EXPERT CONFERENCE — GROUNDWATER SCIENCE

Submitters — 337, 349, 357, 387

Topic: Proposed Plan Change 7 to the Canterbury Land and Water Regional Plan

Date of conference: 19 & 31 August 2020

Venue: Via Microsoft Teams and in person

Facilitator: Bill Rainey

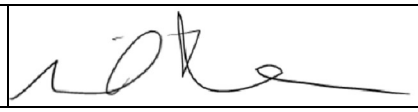
Recorder: Alanna Hollier

1. The Hearing Panel for Proposed Plan Change 7 to the Canterbury Land and Water Regional Plan (**PC7**) approved the expert witness conferencing in respect of groundwater science in relation to PC7.

Attendees

2. Witnesses who participated and agreed to the content of this Joint Witness Statement (**JWS**):

Name	Employed or engaged by	Signature
Mr Mike Thorley	Christchurch City Council	
Dr Mike Freeman	As One Inc	
Dr Helen Rutter	DairyNZ Limited	
Mr Jeremy Sanson	Waimakariri Irrigation Limited (WIL)	
Mr Zeb Etheridge	Environment Canterbury	
Ms Amber Kreleger	Environment Canterbury	

Mr Neil Thomas	Waimakariri Irrigation Limited (WIL)	

Environment Court Practice Note

3. All participants confirm that they have read the Environment Court Consolidated Practice Note 2014 and in particular Section 7.1 (Code of Conduct, Duty to the Court and Evidence of an expert witness) and Appendix 3 - Protocol for Expert Witness Conferences and agree to abide by it.

4. Ms Kreleger acknowledges that she is an employee of the Canterbury Regional Council. Notwithstanding that, Ms Kreleger confirms that she prepared and will present her evidence as an independent expert and in compliance with the Code of Conduct.

5. Mr Etheridge acknowledges that he is engaged by the Canterbury Regional Council. Notwithstanding that, Mr Etheridge confirms that he prepared and will present his evidence as an independent expert and in compliance with the Code of Conduct.

6. Dr Rutter acknowledges that she is engaged by DairyNZ Limited. Notwithstanding that, Dr Rutter confirms that she prepared and will present her evidence as an independent expert and in compliance with the Code of Conduct.

7. Mr Thorley acknowledges that he is engaged by Christchurch City Council. Notwithstanding that, Mr Thorley confirms that he prepared and will present his evidence as an independent expert and in compliance with the Code of Conduct.

8. Dr Freeman acknowledges that he is engaged by As One Inc. Notwithstanding that, Dr Freeman confirms that he prepared and will present his evidence as an independent expert and in compliance with the Code of Conduct.

9. Mr Sanson acknowledges that he is engaged by the Waimakariri Irrigation Limited. Notwithstanding that, Mr Sanson confirms that he prepared and will present his evidence as an independent expert and in compliance with the Code of Conduct.

10. Mr Thomas acknowledges that he is engaged by the Waimakariri Irrigation Limited. Notwithstanding that, Mr Thomas confirms that he prepared and will present his evidence as an independent expert and in compliance with the Code of Conduct.

Experts' qualifications and experience

11. These are set out in each experts' evidence. For Zeb Etheridge and Amber Kreleger of the Canterbury Regional Council, this is set out in Appendix A of the Plan Change 7 section 42a report.

Purpose of expert conference

12. The purpose of the conference is to assist the Hearing Panel by responding to a series of questions relating to groundwater science and associated issues.

13. For each question, the experts state matters on which they agree and on which they do not agree, with reasons.

Connectivity between Waimakariri Plains and Christchurch aquifer

14. This relates to the potential for nitrate from the Waimakariri Zone to be transported to the Christchurch water supply aquifer.

Relevant factors

- Groundwater level and flow direction (piezometric gradients)
- Measured nitrate concentrations
- Preferential flow paths (anisotropy)
- Speed and timing of nitrate transport to Christchurch
- Water balance
- In summary, do areas of the Waimakariri Plains form part of the Christchurch drinking water catchment

Groundwater level and flow direction (piezometric gradients)

15. The modelled water levels in three 150m deep wells (BX23/0773, BX23/0763 and BX23/0770), broadly represent the relative water levels measured (over a 2-year period) albeit with some differences. The modelled water levels are higher than the measured water levels in two of the wells (BX23/0773 and BX23/0763 respectively), but the order of water levels from highest to lowest replicates the measured data.

16. Mr Etheridge, Mr Thorley, Dr Freeman and Ms Kreleger consider that it is important to look at the wider distribution of groundwater levels across the whole dataset, which indicate a potential for deep groundwater flow towards Christchurch.

17. Mr Thomas, Dr Rutter and Mr Sanson consider that there is insufficient deep water groundwater level data (ten points measured on the September 2017 survey). The three bores above represent the best dataset available to assess deep flow directions around the river, and consider that the above three wells indicate the flow direction east-north-east (parallel to the river). They are not convinced that the modelled flow direction matches the flow direction indicated by measured groundwater level data. They consider that more data is required to be able to say with any confidence which direction groundwater flows.

Measured nitrate concentrations

18. This relates to whether nitrate concentrations in Christchurch groundwater could be higher than the modelled results indicate.

19. The experts discussed how nitrate contamination already present in the Christchurch aquifer was accounted for in the modelling and the potential for the projected nitrate concentrations to be higher if more contamination is present than was assumed.

20. Mr Etheridge clarified that the baseline nitrate concentrations presented in the Kreleger and Etheridge 2019 report were used for context and as a starting point for the graphs which show projected nitrate concentration increases over time. The modelling work assumed that there are no sources of nitrate contamination in Christchurch and that the only source of nitrate contamination shown in the model results is from north of the Waimakariri River.

21. The experts agree that <u>if</u> nitrate is transported from north of the Waimakariri River into the Christchurch aquifer it could, under some circumstances and in some locations, combine with nitrate contamination sources local to the Christchurch area and lead to higher nitrate concentrations than the model results indicated.

22. For clarification, the areas of particular concern are located in the south-west and north-east (i.e. Belfast) where concentrations of nitrate-nitrogen are already elevated.

23. The experts agree that the nitrate concentrations are increasing in the deep long-term monitoring well at Russley (M35/6791), but they do not agree on the cause of that trend.

Preferential flow paths (anisotropy)

24. This relates to the implications of anisotropy and the uncertainty around this for the modelled nitrate concentrations.

25. Anisotropy is a property that represents the preferential permeability direction which can influence groundwater flow and nitrate transport pathways. Anisotropy is set as a parameter in modelling. It is important because it could potentially influence transport of nitrates from the Waimakariri Zone to Christchurch.

26. Mr Etheridge clarified that although lateral anisotropy was applied to the model, he considers that this has a limited influence on the modelled transport of nitrate into the Christchurch aquifer.

27. Dr Rutter considers that it is not clear how anisotropy has affected the results of the model.

Speed and timing of nitrate transport to Christchurch

28. This relates to the use of groundwater age determinations to indicate the length of time it could take for nitrate to migrate from the Waimakariri plains to Christchurch.

29. The experts consider that if nitrates migrate beneath the Waimakariri River, then nitrate concentrations could increase faster than indicated in the Kreleger and Etheridge 2019 report.

30. This could have implications for the rate of nitrate loss reduction required to achieve targets.

Water balance

31. The experts have been referred to recently compiled material provided by Mr Etheridge which gives modelled estimates of groundwater flow from the Waimakariri Zone to the Christchurch Zone. This information was not available at the time expert evidence was compiled for Plan Change 7 and the experts have not evaluated this information in any detail.

32. That material in summary indicates that the median modelled rate of groundwater flow from the Waimakariri plains aquifer to the Christchurch aquifer is 4.1 m^3/s, with a range of 2.4 to 5.7 m^3/s within the 90% confidence interval. The median represents

23% of the total Christchurch aquifer water budget (17 – 25% at the 90% confidence interval).

In summary, do areas of the Waimakariri Plains form part of the Christchurch drinking water catchment

33. The experts agree that there is potential for recharge to part of the Christchurch aquifer system from north of the Waimakariri River.

34. There is disagreement over the strength of evidence to support recharge from north of the river, and disagreement over the spatial extent of the Christchurch aquifer which receives recharge from north of the river.

35. Mr Etheridge, Ms Kreleger, Dr Freeman and Mr Thorley consider that there is sufficient evidence of recharge to the Christchurch aquifer system from north of the river and that an extensive proportion of the Christchurch aquifer is recharged from this area. These experts consider that areas of the Waimakariri Plains form part of the Christchurch water supply aquifer catchment.

36. Dr Rutter, Mr Sanson and Mr Thomas consider that there is potential for recharge to part of the Christchurch aquifer system from north of the Waimakariri River at depth, but there is too much uncertainty concerning this due to the lack of information and measurement data relating to the deep aquifer.

Baseline groundwater quality, trends and nutrient load to come within the Waimakariri Zone

37. This relates to historical and current measured nitrate concentrations and their potential to increase significantly above currently measured concentrations in groundwater and streams.

Relevant factors

- Modelled nitrogen loss rates from land
- Nitrate trend analysis
- Past and future land use and land management changes
- Spatial variability of nitrate-nitrogen concentrations
- Modelled projections of future nitrate concentrations

Modelled nitrogen loss rates from land

38. This relates to whether the nitrogen loads applied to the model are likely to overestimate or underestimate actual nitrogen loss rates in the Waimakariri Zone.

39. The experts agree that there is significant uncertainty over the modelled loss rates.

Nitrate trend analysis

40. This relates to the implications of uncertainty over nitrate trends in the Waimakariri Zone for the proposed plan rules.

41. The experts agree that modelling of nitrate-nitrogen concentrations in surface water and groundwater involves inherent uncertainty which needs a carefully developed and implemented ongoing monitoring and investigation programme to evaluate the modelling.

42. The experts agree that comparison of modelled and measured nitrate concentrations at individual wells should be treated with caution due to the coarseness of the scale of the model. The model is not a good predictor of nitrate concentrations at individual water supply wells. The model is most useful when used to estimate nitrate concentrations across a broader area or in groundwater-fed surface water which receive water from a broad area.

43. Mr Thomas, Mr Sanson and Dr Rutter note, however, that modelled nitrate concentrations at WDC wells and private water supply areas, are consistently much higher than measured concentrations, and may reflect contradictory trends to what is predicted by modelling.

44. Ms Kreleger and Mr Etheridge consider that any comparison of modelled and measured nitrate concentrations needs to be undertaken with a good understanding of the factors that influence water quality in any given well. These include knowledge of recent land use and land management changes in the well recharge area, climatic conditions during the monitoring period and lag times. They refer to information presented in the Kreleger and Etheridge 2019 report which shows that modelled and measured nitrate concentrations in 14 shallow wells are broadly comparable.

Past and future land use and land management changes

45. This relates to the extent to which recent land use or land management change has occurred which may not be reflected in our current measured nitrate concentration data.

46. The experts agree that recent land use intensification has occurred in some areas of the Waimakariri Zone (such as the Eyrewell Forest conversion) and that the full effects of this intensification are unlikely to be reflected in current measured nitrate concentration data.

Spatial variability of nitrate-nitrogen concentrations

47. This relates to areas of very high nitrogen loss rates in the inland Waimakariri Plains.

48. Mr Etheridge, Ms Kreleger, Mr Thorley and Dr Freeman agree that faster reductions in nitrate loss rates in the inland Waimakariri Plains area to the south of Eyre River, could help to meet nitrate concentrations in Christchurch and some receptors in the Waimakariri Zone more quickly.

Modelled projections of future nitrate concentrations

49. This relates to how much confidence there is in modelled projections of nitrate concentrations decades into the future.

50. The experts agree that the uncertainty with model predictions increases the further the modelling extends into the future.

Nitrate Priority Area (NPA) delineation

51. This relates to the suitability of the Nitrate Priority Area (NPA) proposed in PC7.

52. The experts agree that there is a robust science basis for a larger NPA that includes land where drainage and run-off are likely to contribute nitrogen to receptors which exceed or are predicted to exceed nitrate-nitrogen targets.

53. The experts agree that provision of more information on the impact of land use in the Waimakariri River catchment, which falls outside of the NPA, on nitrate concentrations in the river and effects on Christchurch aquifer water quality is needed to determine whether there is a need to extend the NPA.

Nitrate targets and reduction rates

54. This relates to the relationship between nitrate concentration targets and required nitrate loss reduction rates.

Relevant factors

- New National Policy Statement for Freshwater Management 2020 targets (numeric attribute states)
- 1mg/L nitrate-nitrogen target for community supply
- Basing nitrate loss reduction targets on median modelled values

New National Policy Statement for Freshwater Management 2020 targets (numeric attribute states)

55. Some of the surface water quality receptor targets used in the modelling are now inconsistent with the national bottom line for nitrate-nitrogen in the National Policy Statement for Freshwater Management 2020.

56. The experts agree that greater nitrogen loss reduction rates could be required to meet the new national standards.

1mg/L nitrate-nitrogen target for community supply

57. This relates to how nitrate-nitrogen loss reduction targets could change if the objective was a nitrate-nitrogen limit of 1 mg/L in drinking water. The experts agree that this would involve significant additional reductions in nitrogen loss in some areas.

Basing nitrate loss reduction targets on median modelled values

58. The experts agree that greater nitrogen loss reduction would be required if the maximum or 95th percentile modelled nitrate concentrations were used instead of the median values.

Remediation, adaptive management and monitoring

59. This relates to the inclusion of alternative approaches such as managed aquifer recharge (MAR) and targeted stream augmentation (TSA) to meet nitrate targets.

Relevant factors

- Feasibility of MAR and stream augmentation
- Benefits of MAR and stream augmentation
- Adaptive management based on monitoring

Feasibility of MAR and stream augmentation

60. The experts agree that MAR, stream augmentation and other on the ground actions have the potential to help reduce nitrate concentrations at catchment and sub-catchment scale.

Benefits of MAR and stream augmentation

61. The experts consider that it may be possible to achieve the nitrate targets more quickly if MAR, stream augmentation and other on the ground actions are undertaken in combination with nitrate loss reductions from land.

Adaptive management based on monitoring

62. The experts agree that it is critically important that a specifically designed ongoing monitoring programme needs to be established to assess whether the nitrate targets are being met, or are likely to be met, to determine when no further nitrate loss reductions are required.

63. The experts agree that the current monitoring programme is unlikely to be suitable for this purpose.

Model peer review

64. This relates to the adequacy of the peer review of the Waimakariri groundwater model.

Relevant factor

- Waimakariri peer review process

Waimakariri peer review process

65. The experts agree that the model peer review process has not been sufficiently documented.

66. Mr Thomas, Mr Sanson, Dr Freeman, Mr Thorley and Dr Rutter agree that in the absence of a comprehensive, documented peer review they do not have a high-level of confidence in the outputs of the model.