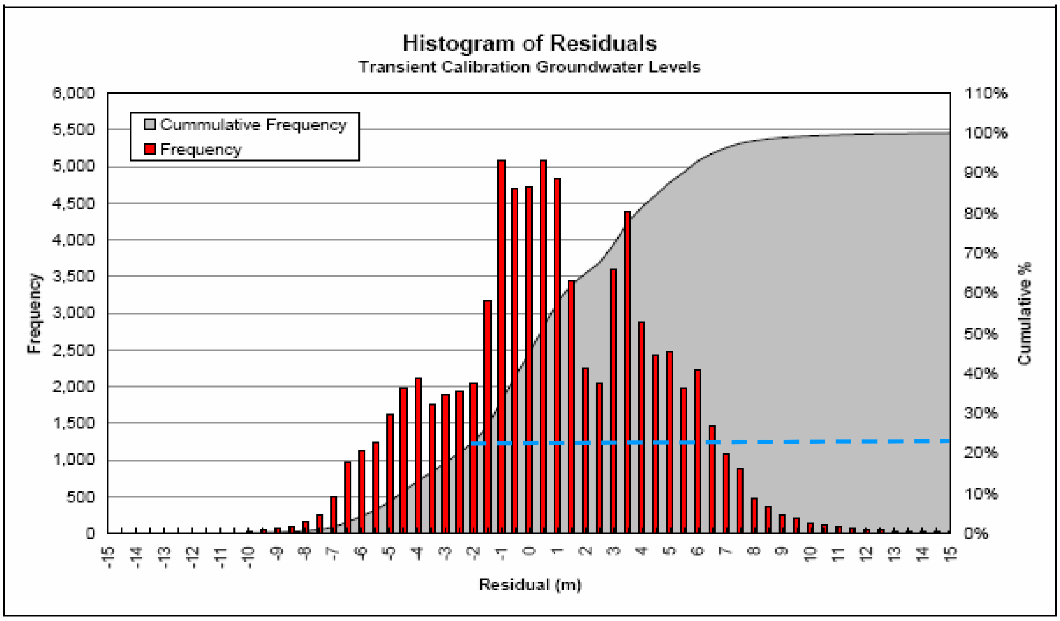

Figure 5: Histogram of transient groundwater residuals

Figure 8

22. The model predictions reported in Appendix E have been applied to contour plots of groundwater mounding (Appendix F), depth to shallow groundwater (Appendix G), and changes in areas of modelled shallow groundwater levels (Appendix H). In my opinion, these predictions may be considered to be indicative only, and there is a need for reassessment of the magnitude and distribution of effects from increased groundwater levels as a result of implementation of CPWES.

References

Bidwell, VJ; Callander, PF; Moore, CR (1991): An application of time-series analysis to groundwater investigations and management in Central Canterbury, New Zealand. *Journal of Hydrology (NZ),* 30(1): 16-36.

CSWS (2002): Canterbury Strategic Water Study. Prepared for Ministry of Agriculture & Forestry, Environment Canterbury, and Ministry for the Environment, by Matthew Morgan, Vince Bidwell, John Bright, Ian McIndoe and Christina Robb. *Lincoln Environmental Report No. 4557/1.*

MAF (2003): Groundwater Management Tools: Analytical procedures and case studies. Prepared for MAF Policy by Vince Bidwell. *MAF Technical Paper No.2003/06* (available from the MAF website).