In the matter of	The Resource Management Act 1991
and	
In the matter of	Proposed Plan Change 7 to the Canterbury Land and Water Regional Plan by the Canterbury Regional Council

Summary of submission and evidence of Dr Douglas Alexander Rankin

Dated: 13 November 2020

BACKGROUND

EXPERTISE

1. My name is Douglas Alexander Rankin. I have outlined my background and expertise in my evidence in chief (**EIC**) and submission.

SUBMISSION

2. I have presented a personal submission (Submitter number PC7-220) which has outlined my concerns about a limited aspect of the Canterbury Land and Water Regional Plan (**CLWRP**) Plan Change 7 (**PC7)**. This concerns the impact of PC7 on Christchurch's groundwater. PC7 will subject future generations of Christchurch residents to a significant reduction in the high quality of our city's current pure drinking water supply and costs of replacement, and to the attendant human health risks and costs, if the appropriate action is not taken now to prevent this.

EVIDENCE

3. I have submitted EIC and rebuttal evidence in support of my submission.

SUBMISSION TO THE HEARING PANEL

4. Today I wish to summarise my submission and evidence and outline the relief I seek.
5. I have listened to and/or read and examined and considered the following additional evidence and material in constructing this submission:
    (a) The expert witness joint witness statement conference report on the groundwater science (**JWS**) that I had not seen while constructing rebuttal evidence;
    (b) The section 42a Officers Report that I had not considered at the time of writing my rebuttal evidence;
    (c) The rebuttal evidence of Mr Michael Thorley, Ms Janice Carter, Ms Bridget O'Brien, and Dr Belinda Margetts for the Christchurch City Council (**CCC**);
    (d) The rebuttal evidence of Mr Neil Thomas, Dr David Black, Ms Bianca Sullivan, Mr Stuart Ford, and Mr Michael Copeland for Waimakariri Irrigation Limited (**WIL**);
    (e) The presentations to the Hearing by Environment Canterbury (**ECan**; the Canterbury Regional Council (**CRC**))
    (f) The presentations to, and discussions with, the Hearing panel by Ms Vicki Buck, Ms S Kikstra, Meridian Energy, SOL Screening and Crushing and Lands and Survey South

Ltd, W J Winter and Sons (David and Desmond Winter), Dr John Talbot (Bowden Environmental), Victoria Caseley, Ms Baker (Styx Living Laboratory Trust), Dr Graham Fenwick, Dairy Holdings Ltd (including Mr Glass and Mr Thomas), Mr Tim Wells (Carleton Dairies Ltd), and Dairy NZ (Ms Charlotte Wright, Dr Graeme Doole, and Dr Helen Rutter); between Tuesday 29 September and Thursday 1 October.

6. Whilst this is not an Environment Court Hearing, I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014. I have complied with the Code in preparing this supplementary evidence and I agree to comply with it in presenting evidence at this Hearing. The evidence I give is within my area of expertise, except where I state that my evidence is given in reliance on another person's evidence or published material. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

SUBMISSION TO THE HEARING PANEL

Threat to Christchurch's groundwater

7. Christchurch's groundwater is used to provide drinking water to the city and environs. The water is pure enough to use in its untreated state. However, this pure water source will become contaminated with nitrates in the future as a result of the intensive dairy farming that has been allowed on part of the Canterbury Plains. Sadly, this is an entirely predictable outcome based on the overseas experiences of intensive dairy farming where cattle graze on pasture[1]. The nitrate concentrations in the drinking water will rise to levels which will pose a significant health risk to the Christchurch population. This risk is both in terms of increased cancer risks and in poor birth outcomes, with their attendant social and financial costs to the population. A new drinking water source would have to be found.
8. The current nitrate concentrations in Christchurch's drinking water are low and typically 1.0 mg NO_3^--N/L (milligrams of nitrate-nitrogen per litre). The drinking water is obtained by combining roughly equal proportions of water from various shallower CCC wells of depths < 50 metres, and deeper wells from 50 metres to > 200 metres, although as groundwater nitrate levels rise more water is taken from lower-nitrate deep wells.
9. Nitrate concentrations are lowest in the deep aquifers (Table 1). Christchurch's drinking water quality would not be as good as it is without the low nitrate deep groundwater available to dilute the higher nitrate groundwater from shallower and mid-depth aquifers.

[1] Paragraphs 15-21, D A Rankin EIC

The water in Christchurch's deep groundwater wells is essentially all 'old' water between 200 and 1200 years old. In contrast, water in the shallower groundwater wells is normally much younger. Christchurch's high quality drinking water is maintained (even though some shallow wells are nitrate compromised) because there are at present other deep wells which are not. Once the nitrate concentrations in the deep wells rise and are compromised, Christchurch has lost its high quality drinking water resource.

Table 1: Nitrate-N concentration (mg NO_3^--N/L) statistics for Christchurch groundwater[2]

Depth range	Median	Mean	95th percentile	Maximum
< 30 m	2.5	3.4	7.6	27
30 – 80 m	2.4	2.3	6.1	7.3
> 80 m	0.3	0.6	1.6	2.6

10. It is thought that much of Christchurch's groundwater comes from water flowing in old, porous, gravel river-bed channels buried under the plains, with water moving under the current bed of the Waimakariri River and into the Christchurch aquifers.
11. ECan have developed a groundwater model to examine the fate of nitrate nutrients released from farming in the Waimakariri Zone (**WZ**). This model predicts increases in steady state nitrate concentrations in all of Christchurch's aquifers and drinking water as a result of current and future proposed farming practices in the WZ[3]. The steady state concentration is a constant concentration reached at a future point once the full impacts of any farming activities are fully expressed uniformly throughout various groundwater or surface water bodies. In particular nutrients leaching from land use on plains to the north of the Waimakariri River within a 34,000 Ha interzone transfer source area end up in the groundwater in the Christchurch aquifers. The outputs from this model have been used by the Waimakariri Zone Committee (**WZC**) and ECan to inform a recent plan change process and to construct PC7.
12. Amongst other consequences, nitrate concentrations will increase from current levels in <u>all</u> Christchurch aquifers due to current management practice (**CMP**) and future farming practices, such as current consented at good management practice (**GMP**), in the interzone transfer source area, as illustrated by data in Table 2.

[2] Table 1, D A Rankin EIC
[3] Paragraphs 22-47, D A Rankin EIC

13. All median (50th percentile) aquifer nitrate concentrations will rise to levels significantly above those currently observed in the Christchurch aquifers, and especially those in the deep aquifers. Large increases also occur in 95th percentile concentrations in the deep aquifers. Nitrate concentrations in all aquifers trend to similar levels, < 7.5 mg NO_3^--N/L with 95 % certainty and < 9.4 mg NO_3^--N/L with 99% certainty[4]. There is essentially no difference between farming under CMP and GMP, as the results are the same within experimental error (estimated at about 30%).

Table 2: Comparison of modelled nitrate concentrations with current observed aquifer concentrations in different depth Christchurch aquifers for different farming scenarios[5]

Aquifer/Scenario	Median (50th percentile)		95th percentile	
	Current concentrations	Modelled from farming in WZ†	Current concentrations	Modelled from farming in WZ
Shallow aquifer nitrate (mg NO_3^--N/L)				
A; Current practice (CMP)	2.5	3.4 ↑	7.6	7.5
C; current consented at GMP	2.5	3.7 ↑	7.6	7.9
Mid aquifer nitrate (mg NO_3^--N/L)				
A; Current practice (CMP)	2.4	3.8 ↑	6.1	7.1
C; current consented at GMP	2.4	4.1 ↑	6.1	7.4
Deep aquifer nitrate (mg NO_3^--N/L)				
A; Current practice (CMP)	0.3	4.5 ↑↑↑	1.6	7.0 ↑↑↑
C; current consented at GMP	0.3	4.7 ↑↑↑	1.6	7.3 ↑↑↑

† ↑/↓ increased/decreased up to 2.2 times; ↑↑/↓↓ increased/decreased up to 4.3 times; ↑↑↑/↓↓↓ increased/decreased up to 16 times

14. The impacts of GMP farming in the interzone transfer source area on the shallow, mid and deep Christchurch aquifers can be seen visually in data presented in Figure 1. The very large increase in the current median nitrate concentration in the deep aquifer can be seen when compared to the modelled median (50th percentile) value. Lesser increases occur in the shallow and mid aquifers. Where the various modelled percentile data for the three aquifer depths sit in relation to the maximum allowable value (**MAV**) of nitrate permitted in the drinking water standard can also be seen. Ninety five percent of the expected deep aquifer nitrate concentrations will be less than 7.3 mg NO_3^--N/L and ninety nine percent will be less than 8.4 mg NO_3^--N/L.

[4] Table 2, D A Rankin EIC
[5] Table 3, D A Rankin EIC

15. There is a high likelihood that there will also be other contributions to Christchurch's groundwater nitrate concentrations from farming outside the WZ but elsewhere within the Waimakariri catchment. This is further discussed later. These contributions will add to, and further increase, the nitrate concentrations in the Christchurch aquifers. If, for example, half as much again of nitrate arose in the Christchurch aquifers from farming elsewhere in the Waimakariri catchment, then all percentile nitrate concentrations would rise significantly (half as much again) and some would exceed the MAV of the drinking water standard (see Figure 2).

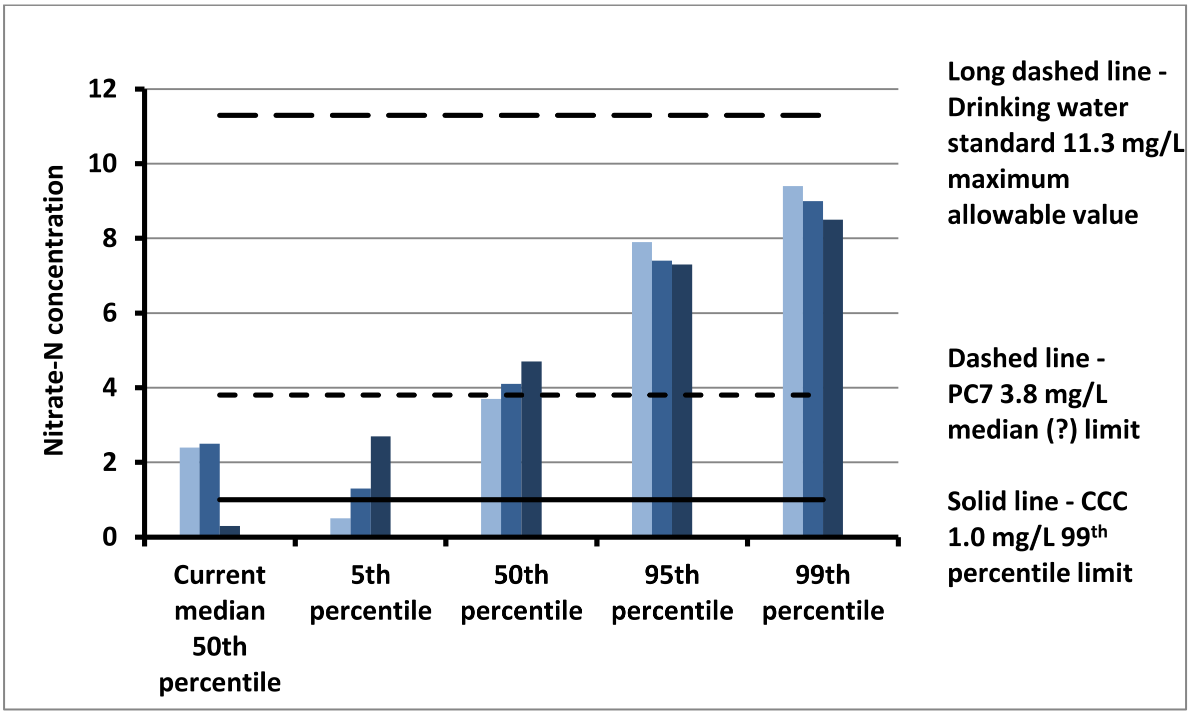

Figure 1: Current and modelled nitrate concentrations in shallow (light blue), mid (mid blue) and deep (dark blue) Christchurch aquifers from current consented at GMP farming in the interzone transfer source area in the Waimakariri Zone NPA

16. These key results set out clearly the predicament facing Christchurch's groundwater largely as a result of the intensive dairy farming permitted in the WZ and Waimakariri catchment.
17. The results also clearly demonstrate that the CRC, in granting permission for irrigated intensive dairy farming on the land where Eyrewell Forest once stood[6], will automatically lead to a significant reduction in the quality of Christchurch's drinking water supply. Unless this farming is stopped, or alternative low-nitrate emission dairy farming and other low-

[6] The nitrate released from forestry activity being far less than that released from intensive dairy farming

nitrate emission practices and farming methodologies are used in the interzone transfer source area, this will be a permanent change.

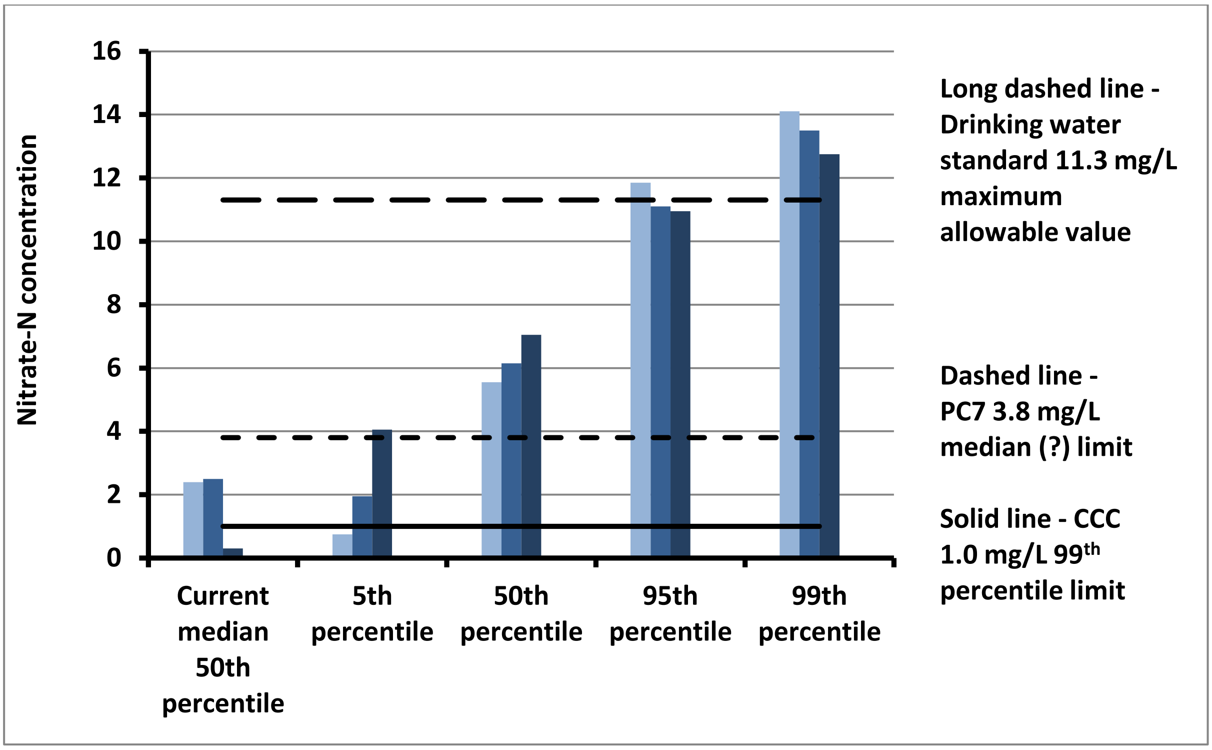

Figure 2: Current and modelled nitrate concentrations in shallow (light blue), mid (mid blue) and deep (dark blue) Christchurch aquifers. Contributions come from current consented at GMP farming in the interzone transfer source area in the Waimakariri Zone NPA plus hypothetical half as much more load from farming elsewhere in the Waimakariri catchment

18. Impacts from different farming scenarios on different zones or areas in Christchurch's deep aquifers were also quantified by the ECan groundwater model (Table 3). All (Scenarios C, D and E) show significant similar increases in nitrate concentrations in Christchurch's deep aquifers in time. In contrast a less intensive dryland farming option (H) results in a markedly lesser impact.
19. The increases in nitrate concentrations in the Christchurch aquifers will take some time to be realised, or in other words for 'load to come' or 'for the mail to arrive in the post'. It will take over 200, 800 or 1200 years for the steady state concentrations to be reached in the deep West, Central and East aquifers, respectively.
20. As most intensification of farming and dairy farming has only occurred in the WZ in the last 30 years or so, increases in nitrate concentrations would not necessarily be expected to be visible or detectable in the deep aquifers as yet, let alone have reached steady state values.

Table 3: Current median (50th percentile) and median steady state nitrate concentrations (5th and 95th percentiles in parentheses) modelled in the three deep Christchurch aquifer zones for different farming scenarios[7]

Site	Current measured, mg NO_3^--N/L	C; Current consented at GMP†, mg NO_3^--N/L	E; PC5PA‡, mg NO_3^--N/L	D; Current pathways*, mg NO_3^--N/L	H; Dryland farming, mg NO_3^--N/L	Lag time (years)
West	0.3	4.0 (1.2-6.9)	4.2 (1.3-7.3)	4.1 (1.3-7.1)	1.07 (0.44-1.72)	200
Central	0.3	5.2 (3.4-7.4)	5.6 (3.6-7.9)	5.4 (3.5-7.6)	1.40 (1.07-1.78)	800
East	0.3	5.2 (3.4-7.4)	5.6 (3.6-7.9)	5.4 (3.5-7.6)	1.40 (1.07-1.78)	1200

† Data from Table 4-10 where column is (incorrectly) labelled as GMP
‡ PC5PA – Current CLWRP Plan Change 5 Permitted Activity Rules
* Current pathways – GMP with limited uptake of irrigation and winter grazing

PC7 proposal

21. PC7 proposes to permit more intensive farming and nitrogen release into the WZ, but also requires multiple future reductions in nitrogen released from many farms in future plan changes and cycles to meet the outcomes PC7 seeks[8]. However, exactly what amounts of nitrogen that PC7 will release into the environment is not clear from the data presented in the reports that background PC7.
22. PC7 proposes a nitrate threshold or limit of 3.8 mg NO_3^--N/L (Table 4) in the three deep Christchurch groundwater aquifers, ostensibly to protect Christchurch's drinking water.

Table 4: Increases in median steady state nitrate concentrations (5th and 95th percentiles in parentheses) modelled in the Christchurch deep aquifer zones for different farming scenarios including PC7[9]

Site	D; Current pathways, mg NO_3^--N/L	H; Dryland farming, mg NO_3^--N/L	F; Proposed PC7*, mg NO_3^--N/L	Median concentration increase PC7§	Lag time (years)
West	4.1 (1.3-7.1)	1.07 (0.44-1.72)	3.8	12.7x, 1170%	>200
Central	5.4 (3.5-7.6)	1.40 (1.07-1.78)	3.8	12.7x, 1170%	>800
East	5.4 (3.5-7.6)	1.40 (1.07-1.78)	3.8	12.7x, 1170%	>1200

* This limit would not be met after the first ten-year PC7 plan cycle. It would only be achieved after the end of the second ten-year PC7 plan cycle, assuming all the required reductions in nutrient release were met by dairy and other farmers in the interzone transfer source area

[7] Table 4, D A Rankin EIC
[8] Paragraphs 48-70, D A Rankin EIC
[9] Table 7, D A Rankin EIC

§ Relative to current median concentration in aquifers of 0.3 mg NO_3^--N/L

23. However, it is quite clear from data in my evidence (originating from various ECan reports) that the nitrate limit set and PC7 rules will not maintain the current high quality drinking water from Christchurch's aquifers <u>at all</u>[10]. A future goal of 1.0 mg NO_3^--N/L for Christchurch's aquifers is suggested but <u>the adoption of PC7 would actually prevent and preclude ever achieving a 1.0 mg NO_3^--N/L goal</u> in any of Christchurch's aquifers.

Risks posed by nitrate in drinking water

24. I have shown evidence of the risks and damage posed by these increases in nitrate concentrations in drinking water to human health and well-being[11], as have others[12]. Proposed plan changes take drinking water nitrate concentrations to levels that are too high, even though they are below the current New Zealand drinking water standard. The current New Zealand drinking water standard is only set to protect against methemoglobinemia and therefore may not be suitable for protecting wider public health. From the data I have presented current median nitrate concentrations in Christchurch's deep groundwater aquifers (0.3 mg NO_3^--N/L) are generally safe for drinking and pose no hazard. However, levels above about 0.87 mg NO_3^--N/L have been shown to pose an increased hazard[13], and so current 95th percentile concentrations in the deep Christchurch aquifers of 1.6 mg NO_3^--N/L pose a health risk. High levels found currently in the shallow and mid depth aquifers (medians of 2.4 and 2.5 mg NO_3^--N/L, respectively, and 95th percentiles of 7.6 and 6.1 mg NO_3^--N/L, respectively) pose a significant hazard and human health risk. Current farming practices and PC7, of course, once the nitrate concentrations increase as the 'mail arrives in the post', will result in nitrate levels across the board in all three aquifers that will pose a significant hazard and human health risk.

PC7 is contrary to the National Policy Statement for Freshwater Management and the Resource Management Act

25. I have shown that aspects of PC7 are contrary to the Resource Management Act (**RMA**), do not reflect sustainable management of resources, and are particularly contrary to the National Policy Statement for Freshwater Management (**NPSFM**) 2017 and 2020[14]. No data is

[10] Paragraphs 50-56, D A Rankin EIC
[11] Paragraphs 71-91, D A Rankin EIC
[12] For example T Chambers, EIC for Christchurch City Council
[13] T Chambers, EIC for Christchurch City Council
[14] Paragraphs 107-119, D A Rankin EIC

given by ECan to show whether water quality is maintained or improved within Freshwater Management Units, or to address issues of over-allocation of water resources, as is required under the NPSFM. As it is impossible to tell whether PC7 will maintain or improve water quality required under the NPSFM, PC7 is therefore *ultra vires.* In addition, PC7 is contrary to many objectives of the Canterbury Water Management Strategy (**CWMS**)[15].

Relief originally sought by myself

26. I originally requested that the permissive PC7 and current farming in the interzone transfer source area should be stopped so that the high quality of Christchurch's deep groundwater can be retained. I also requested that the Canterbury Land and Water Regional Plan (**CLWRP**) needs to be modified to be consistent with the RMA. It is not just Christchurch's groundwater that will be damaged by PC7 and the CLWRP, but the environment and groundwater in the WZ will be damaged and not restored to a healthy state. The health and wellbeing of residents in Christchurch and in the WZ will be damaged, as will be the health and well-being of those who visit and use the resources in the WZ.

Section 42a Officers Report

27. In section 8.20 in Part 5: Submissions on PC7 Part C of the Officers Report[16] ECan states "that setting limits for waterbodies outside of the Waimakariri subregion including Christchurch's aquifers is outside the scope of the plan change (which is to set limits for FMUs in the Waimakariri sub-region)". This perhaps suggests that PC7 need not consider impacts of farming in the WZ on any water bodies outside the WZ should this occur, such as in the Christchurch aquifers. ECan goes on to say "However, the proposed provisions also specifically manage risks to Christchurch aquifers, by establishing a NPA (which includes the majority of the modelled source area for the Christchurch aquifers) and requiring consent holders to reduce nitrogen losses below Baseline GMP over two stages." My view is that this last sentence is misleading for a number of reasons.
28. In supporting documentation for PC7, reference is made to the WZC choosing a nitrate concentration limit of 3.8 mg NO_3^--N/L in Christchurch's aquifers as part of its response to 'doing its bit' and protecting Christchurch's groundwater drinking water source[17]. ECan has shown that farming in the interzone transfer source area in the NPA in the WZ and adoption

[15] Paragraphs 92-106, D A Rankin EIC
[16] Paragraph 8.20, page 473, Section 42a Officers Report
[17] Paragraphs 50-64, D A Rankin EIC

of PC7 will lead to a significant degradation of water quality in the Christchurch aquifers including the deep aquifer. ECan and the WZC with PC7 have set limits on farming in the WZ that allow the current nitrate concentrations in the deep Christchurch aquifers supplying Christchurch's drinking water to increase over 10 fold from what they are now, and likely to a point where they pose a significant health risk should that water be used for drinking. ECan has not set limits on farming that will ensure retention of the current nitrate concentrations and quality of the deep groundwater in Christchurch's aquifers. Thus, ECan does not appear to have considered the impacts from farming under PC7 in an integrated and holistic manner as required under the RMA, or avoided, remedied or mitigated those impacts. In addition, this land use will not control the discharge of contaminants that will maintain or enhance the quality of water in water bodies (the Christchurch aquifers) as ECan is required to do[18]. Therefore, in my view the statement that PC7 has provisions to specifically manage risks to Christchurch's aquifers is not true and is misleading.

29. The proposed PC7 planning situation is tantamount to ECan saying farming can be permitted in a zone and it does not matter if this has major negative impacts on water quality in an adjacent zone. A corollary to this situation is that in the future when the Christchurch/West Melton Zone (**CWMZ**) decides it wants to set a nitrate limit of < 1.0 mg NO_3^--N/L in the Christchurch groundwater aquifers (for argument's sake) as part of a plan change, the CWMZ won't be able to ensure that this limit will be achievable. This is because farming causing pollution of the aquifers is not in their zone and so is therefore outside their control and so outside of the 'scope' of any such plan change they would like to make. Alternatively the CWMZ would need to ask the WZ if it could reduce its nitrate leaching from farming into its aquifers. I strongly doubt WZ farmers would be interested or too impressed with such a request. This creates a significant and unrealistic tension between zones and communities, which is something that ECan is charged with managing, not creating. It appears as though ECan is abdicating and avoiding its responsibilities under the RMA and ignoring the consequences of its actions and those of the zone committees it has set up to 'manage' water and land resources. This could lead to a situation where no one can 'fix' the problem because it is the fault of another zone that one has no control over.

30. Policy 4.5 in the CLWRP sets out prioritisation for the take of water for particular end uses. The take for community drinking water supplies are a first order priority and takes for other needs such as for irrigation and other economic activities, and maintaining river flows

[18] Paragraph 6.2, page 576, Section 42a Officers Report

needed for recreational activities, are second order priorities[19]. If PC7 is permitted, and water for irrigation is allowed, and farming facilitated by this irrigation then pollutes Christchurch's high quality drinking water, then a second order water provision priority has been allowed to take precedence over a first order water provision priority. In other words drinking water has been polluted to allow irrigation. This would be completely contrary to the intent of Policy 4.5 of the CLWRP. PC7 cannot be contrary to the CLWRP.

31. PC7 is required to give effect to the NPSFM, which in Policy C1 directs Regional Councils to manage freshwater, land use and development in an integrated and sustainable way so as to avoid, remedy or mitigate adverse effects, including cumulative effects[20]. PC7 does not do this but knowingly permits degradation of groundwater used for drinking water in the CWMZ by permitting unsustainable farming on land in the adjacent WZ. This is not integrated and sustainable management or development but piecemeal siloed management or development, contrary to Policy C1. The conclusion on the analysis of the NPSFM[21] states the provisions of PC7 are critically important to a range of outcomes and by implication that PC7 delivers these. I do not agree that PC7 delivers the outcomes, and particularly those in paragraph 9.54 parts a, b, d, e, f and i.

Relief sought by other parties and evidence from other parties

32. I have read a number of submissions[22], evidence from submitters, and evidence and rebuttal evidence from expert witnesses appearing for various parties. Submissions and evidence include opposition to PC7 by affected farmers, because many current intensive farming practices and much farm investment would have to be curtailed or changed (in some cases severely) in a number of areas[23]; concerns that the ECan groundwater modelling was neither accurate or appropriate for predicting future nitrate groundwater and surface water concentrations in the WZ and Christchurch aquifers[24] and for constructing PC7; opposition from Christchurch citizens worried about impacts on their drinking water[25]; through to tacit

[19] Paragraph 11.106, page 219, Section 42a Officers Report
[20] Paragraph 9.38, page 585, Section 42a Officers Report
[21] Paragraph 9.54, page 587, Section 42a Officers Report
[22] Paragraph 4, D A Rankin rebuttal evidence
[23] For example, the evidence of experts for Dairy NZ and WIL
[24] For example, the evidence of experts for Dairy NZ and evidence of experts for WIL
[25] For example, the submissions of V Buck and others and the CCC, and evidence from experts appearing for the CCC

support from parties so long as significant changes were made to PC7 to facilitate alternative pathways[26] and outcomes.

Criticism of the ECan groundwater model

'Poor agreement' between current and predicted concentrations

33. Criticism of the ECan groundwater model by Dairy NZ and WIL expert witnesses[27] on the basis of poor agreement between current well and aquifer nitrate concentrations and future predicted steady state concentrations is not valid, as <u>there is no expectation that current concentrations are a proxy or predictor for future nitrate concentrations</u>[28]. Current concentrations reflect past land use, whereas future predicted steady state concentrations reflect current land use, or future different use, once equilibrium is reached. The comments on this apparent 'poor agreement' are meaningless and irrelevant. They do not weaken the model and are not contradictory to the model as these particular parties suggest in the Joint Witness Statement – Groundwater Science[29] (**JWS**).

Load to come and denitrification mechanism

34. WIL witnesses claim there is no 'load to come' (Dairy NZ experts hold a contrary view and agree there is 'load to come'), which in WIL's view means the model is inaccurate. This analysis is incorrect and does not weaken the model[30]. I note in the JWS that all experts (including WIL experts) agree that there will be 'load to come' in the Eyrewell Forest conversion[31]. WIL suggest denitrification could be occurring especially in the deep aquifers but I suggest the mechanism suggested seems unlikely[32]. ECan did not include nitrate attenuation in aquifers in their model as they felt there was not strong enough evidence or a basis to support this.

Groundwater flow direction and flow under Waimakariri River

35. The groundwater hydraulic flow data used in construction of the model is based almost entirely on shallow well piezometric data. This data shows surface groundwater flow from

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[26] For example, the submission and evidence of experts for WIL
[27] For example, Mr Neil Thomas EIC, and Dr Helen Rutter EIC
[28] Paragraphs 9-24, 41-44, 48, 50 , 53-56, 61, 74, 77-78, D A Rankin rebuttal evidence
[29] Paragraph 43; note these are the views only expressed by N Thomas, J Sanson and H Rutter, JWS – Groundwater Science
[30] Paragraphs 40, 46, 49, 53, 56, 58, D A Rankin rebuttal evidence
[31] Paragraph 46, JWS – Groundwater Science
[32] Paragraphs 51-52, 57-58, D A Rankin rebuttal evidence

the interzone transfer source area, and also from an area south of the Waimakariri River further downstream[33], head straight to Christchurch. Flow from the interzone transfer source area presumably passes beneath the Waimakariri River, rather than following the current surface expression of the Waimakariri River as it turns east and empties to the north of Christchurch. Unfortunately there is a paucity of wells and data, and especially deep well data, in the WZ and the interzone transfer source area, and areas between it and Christchurch. Therefore, there is greater uncertainty in the direction of deep groundwater flow from the Waimakariri River where it emerges on the plains, or from the interzone transfer source area, or the area on the south bank, and whether it also follows the same direction as the shallow groundwater straight towards Christchurch.

36. In summary all experts agree on the potential for recharge to part of the Christchurch aquifer system from north of the Waimakariri River[34] (the interzone transfer source area in the NPA). A number consider there is sufficient evidence to confirm that such areas form part of the Christchurch water supply aquifer catchment[35] while others believe recharge at depth is uncertain[36] because of limited data. The experts all agree that more information on the impact of land use in the Waimakariri catchment that falls outside of the NPA, on the nitrate concentrations in the river and effects on the Christchurch aquifer water quality (nitrate concentrations), is needed. That is to say the model and the NPA should be expanded to consider contributions from outside the WZ, such as from the south side of the Waimakariri River, to determine whether the NPA feeding the Christchurch aquifers needs to be extended[37]. The Waimakariri River over geological time has emptied to the coast north of Christchurch as it does now, and to the south of Christchurch into Lake Ellesmere, and at different points in between. Given that the surface groundwater flow from the interzone transfer source area heads straight to Christchurch, rather than follow the current surface expression of the Waimakariri River as it turns east and empties to the north of Christchurch, it would seem reasonable that the same could equally apply to the deeper and deep groundwater from that source too.

[33] See Fig 1 for direction of flow (at right angles to piezometric contours; ECan data), page 12, H Rutter EIC
[34] Paragraph 33, JWS – Groundwater Science
[35] Paragraph 35, Z Etheridge, A Kreleger, M Freeman, M Thorley, JWS – Groundwater Science
[36] Paragraph 36, H Rutter, J Sanson, N Thomas, JWS – Groundwater Science
[37] Paragraph 53, JWS – Groundwater Science; also see paragraph 57 and footnote 27, D A Rankin, rebuttal evidence

Construction of groundwater model and confidence in results

37. All the experts, except those from ECan, who constructed the model with advice and feedback from other peers and groundwater scientists, "agree that in the final absence of a comprehensive, documented peer review they do not have a high-level of confidence in the outputs of the model."[38] Although this may be their genuinely held view, I do not agree with this. At one level I am not surprised by this conclusion, as I have found it very difficult to read the many reports that refer to different aspects of the model's construction and results, and piece together a clear picture of what everything means in the face of sometimes contradictory statements. However, if, for example, this means that the results of all this modelling have no credibility, and can be ignored or dismissed, then that leaves this whole plan change in a very parlous state. A lot of money and effort has been spent developing a sophisticated comprehensive model to assist in the PC7 process and determine the likely outcomes from farming on surface water and groundwater in the WZ and Christchurch aquifers.
38. It is true ECan have not provided a separate independent peer review of the model. However, the process and assumptions used to develop the model have been extensively and thoroughly discussed, albeit in a fragmented fashion, in various ECan reports, and particularly in Kreleger and Etheridge (2019), Etheridge and Hanson (2019), Lilburne et al. (2019), and Harris (2019). I attended a presentation made by Zeb Etheridge on the model to the Science Stakeholders Advisory Group of the Waimakariri Zone Committee, of which I was a member since its inception. As a scientist I was very impressed by the presentation and especially the thoroughness of the development of the model and ground truthing processes carried out by ECan, including the extensive workshop processes and consultation carried out with a number of highly qualified groundwater scientists based here in Canterbury. As described in the reports, the views of these scientists were carefully elicited after presenting data, and letting them decide, guide and make suggestions as to the meaning of the data and results in as unbiased a manner as possible, through to what needed to be included in the model. Their views were then included in the model where they could be, and noted as concerns where they could not. This is in part why I hold the view that this is an elegant and comprehensive study.
39. Clearly "a comprehensive, documented peer review" performed independently could give experts appearing before you some comfort as to the validity of the model and its outputs.

[38] Paragraph 66, JWS – Groundwater Science

More information from ECan on nitrate levels in the WZ and/or examples from throughout Canterbury, where there are clear signs that nitrate levels are climbing in groundwater throughout much of the region from recent dairy farming, would also likely help. ECan should be providing such data so that good sound decisions can be made on which to base sustainable resource use, planning and management. Other parties such as the farming community could also take more comfort, or not, as may be the case, from more certainty around the data and the model.

40. In my view, from reading the various detailed reports as touched on in my evidence, a very thorough outline of the model and processes used to develop it has been presented, and overall I have a lot of confidence in what has been done. I conclude "As a scientist, looking at the level of detail in hypothesis development around the model, groundwater system and data analysis, stochastic model development, modelling process development and description, uncertainty analysis, ground truthing; peer group analysis, review, feedback and discussion; and final results, it is my view that the model and its results are entirely plausible, and that the overall model is the result of an elegant and very thorough, comprehensive study."[39] Even if predicted nitrate concentrations in the deep Christchurch aquifer are overestimated by 100 %, which is highly unlikely in my view, the predicted median and 95th percentile concentrations of about 2.3 and 3.6 mg NO_3^--N/L would still be well in excess of those considered suitable for drinking water, and very large increases on what is currently found (0.3 and 1.6 mg NO_3^--N/L, respectively).

Relief sought by the Christchurch City Council

41. The CCC has sought that PC7 be modified so that the amount of nitrogen that can be released from farming into the interzone transfer source area is reduced by 80 % over a shorter number of years (perhaps 40 % in the first 10 years and another 40 % in the second 10 years) in order to achieve a 1.0 mg NO_3^--N/L goal in Christchurch's drinking water[40], this being an upper limit for nitrate in the city's groundwater[41].
42. I agree with this general approach.
43. However, as I have shown in my rebuttal evidence[42], based on ECan model data for the current consented at GMP farming scenario, larger nitrogen reductions of between 88.24 and 89.36 % would be required to achieve a 99th percentile nitrate concentration (maximum)

[39] Paragraphs 56-57, D A Rankin rebuttal evidence
[40] Paragraph 139, M Thorley EIC for Christchurch City Council
[41] Paragraph 4, page 1, Submission 337, Christchurch City Council
[42] Paragraphs 34-38, D A Rankin rebuttal evidence

limit of 1.0 mg NO_3^--N/L (Table 5[43]), which is higher than the 80 % reduction requested by the CCC. Such reductions agree with the general statements made by the experts in the JWS, where significant additional reductions in nitrogen loss (over and above 80%) might be needed in some areas[44], and where greater nitrogen loss reduction would be required if the maximum or 95th percentile modelled concentrations were used instead of median values[45]. Reductions in nitrogen released to the environment in other farming areas may also be required to protect Christchurch's drinking water, if it is found that other land use elsewhere in the Waimakariri catchment also contributes nitrate to the Christchurch aquifers, as suggested in the JWS[46].

44. Returning to the WZ situation, if there was a requirement that all Christchurch aquifers were to meet a 99th percentile 1.0 mg NO_3^--N/L nitrate concentration then an 89.36% reduction in nitrogen released from farming in the interzone transfer source area would be required.

45. The data in Table 5 show the expected lower median and 95th percentile nitrate concentrations in the Christchurch aquifers when the 88.24 to 89.36 % reductions in nitrogen released from farming were applied to meet the 1.0 mg NO_3^--N/L nitrate concentration limit at the 99th percentile level.

Table 5: Comparison of calculated nitrate concentrations for the current consented at GMP farming scenario in the interzone transfer source area in the NPA with current observed aquifer concentrations (mg NO_3^--N/L) in different depth Christchurch aquifers for the percentage reductions in nitrogen load required to achieve a 99th percentile 1.0 mg NO_3^--N/L nitrate concentration limit

Aquifer	Median (50th percentile)		95th percentile		99th percentile		
	Current concen-trations	Model nitrate concen-trations	Current concen-trations	Model nitrate concen-trations	Current concen-trations	Model nitrate concen-trations	Percent N reduction
Shallow	2.5	0.39	7.6	0.84	-	1.0	89.36
Mid depth	2.4	0.46	6.1	0.82	-	1.0	88.89
Deep	0.3	0.55	1.6	0.86	-	1.0	88.24

43 Table 3, D A Rankin rebuttal evidence
44 Paragraphs 56 and 57, JWS – Groundwater Science
45 Paragraph 58, JWS – Groundwater Science
46 Paragraphs 21, 52 and 53, JWS – Groundwater Science

46. However, in doing so note that the median nitrate concentration in the deep aquifers would rise from the current 0.3 mg NO_3^--N/L to 0.55 mg NO_3^--N/L, an 83 % increase, which may or may not be an acceptable increase in nitrate concentration, or loss in water quality, for this main source of Christchurch's drinking water. In contrast, in order to retain the current median concentration in the deep aquifers a reduction of nitrate nitrogen release of 94% is required[47]. ECan does not provide a worst case scenario of what farming would actually be permitted in the WZ under PC7, leaving this open-ended, so greater reductions in nitrogen released may be needed than those illustrated here.

Relief sought by WIL

47. WIL has sought revisions to PC7 as they feel current reductions required on nutrient release are too high and restrictive on their shareholders. Also WIL wish to pursue water storage proposals to assist with managed aquifer recharge (**MAR**) and targeted stream augmentation (**TSA**) to better address the outcomes sought by the WZC and these proposals cannot be undertaken under the current PC7 policy framework[48]. The groundwater experts in their JWS offered the view that MAR and TSA had the potential to offer benefits in reducing nitrate concentrations at catchment and sub-catchment scale[49].
48. However, analysis of the WIL MAR and TSA proposals reveals that large quantities of water are required and that no allowance has been made for MAR to address the contamination that will arrive in the Christchurch aquifers[50] and elsewhere in the WZ. The WIL MAR and TSA analysis also relies on using data from the ECan groundwater model that WIL considers inaccurate[51]. In addition, because MAR and TSA do not remove nitrogen load from the WZ but simply 'dilute pollution', unlike PC7 which proposes to remove some of the nitrogen load from the WZ, the environment outcomes in the WZ from the 'WIL Solution' will be worse than what PC7 proposes[52]. Therefore, I have no faith in the claims by WIL that their proposed solution will achieve the proposed water quality targets, or that this will be achieved more quickly because of the use of MAR and TSA[53]. Much more detailed and considered analysis needs to be completed before any of the WIL proposals should be

[47] Scenario 4, Table 10, D A Rankin EIC
[48] Paragraph 59, D A Rankin rebuttal evidence
[49] Paragraphs 60-61, JWS – Groundwater Science
[50] Paragraphs 62-68, D A Rankin rebuttal evidence
[51] Paragraph 63, D A Rankin rebuttal evidence
[52] Paragraphs 69-72, D A Rankin rebuttal evidence
[53] Paragraph 76, D A Rankin rebuttal evidence

considered as offering a viable solution for excessive nutrient release and pollution in the WZ[54].

49. Dr David Black[55] has provided rebuttal evidence for WIL in response to evidence of Dr Tim Chambers and Ms Bridget O'Brien for the CCC.
50. In paragraph 8 in discussing the context for his rebuttal of Dr Chambers' evidence, in which Dr Chambers discusses the basis for a proposed reduction in the nitrate concentrations permissible in the Christchurch aquifers, Dr Black states "It is argued that there is an evidential basis for considering that adverse effects could occur at lower levels than the standard. This is contrary to the evidence based position adopted by WHO". I find this last sentence confusing and misleading on a number of levels.
51. The World Health Organisation (**WHO**) has set a drinking water standard to protect infants from methemoglobinemia, and will have used an evidence based approach in deciding on that standard. However, this standard is not based on a consideration of other health risks[56], such as cancer and poor birth outcomes[57]. In other words the current drinking water standard may not be appropriate to protect the public from cancer and poor birth outcome risks associated with nitrate in drinking water. Dr Chambers presents a growing body of evidence that there is an association between drinking water nitrate and colorectal cancer[58]. There is a statistical association that greater cancer risk occurs at much lower nitrate concentrations than those in the current drinking water standard, such as at concentrations down as low as 0.87 mg NO_3^--N/L[59]. Based on evidence from the literature Dr Chambers concludes that the current drinking water standard is not set at a low enough nitrate concentration to provide protection from an increased risk of colorectal cancer, a view also expressed by others in the literature[60].
52. Dr Black appears to take issue with Dr Chambers' deterministic approach[61], which in his view overturns WHO and international best practice when Dr Chambers suggests reducing the target threshold for nitrate nitrogen to 1.0 mg/L[62], and which also does not meet the

[54] Paragraph 72, D A Rankin rebuttal evidence
[55] Rebuttal evidence of Dr David Russell Black, 18 September 2020
[56] Paragraph 72, D A Rankin EIC
[57] Paragraph 73, D A Rankin EIC
[58] Paragraphs 16-34, T Chambers EIC; Paragraph 14c, Rebuttal evidence of Dr David Russell Black
[59] Paragraph 43, T Chambers EIC; Paragraph 79, D A Rankin EIC
[60] Paragraphs 81, 88, and 89, D A Rankin EIC
[61] Paragraph 14c, Rebuttal evidence of Dr David Russell Black
[62] Paragraph 14d, Rebuttal evidence of Dr David Russell Black

Bradford Hill assessment methodology and tests for epidemiological associations[63] according to Dr Black.

53. However, in the absence of a proper standard rigorously based on established science to address concerns about the validity of using the current methemoglobinimea based drinking water standard, and especially it's suitably as a standard to protect a population from possible colorectal and other cancer and poor birth outcome risks[64], the question remains what should be done? The recent review of the NZ drinking water standard (NZ 2018 Standards) only dealt with concerns about microbiological contamination, and not with other ideas such as carcinogenesis or poor birth outcomes[65].

54. Dr Black takes the view that a separate 'pseudo standard' of 1.0 mg NO_3^--N/L proposed by the CCC be rejected on the basis that it has no proper basis in terms of established causation and therefore has poor scientific integrity, and that the current drinking water standard should apply[66]. Dr Black suggests that 'pseudo standards' if adopted may possibly waste resources for no purpose. I agree that this could waste resources in some circumstances, for example, where a standard was sufficient to protect the public from all health risks. If a more stringent 'pseudo standard' was adopted that could add more costs but not provide any greater protection, if the standard used already provided protection from all health risks.

55. Dr Black also suggests 'pseudo standards' may cause a false sense of public reassurance[67]. I don't agree that this will always necessarily apply. For example, a false sense of security could arise in the case of adopting the current drinking water standard and assuming this protects the population from more recently identified colorectal cancer and other health risks. The current drinking water standard (maximum allowable value (MAV) of 11.3 mg NO_3^--N/L) is only designed to protect against methemoglobinemia[68]. If it is found that the current drinking water standard needs to be reduced to a MAV of 1.0 mg NO_3^--N/L to protect against colorectal cancer and other health risks, then adopting the current drinking water standard (MAV of 11.3 mg NO_3^--N/L) is clearly not protecting the public and could clearly be providing a false sense of public reassurance.

56. A precautionary approach is needed as there is increasing scientific evidence of serious health implications from nitrate in drinking water. For example, until the drinking water

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[63] Paragraphs 16 and 17, Rebuttal evidence of Dr David Russell Black
[64] Paragraph 80, D A Rankin EIC
[65] Paragraphs 20 and 23, Rebuttal evidence of Dr David Russell Black
[66] Paragraph 24, Rebuttal evidence of Dr David Russell Black
[67] Paragraph 24, Rebuttal evidence of Dr David Russell Black
[68] Paragraphs 72-75, D A Rankin EIC

standard is reviewed, and especially until a standard is established to ensure there is no cancer or poor birth outcome risk from nitrate in drinking water, then the nitrate concentrations should be retained as they are now in the Christchurch aquifers. No increase should be knowingly allowed. This would meet the needs of Christchurch citizens, who do not want to lose their precious high quality groundwater drinking water resource. As has been shown in my rebuttal evidence[69], applying a 1.0 mg NO_3^--N/L upper limit as the CCC proposes would not quite retain the median nitrate concentration of 0.3 mg NO_3^--N/L in the deep aquifer. Therefore it may be necessary to apply a more stringent limit.

Adaptive management based on monitoring

57. In the JWS "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"[70] and "that the current monitoring programme is unlikely to be suitable for this purpose"[71]. I agree with both these sentiments but do add a note of caution.
58. Establishment of some key new wells, and extensive monitoring of wells in the wider WZ, including the interzone transfer source area and areas down to Christchurch, elsewhere in the Waimakariri catchment, and in the Christchurch groundwater zone, are needed. This is particularly required to help monitor and confirm groundwater flow direction in the shallow through to deep groundwater from any relevant areas on the Canterbury plains both north and south of the Waimakariri River and the threat posed to Christchurch's groundwater.
59. An adaptive management approach has been suggested by Mr Thorley, Dairy NZ (Dr Rutter), Federated Farmers, and others to deal with the problems with nutrient release from PC7 and Christchurch's groundwater issue[72]. Such an approach requires detailed data and normally a situation where impacts and feedback from changes to parameters can be quickly and accurately detected. However, in the current situation, changes in aquifer nitrate concentrations from altered farming practices may take many years to work their way through the system and to manifest themselves, and may show significant variability, and so such a procedure is likely to be of limited utility[73]. By the time problems are finally clearly established, farming practices will be well and truly entrenched as will pollution in the

[69] Paragraphs 34-38, D A Rankin rebuttal evidence
[70] Paragraph 62, JWS – Groundwater Science
[71] Paragraph 63, JWS – Groundwater Science
[72] Paragraph 48, M Thorley EIC for Christchurch City Council
[73] Paragraphs 58, 73-76, D A Rankin rebuttal evidence

aquifers connected to the Christchurch aquifers, and it will take some time to work their way out of the system if changes were made. In addition, a significant amount of time will be needed to change the farming causing the problem, as is the case now. In the interim groundwater drinking water supplies in Christchurch and the WZ would be severely compromised.

Hearing presentations

47. I would like to comment on a few of the presentations where they provide context to the landscape and problems in front of us. It is clear the farming sector in the WZ, and no doubt elsewhere throughout Canterbury and the country, remains under significant threat financially and environmentally from the widespread adoption of intensive farming and particularly dairy farming. Unfortunately the farming sector and its leadership have paid little heed to the warnings it has had in recent years. Also the sector has undertaken many changes and made major investment (such as in dairy farming) that have only worsened and added to those problems. Mr Glass for Dairy Holdings Ltd (and involved in WIL) spoke passionately to the Hearing panel about the financial difficulties facing dairy farmers and their fear of what the future holds. This is especially true with regards to environmental constraints in zones identified in the NPA where large proposed reductions in nutrient release means that farmers will not be able to continue farming as they currently know it. Mr Glass suggested farmers are engaged in the current process and will do what they need to do as soon as they know what that constitutes, and so long as there is 'balance' in this approach and so long as the changes required are practicable and achievable. I doubt the WIL farmer shareholders and farming community have had the current threat to Christchurch's groundwater clearly explained to them, and why a number of them are responsible for this, so that they can then understand why and what they might need to do to rectify this situation, if indeed they can or want to. This is really a terrible situation for many WZ farmers to be in. Sadly it is of the industry's making where it has supported and facilitated the recent milk 'gold rush'.
48. Understandably, as these issues have come to a head, farmers feel threatened and under siege, as, for example, discussed by Mr Wells from Carleton Dairies Ltd (and also a director of WIL). Mr Wells mentioned dairy farms were unfairly blamed for poor environmental outcomes and cited multiple septic tanks in the WZ as being possible candidates for the problems. Sadly this is not the case; the 5535 authorised discharges from on-site sewage

effluent in the WZ amount to an estimated 40 t/yr of nitrogen[74], only 1.1 % of the estimated 3,669 t/yr discharged below the root zone from farming under current consented at GMP[75]. Suggestions such as these seem to be trying to deflect the focus from the issues at hand. When information is given it needs to be accurate so that we are able to properly recognise problems. Then it may be possible to do something about them.

49. Dr Doole from Dairy NZ spoke about the financial fragility and high indebtedness of many dairy farming operations in the WZ.

50. Mr Dave Winter spoke of the risk to his potato farming operation if MAR was adopted by WIL as a 'dilution of pollution' solution, and which has the potential to turn his potato growing land close to Kaiapoi into a swamp, as a result of a raised water table and return of downplain springs. Presumably this risk applies in other areas illustrating that MAR may cause other unintended problems.

51. Dr Fenwick spoke of the threats from nutrients and MAR to the Canterbury and WZ groundwater ecosystem, and the need to protect its critical ecosystem service function, for the health and sake of our environment and ourselves.

52. Ms Vicki Buck spoke of the need to protect Christchurch's precious highly valued pure untreated groundwater drinking water source.

53. We have reached a very sad state of affairs and now we have to do something to fix it. It is the responsibility of industry and community leaders to be well informed so that they can provide accurate information to their members and communities. The problems we are taking about have been around for a number of years and still remain. The whole community, rural and urban, needs to be properly informed of these issues, so that a meaningful pathway forwards can be developed.

Relief sought via PC7 to protect Christchurch's drinking water aquifers

60. In terms of my own preferences for protection of Christchurch's groundwater drinking water source for the Christchurch population for posterity I would prefer to see Christchurch's median nitrate concentration in the deep aquifers retained at the current level of 0.3 mg NO_3^--N/L, and appropriate legally enforceable actions and limits enshrined in rules in PC7 around nitrogen reductions required and nitrogen limits set in the interzone transfer source area to ensure that this will happen. ECan should not be promoting a plan change, which, on

[74] Table 1, page 8, Loe and Clark (2017)
[75] Table 9, D A Rankin EIC

the basis of its own data and analysis, would lead to a severe degradation in the quality of Christchurch's groundwater drinking water supply.

61. How could this be achieved?
62. ECan would regulate the annual nitrogen load (nitrogen as kg/Ha/yr) released from farming in the interzone transfer source area, and any other additional areas that feed into the Christchurch aquifers. The loads that were to be permitted could be calculated based on the current consented at GMP data set[76] and results for the modelled nitrate concentrations that will eventuate in the Christchurch aquifers.
63. What would these loads likely amount to?
64. The groundwater flow rate from the Waimakariri plains aquifer in the interzone transfer source area to the Christchurch aquifer has recently been determined[77] to be about 4.1 m^3/s. The mean 99^{th} percentile predicted steady state nitrate concentration in the Christchurch aquifers, resulting from current consented at GMP farming in the 34,000 Ha interzone transfer source area is 8.97 mg NO_3^--N/L[78]. Thus an estimate of the load that has leached below the root zone in the interzone transfer source area and contributed to produce such nitrate concentrations in the Christchurch aquifers will be about

= (8.97/1000/1000) kg/L* (4.1*1000) kg/s*(60*60*24*365) s/yr*(1/34,000) per Ha

= 34.1 kg/Ha/yr.

65. This is an entirely reasonable figure given the nitrogen losses observed from dairy and other farming in this area[79]. The load from this farming will result in a median nitrate concentration in the deep aquifers of 4.7 mg NO_3^--N/L[80]. If there is a desire to retain the deep aquifer nitrate concentration at the current observed median of 0.3 mg NO_3^--N/L, this implies that this nitrogen load will need to be reduced to about (0.3/4.7*34.1), i.e., 2.18 kg/Ha/yr.
66. This reduced nitrogen load loss/yr in the interzone transfer source area would then become the annual limit for nitrogen released from any farming activities carried out in this area. It might be necessary for this load limit to be halved so that a safety factor is built in to the

[76] According to ECan data the nitrate loss from this scenario is 3669 tonnes/yr into the WZ (Scenario C, Table 9, D A Rankin EIC). However, a lesser amount will be discharged into the interzone transfer source area (but this will be known from the way the farming model has been built) as the interzone transfer source area of 34,000 Ha, for example, is only a part of the farmed land area in the WZ.

[77] Paragraph 32, JWS – Groundwater Science

[78] Using data from Table 2, D A Rankin EIC

[79] For example, 27-65 kg/Ha/yr for irrigated dairy farming, Table 9, Harris (2019)

[80] Data from Table 2, D A Rankin EIC

system to ensure that the desired nitrate concentrations will not be exceeded in the Christchurch aquifers from whatever land use activity that remains permitted.

67. The final chosen annual load limit has to be included and written into the CLWRP and any other relevant plans along with the successive planned reductions in nitrogen loads that might be permitted over time to allow all those farmers within areas that impacted the Christchurch aquifers a reasonable time frame within which to phase in different farming options to meet those new load limits. No new farming or expansion of farming shall be permitted in this area other than that that would meet the load limit. This would permit changes to other appropriate forms of low nitrogen release farming that could be carried out in the areas that feed the Christchurch aquifers as old inappropriate farming practices were phased out. Clear unambiguous signals would be sent to the farming community.

68. ECan would need to regularly monitor this process and impacts on selected wells to ensure that the reductions in nutrients released from farming were having the desired effect on maintaining Christchurch's groundwater quality. In addition the same process would need to be applied to any other farming areas found to be contributing nitrate to the Christchurch aquifers, after further modelling was completed by ECan elsewhere in the Waimakariri catchment to identify any such additional source areas.

69. Such a protocol would ensure Christchurch's drinking water and source would be protected for the future.

70. Alternatively, if you decided a 99th or 99.9th percentile 1.0 mg NO_3^--N/L limit in Christchurch's deep groundwater aquifers requested by the CCC was permissible, and that the 83 % increase in median nitrate concentrations from the current 0.3 to 0.55 mg NO_3^--N/L that this would inevitably lead to was consistent with the NPSFM and RMA, then the same process could be applied but using different and appropriate parameters reflecting the small increase in nitrate concentrations (or a decrease in water quality in Christchurch's deep aquifers) that would inevitably be permitted (Figure 3). In this case the nitrogen load loss permitted from farming would be about (0.55/4.7*34.1 or 1.0/8.5* 34.1), i.e., 4.0 kg/Ha/yr. The remaining parts of the protocol would need to be completed as in paragraphs 66 to 68.

71. The data in Figure 3 visualise the consequences of reducing the nitrate loss to meet the proposed CCC nitrate limit in the deep Christchurch aquifer, as discussed in the preceding paragraph. Whereas the current 95th and 99th (data not shown) percentile nitrate concentrations would be reduced by meeting that limit, the median concentration is significantly increased.

Concluding Comments

72. I have provided evidence to show the magnitude of impacts of PC7 on Christchurch's aquifers, what action is needed to alter this trajectory, and the risks that increased nitrate levels in drinking water pose to our community. I have shown that recent literature suggests a 'safe' drinking water nitrate concentration is essentially what we currently have in Christchurch's deep water aquifers, i.e., a median concentration of 0.3 mg NO_3^--N/L. I have also drawn attention to the inconsistency of PC7 with respect to the CWMS, NPSFM (both the 2017 and 2020 versions) and RMA. It is my view that you do not have enough data to show that water quality is being maintained within FMUs in the WZ. Without this there is no surety that the requirements of the NPSFM and RMA will be met. All these combined factors lead me to the conclusion that PC7 cannot be permitted in its current state.

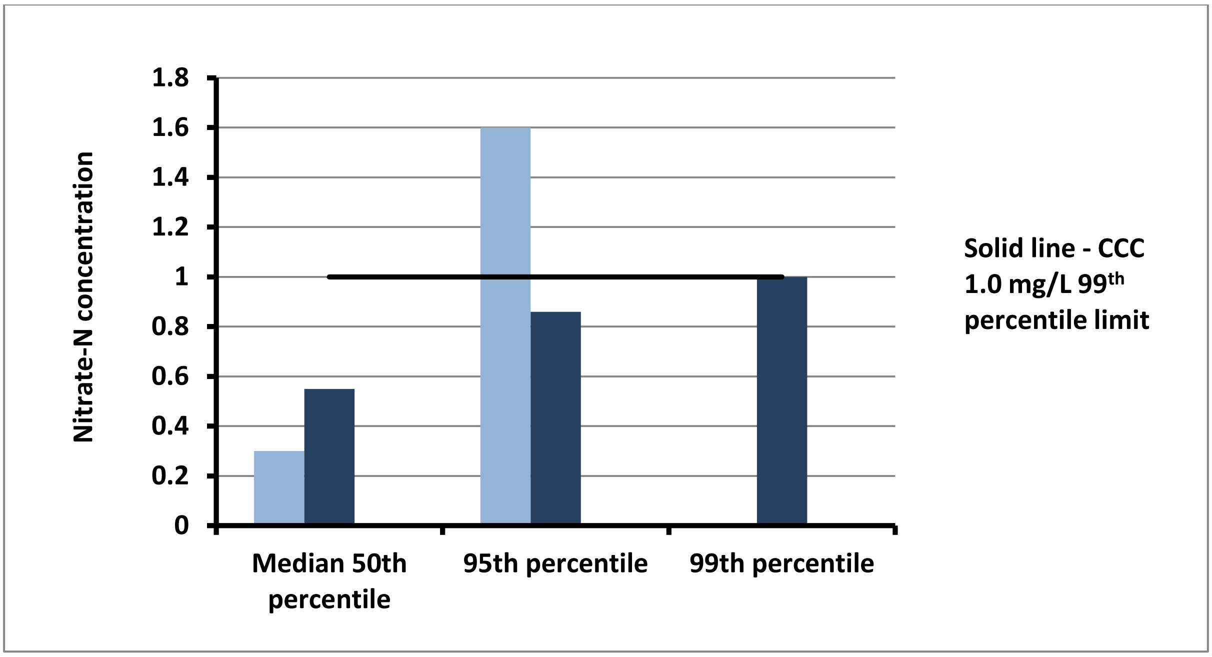

Figure 3: Current (light blue) and modelled (dark blue) nitrate concentrations in the deep Christchurch aquifers after an 88.24% reduction in the nitrate loss from current consented at GMP farming in the interzone transfer source area in the Waimakariri Zone NPA required to meet the CCC 1.0 mg/L nitrate limit

73. In addition, changes will be needed to the CLWRP as this permissive plan and rules will likely also mean the NPSFM 2020, and therefore the RMA, is not being adhered to.

74. I have also outlined what needs to be done to reverse this situation and protect Christchurch's drinking water supply, including the setting of appropriate limits on farming activities in areas that leach nutrients into the Christchurch aquifers, and including how

much nitrogen load can be lost from farming areas so that Christchurch's drinking water concentrations remain at safe protected levels.

75. The risk posed from the contamination of Christchurch's groundwater with nitrate leachate from the continued and expanded unsustainable farming practices in the WZ is known. We also know that the risk can be removed and the contamination prevented. Therefore the extensive high-nutrient release farming in the WZ that feeds nitrates into the Christchurch aquifers now or in the future must not continue. The farming currently permitted needs to be progressively removed and replaced by farming activities that have minimal nitrate leachate, and that protect Christchurch's precious groundwater drinking water resource. This is essential to prevent another disastrous environmental and economic failure. Local government (ECan) must accept its responsibility to protect our environment, and in this case Christchurch's groundwater. It must consider all externalities and impacts and not just the imperatives of the farming community.

76. The adoption of PC7 will, unless modified:
    (a) cement in place a degraded freshwater environment in the WZ and Christchurch for the future
    (b) permit further uneconomic farm development (when externalities are included)
    (c) mean Christchurch will lose its outstanding high-quality safe groundwater drinking-water resource
    (d) subject Christchurch and the WZ to poor birth outcomes and colorectal and other cancers and costs
    (e) incur significant costs for Christchurch for the treatment of its drinking water supply or provision of a new drinking water source

Our community will be poorer as a result.

77. In addition we might end up in a similar situation to one my wife and I recently experienced in the USA. On the back of the front door of a motel in Grand Coulee City, in the middle of a desert area, was a notice warning that the tap water nitrate concentration exceeded the USA 10 mg NO_3^--N/L drinking water limit, and was unsafe for pregnant mothers and infants to drink. The motel owner stated that their groundwater was polluted from the use of fertiliser to grow alfalfa in the region using irrigation water from the nearby Grand Coulee Dam on the Columbia River. The alfalfa was used for feeding cattle. This will be our future unless we do something to stop it.

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