in the matter of: the Resource Management Act 1991

and: submissions and further submissions in relation to proposed variation 1 to the proposed Canterbury Land and Water Regional Plan

and: **Central Plains Water Limited**
Submitter

Statement of evidence of Ian McIndoe (hydrology and water demand)

Dated: 29 August 2014

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STATEMENT OF EVIDENCE OF IAN MCINDOE

INTRODUCTION

1 My name is Ian McIndoe.

2 I am a Soil and Water Engineer, currently employed as Principal Engineer by Aqualinc Research Ltd, of which I am a director.

3 I have 37 years' experience in water resources, hydrology and irrigation related work. I have specialised in water allocation for irrigation and the effect of water restrictions on irrigation reliability and performance.

4 I hold the qualifications of BE (Hons) from Canterbury University and Dip Bus Stud (Finance) from Massey University. I am a board member of Irrigation New Zealand and a member of the New Zealand Hydrological Society.

5 In preparing my evidence I have reviewed the following reports:

5.1 Aqualinc (2007) Canterbury Groundwater Model 2 by Aqualinc Research Limited Report No. 07079/1 October 2007

5.2 Clark, D.A., 2014. Technical report to support water quality and water quantity limit setting process in Selwyn Waihora catchment. Predicting consequences of future scenarios: Surface water quantity

5.3 Environment Canterbury 2014 Proposed Variation 1 to the Proposed Canterbury Land and Water Regional Plan Section 32 Evaluation Report

5.4 Hanson, C., 2014. Technical report to support water quality and water quantity limit setting process in Selwyn Waihora catchment. Predicting consequences of future scenarios. Groundwater quality, Environment Canterbury

5.5 Robson M (2014) Technical report to support water quality and quantity limit setting in Selwyn Waihora catchment Predicting consequences of future scenarios: Overview Report.

5.6 Scott, D. and Weir, J., 2014. Technical report to support water quality and water quantity limit setting process in Selwyn Waihora catchment. Predicting consequences of future scenarios. Groundwater quantity.

6 I have also read the relevant parts of the Officers section 42A Report, the s32 report and the Land and Water Plan, which have been made available through the Council web site.

SCOPE OF EVIDENCE

7 I have been asked by Central Plains Water Limited (*CPWL*) to provide evidence in relation to proposed Variation 1 to the proposed Canterbury Land & Water Regional Plan (*Variation 1*).

8 In my evidence I have been asked to:

8.1 provide an outline of my review of the hydrology aspects of the technical reports prepared by Canterbury Regional Council (the *Council*) and used in the water quantity and quality limit setting process;

8.2 describe the CPWL Scheme demand for water and the need for storage;

8.3 discuss the importance of ensuring Variation 1 accommodates the development of Stages 2+ of the Central Plains Water Enhancement Scheme (*the Scheme*) if the wider sought groundwater outcomes contemplated by Variation 1 are to be met; and

8.4 comment on the groundwater transfer provisions in the Plan Variation.

9 Although this is a Council hearing, I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2011. I have complied with the Code of Conduct in preparing this evidence and I agree to comply with it while giving oral evidence before the hearing committee. Except where I state that I am relying on the evidence of another person, this written evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this evidence.

REVIEW OF COUNCIL REPORTS

10 As noted in my paragraph 8.1, I have undertaken a review of the hydrological aspects of the technical reports that have been relied on by the Council in setting the water quantity and quality limits in Variation 1.

11 The purpose of my review was to understand and comment on the appropriateness of the hydrological processes and assumptions used in modelling for the setting of water quantity and quality limits, as it

might be relevant to informing the N load provided to CPWL in Table 11(j) and the N load for farming more generally in the wider catchment.

12 In particular, the aim was to identify model issues and shortcomings, how they might impact on the results and what actions could be taken to address the issues. The key questions I set out to answer were:

a) Is the modelling process robust and reliable?

b) How much uncertainty is there in the results?

13 The modelling undertaken by the Council that underlies Variation 1 comprises a number of separate models that have been run and then the outputs from each 'collated' together. This has required the use of a number of assumptions as to how each model (and the outputs from each model) relate to each other.

14 In regard to hydrology, there were four separate hydrological models used by the Council to support the water quality and quantity limits set out in Variation 1. These (with reference to the relevant model author) are:

1. Soil water balance modelling (David Scott);

2. Groundwater modelling (Julian Weir);

3. Stream flow modelling (Daniel Clark); and

4. Hydrological modelling related to water quality (Carl Hansen).

15 Each is discussed below.

1. Soil water balance modelling

16 David Scott (the Council) used a simple daily soil-water balance model to determine irrigation demands (pumping from groundwater) and drainage to groundwater in the Selwyn-Waihora zone.

17 I identified several factors/ assumptions in the modelling that I considered were problematic and could influence the outcomes in a way that could lead to bias. They are summarised in Table 1.

Table 1: Soil water balance modelling review

Parameter/ Assumption	Effect on irrigation demand	Effect on drainage to groundwater
Measured rainfall increased by 10%	Unknown, probably underestimated	Probably overestimated
100% pasture	Overestimated	Probably underestimated
Crop factor = 1	Slightly overestimated	Slightly underestimated
PAW incorrectly adjusted for depth	Slightly overestimated	Slightly overestimated
Irrigation trigger fixed	Overestimated	Overestimated
Soil filled to field capacity	Overestimated	Overestimated
Efficiency adjustment (x1.25)	Overestimated	Overestimated
No system capacity limits	Overestimated	Overestimated
No annual allocation limits	Overestimated	Overestimated
Restricted irrigation season length	Slightly underestimated	Slightly underestimated
Effect of high water tables at the coast	Overestimated	Overestimated

18 Because the outputs from the soil water balance model were used in subsequent hydrological models, I was interested to know how the parameters or assumptions would affect irrigation demand (the amount of water taken from the groundwater system for irrigation) and drainage to groundwater (the amount of water returning to the groundwater system).

19 As an example, where irrigation demand is overestimated by assuming all landuse is 100% pasture rather than using a land mix closer to existing or expected future land use, a higher volume of water would be taken from the groundwater system resulting in lower groundwater levels and spring flows.

20 Where irrigation demand is overestimated by assuming there are no irrigation system capacity limits (the litres/sec/ha) or allocation limits (annual volume limits) on takes, a higher volume of water would be taken from the groundwater system resulting in lower groundwater levels, but higher drainage would occur partially negating the effects of the higher abstraction.

21 Overall, I found that the majority of the assumptions made for the soil water balance modelling would have the effect of significantly overestimating irrigation demand and would result in excessive

drainage to groundwater. Many of the assumptions do not reflect the current regulatory environment or current irrigation practice.

22 I cannot accurately predict what the effect of overestimation of irrigation abstraction and drainage will be, as a significant degree of hydraulic balancing and water movement will be occurring. Questions such as the effect of the transfer of deep groundwater to shallow groundwater arise. However, under the assumptions used, a higher volume of water will be removed via evapotranspiration, especially in drought years, which I would expect to result in lower stream flows than would be the case if more realistic assumptions were adopted.

2. Groundwater modelling

23 The groundwater modelling was carried out by Julian Weir (Aqualinc under contract to the Council) using the Aqualinc Canterbury groundwater model (and input assumptions that were prescribed by the Council).

24 The model domain was reduced in size to include the area from 5 km north of the Waimakariri River down to 5 km south of the Rakaia River, but otherwise unchanged from when it was calibrated in 2007. I am comfortable with that approach.

25 My interest in the groundwater modelling was to find out if predicted groundwater levels and stream flows were likely to be realistic. I identified six factors in the modelling that I considered were potentially an issue and could lead to uncertainty in estimates of groundwater levels and lowland stream flows. These are summarised in Table 2.

Table 2: Groundwater modelling review

Parameter/ assumption	Effect on groundwater levels	Effect on stream flows
Irrigated area overstated	Overestimated	Overestimated
Model run period (1972 – 2010) shorter than necessary	Uncertainty around range	Uncertainty around range
Long warming period used	Less variability	Less variability
Inputs into model were monthly rather than daily	Step change responses	Step change responses, making stream flow analysis difficult and uncertain
Irrigation scheme race losses not included	Lower than actual	Lower than actual
Irrigation demand & drainage excessively high	High	High

26 My criticism is not about the groundwater model itself; in my view, the model is fit for purpose. My concern is about the inputs into the model and resulting from that, a high degree of uncertainty in the outputs.

27 My biggest concern is whether the estimate of irrigation abstraction at the zone level is reasonable and reliable, because if it is excessive, it will lead to lower groundwater levels and stream flows.

28 Total abstraction is driven by on-farm demand and irrigated area. I have already made the point that on-farm demand estimates are overstated. Aqualinc has mapped actual irrigated area in the zone and found it to be about 90,000 ha with a 5% margin of error. Consented irrigated area, based on the figure used by the Council in the analysis is 114,000 ha, but the Aqualinc GIS analysis carried out during the irrigated area mapping showed that there is a degree of double-counting (land parcels with multiple consents) occurring in that estimate.

29 Overall, my view is that the overestimate of actual irrigated area combined with excessive irrigation demand will result in predictions of groundwater levels and stream flows in dry years that are lower than would occur in practice.

30 I am less concerned about the other assumptions made with respect to the groundwater modelling. Although they may not have had a significant effect on the results, the issues could have been avoided.

3. Stream flow modelling

31 This was carried out by Daniel Clarke (the Council) using a series of Excel spreadsheets.

32 Again, I identified issues with the stream flow modelling, as outlined below in Table 3.

Table 3. Stream flow modelling review

Parameter	Status	Effect on lake volumes	Effect on minimum stream flows
Quick flow volumes	Double counted	Overstated	No effect
Base flow separation	uncertain	N/A	N/A
Selwyn River regression	Uncertain predictions	Unknown	Unknown
Constant flow ratios between streams	Not proven	Uncertain, probably minimal	Uncertain, probably minimal
Flushing flows	Included	Minimal	N/A
Drying reaches	Uncertain	Minimal	Uncertain

Surface water irrigation supply reliability	Probably understated	N/A	N/A
Flow permanence	Included	Minimal	Uncertain
7 Day MALFs	Probably overstated	Minimal	High
Days below ecological flow	Possibly understated	Minimal	High
Current stream flow observations	Limited data	Uncertain	Uncertain

33 I found that estimates of actual stream flows had previously been made using a combination of measured flows and regression with measured data (Clark, 2011a). Because measured flows included base flow (from groundwater) and quick flow (from direct runoff), Clark had to separate the base flow and quick flow.

34 Clark added base flows from each of the groundwater scenarios to the separated quick flow (assumed to be constant for all scenarios) to determine a revised stream flow time series for each scenario.

35 Assuming constant quick flow, which has been derived from measured or regressed data, and applying that to modelled base flows, is questionable.

36 Importantly, adding quick flow to modelled base flow is double counting some of the quick flow volumes going into the lake because the Scott water balance modelling operated on the basis that all rainfall went into the soil and drainage from soil went into groundwater.

37 Because of the uncertainty in stream flow modelling, it is difficult to assess whether the predicted flows, and in particular, the flow differences between scenarios, are realistic. Clark makes the point that modelled scenarios should not be compared to actual measurements. However, without doing that, it is difficult to put the modelled figures into context.

38 I summarised the mean flow and 7DMALF statistics for measured stream flows and for three modelled scenarios, as shown below in Table 4.

Table 4: Mean flow and 7DMALF statistics

Scenario	7D MALF	MEAN
Measured/ current state	4076	8648
Scenario 0 (no irrigation)	5285	11018
Scenario 1 (modelled current state)	2409	9238
Zone Committee solution	4238	12120

39 The current state scenario considers time-varying land use with incremental irrigation development over time to represent the state of the groundwater system as it would have been historically. Flow statistics for this scenario have not been presented by the Council, which is unfortunate, as it would have indicated how well the measured current state matches the modelled current state. In essence, I don't know how well the modelling reproduces measured data.

40 Scenario 1 considers how current (2011) irrigation and land use would have affected groundwater levels and stream flows if the current land use had been in place for the entire simulation period.)

41 That is fine, but due to the implementation of red zones, the majority of groundwater consents in the zone were granted prior to or soon after 2004. There were additional consents granted after 2004, but the majority are subject to restrictions based on groundwater levels (commonly referred to as adaptive management conditions) and would not impact significantly on low flows.

42 From what we have seen from the previous Aqualinc groundwater modelling, the majority of the effect of pumping occurs within the groundwater system in less than three years (Aqualinc (2007). Most is within the first year.

43 That being the case, most of the effects of irrigation expansion, particularly on the low flows, will be fully incorporated into measured low flow data since about 2007. If the modelling was extended to the 2013/14 season, it is my view that the last 8 years of consented takes in terms of effects on low flows would be largely unchanged.

44 On that basis, I would expect groundwater levels and stream flows for the measured scenario to be similar to or slightly higher than for Scenario 1 for the last 8 years or so.

45 For both the measured and Scenario 0 numbers, 7D MALF is just under half mean flow. As measured includes the effect of current use, I would expect 7DMALF and mean for measured to be lower than Scenario 0, which they are. The mean for Scenario 0 appears to be too high, which could result partially from the double counting of quick flow.

46 That comparison gives me some confidence that the Scenario 0 modelling, which does not include any irrigation effects, is in the right ballpark.

47 I have serious concerns about the Scenario 1 figures, both in absolute terms and relative to the other scenarios.

48 Firstly, the mean for Scenario 1 cannot be higher than the mean for measured, especially given the fact that irrigation demand for Scenario 1 has been overestimated. This issue is also seen in R14/11, Fig 2-5 where the Scenario 1 mean is slightly higher than the current state mean.

49 Secondly, there is a big discrepancy in the 7D MALF figures between measured and Scenario 1. For Scenario 1, 7D MALF is about quarter of mean flow, rather than half, which means that the predicted stream flow patterns have changed significantly. That change is definitely not seen in the measured flows.

50 The Scenario 1 low flows are 60% of the measured 7D MALF and only 45% of Scenario 0 7D MALF, which in relative terms, seems much too low. For the zone committee scenario, 7D MALF is about one third of mean flow.

51 It is clear that the existing modelled irrigation scenarios cannot be reliably compared to measured values. That raises the question as to whether the relativity between modelled scenarios is reliable.

4. Hydrological modelling related to water quality

52 This has been carried out by Carl Hansen (the Council). Because my brief has not included a review of the nutrient analysis, I comment only on the hydrological aspects of Hansen's report.

53 My concerns are related to the hydrological assumptions made in the nutrient technical assessments.

54 These assumptions include the suggestions that:

> *"Groundwater system functions as a single unconfined aquifer"* (2.1.2 Groundwater, in Report R14/11 p4)

55 That is not correct. Aquifers are mostly leaky confined or confined. There are virtually no unconfined aquifers. The correct statement is that it functions as an interconnected system.

> *"River recharge goes into deep groundwater and reappears as it approaches the coast. Land surface recharge stays in shallow groundwater"* (2.1.2 Groundwater, in Report R14/11 p4).

56 This conflicts with the Council statement above. In fact, most river recharge goes to shallow groundwater first then to deep groundwater. Some of the upper plains land surface recharge goes to deep groundwater (because there is limited shallow groundwater), some of which reappears as it approaches the coast. A significant proportion of groundwater flow discharges to the Pacific Ocean.

> "*Direct discharge of groundwater to the lake is minor (100 l/s)"* (Table 2-2; White, 2009 cited in 2.1.2 Groundwater, in Report R14/11 p5).

57 This conflicts with groundwater modelling, which found that 33 m^3/s discharges to the lake or the ocean. The water balance numbers given in Table 2-2; White, (2009), are also inconsistent with the Scenario 1 numbers present in Technical Report R14/16. For example, land surface recharge and groundwater pumping are 23.8 and 11.3 m^3/s respectively, while in R14/16, they are 37.9 and 16.4 m^3/s respectively.

58 The nitrate leaching and land surface recharge rates used in the nutrient analysis were taken from Hill and Lilburne (2014) (R14/11, p7). The land surface recharge rates in that report bear no relationship to and are inconsistent with the rates presented in R14/16, which were used to determine stream flows. The Hill & Lilburne rates are about half of the R14/16 rates (R14/11 Table 4-1).

59 However, nitrate loads and concentrations entering the Lake were determined from stream flows derived from data from the groundwater modelling (see R14/11 p8), as calculated by Clark (R14/8).

Overall comment on hydrological modelling

60 It should be clear from the assessments set out above that there is a high degree of uncertainty in the Council hydrological analysis, (which at least in part is acknowledged by the Council authors of the technical reports). That uncertainty leads to further uncertainty in the estimates of nutrient load likely to enter the Lake under the various scenarios considered.

61 The key matters are the overestimates of irrigation demand and drainage and the issues with the irrigated scenarios and the subsequent impact on stream flows and discharges to the Lake. My view is that the impact of irrigation on stream low flows has been overstated. My view is also that mean stream flows may have been overestimated leading to higher discharges to the Lake.

62 It would have been possible to reduce the uncertainty by refining the modelling, primarily by using more realistic inputs based on measured/ known data and ensuring that baseline modelling outputs are consistent with measured data.

CPWL NEED FOR WATER AND STORAGE

63 CPWL has consents to take and use water for irrigating up to 60,000 ha of land between the Waimakariri and Rakaia Rivers. The Scheme has been promoted in three stages: Stage 1 is approximately 20,000 ha between the Rakaia and Selwyn rivers, Stage 2 and 3 covers approximately 40,000 ha between the Stage 1 area and the Waimakariri River.

64 Under Policy 11.4.31 and Rule 11.5.42, the damming of the full flow of water within the bed of the main stem of the Selwyn River/Waikirikiri and within the bed of the Waianiwaniwa River above its confluence with the Selwyn River/Waikirikiri is a prohibited activity.

65 CPWL has submitted seeking the prohibited activity status be removed on the basis that it does not seek to 'close off' options with regard to the storage required for future stages of the Scheme. In this part of my evidence I expand on my analysis of the likely storage requirements for the full development of the Scheme.

66 The areas of the three stages are presented in **Figure 1**.

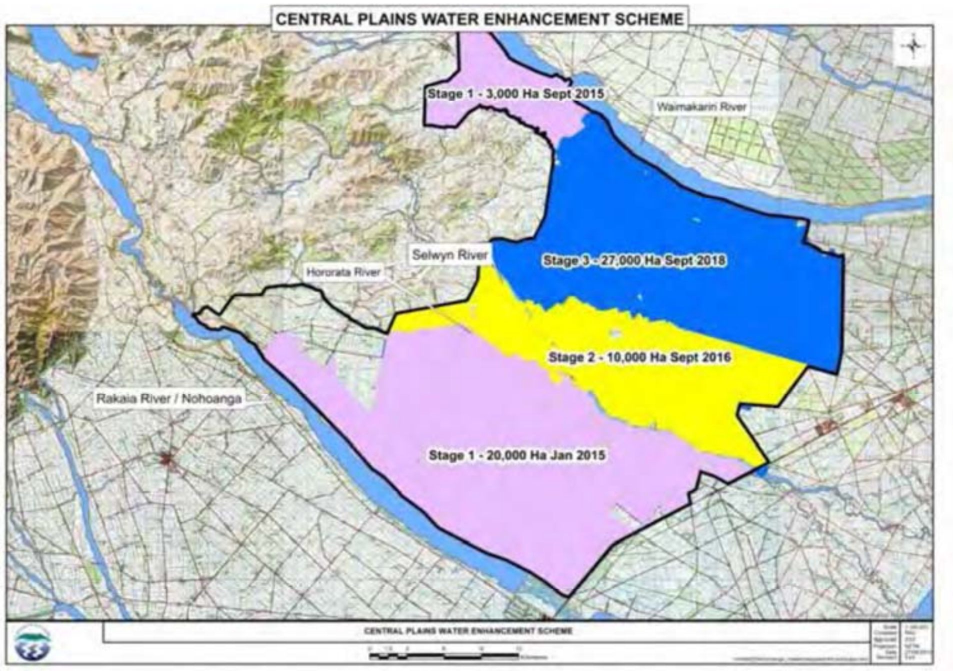

Figure 1 Location of Stages 1 and 2+

67 Stage 1 is presently under construction and is expected to be operational for the 2015/16 irrigation season.

68 Pre-construction shares for some of the 40,000 ha have been taken up by prospective irrigators for Stage 2+, with the expectation that they will have water delivered on-farm in a reasonable timeframe.

69 Peter Brown (Aqualinc Senior Engineer) and I carried out an assessment of irrigation demand in April 2013 for CPWL for the proposed Scheme area. The aim was to refine scheme delivery flow rates and volumes.

70 In assessing irrigation demand, we took into account crops, climate (rainfall and evapotranspiration), soils, irrigation system type and production risks of not meeting full demand.

71 We found that soils in the CPWL command area would be subject to significant moisture deficits, as illustrated in **Figure 2**. Deficits occur when evapotranspiration exceeds rainfall.

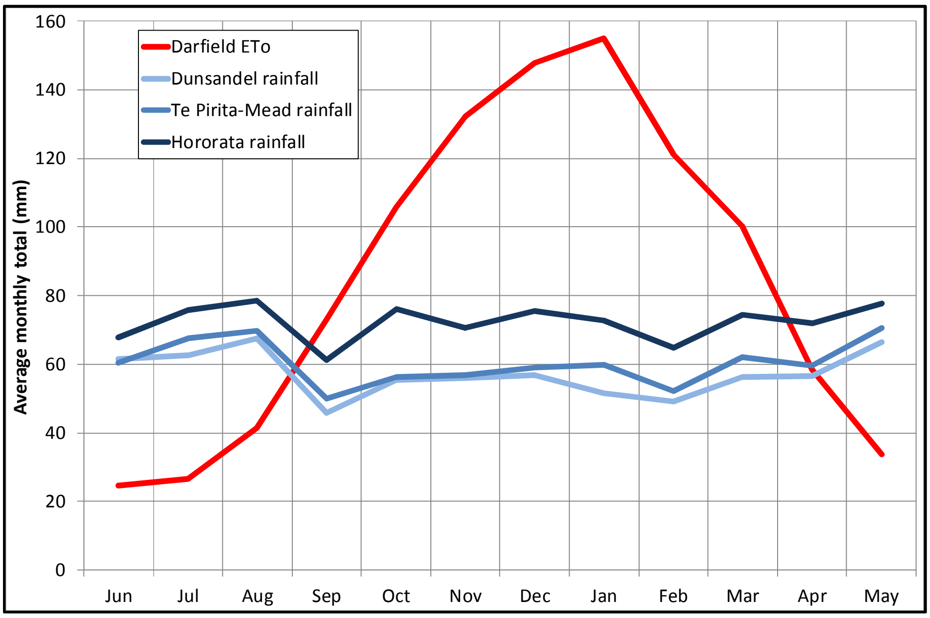

Figure 2: Monthly comparison of rainfall and evapotranspiration in CPWL command area.

72 **Figure 2** shows that significant soil moisture deficits would typically occur from September to April. Irrigation is required to replenish the deficits and maintain production (and was obviously the original reason for the promotion of the Scheme).

73 Our analyses identified that on-farm supply rates needed to be in the range of about 4 mm/day on the better soils and higher rainfall areas, to more than 5 mm/day on the lighter soils in the lower rainfall areas. We concluded that 5 mm/day (0.58 litres/sec/ha) would be appropriate for the on-farm delivery rates.

74 Our analyses also showed that seasonal depth of water required to meet a 1:10 year demand would range from 570 mm on the better soils and higher rainfall areas, to 760 mm/day on the lighter soils in the lower rainfall areas. All of these estimates assumed good practice irrigation and 100% reliable water.

75 Against the above, the Scheme has been designed to deliver 0.6 litres/sec/ha, and the scheme shareholding is based on supplying up to 656.5 mm per year, which equates to an annual volume of just under 400 million m^3/year. These values are consistent with our estimates of irrigation water need. We note that average use will be in the order of 300 million m^3/year.

76 However, the water supply is not 100% reliable. For the Rakaia River supply, the majority of the supply will come from the old Rakaia Band 4 and Band 5 water. The reliability for Stage 1, without

storage is about 78%. In order to give certainty of supply to irrigators, CPWL is targeting a reliability of 98%.

77 To achieve 98% reliability, storage is required. The volume of storage required depends on many factors. These include CPWL's access to lower band Rakaia River water, availability of Waimakariri River water, the size of diversion races, the location of area uptake, land use within the Scheme command area, location of storage, whether irrigators retain access to groundwater, and access to Lake Coleridge water.

78 Our assessment of storage dam sizes required to provide 98% reliability is in the range of 120-180 million m^3. That may come from a large storage dam or a combination of smaller dams, Lake Coleridge water and perhaps groundwater.

79 The Scheme has entered into an arrangement with TrustPower to purchase up to 50 million m^3 of "*stored*" water from Lake Coleridge. That satisfies the immediate storage needs for Stage 1 of the Scheme. However, that arrangement expires in 2031 and I understand there is no right of renewal in respect of that water.

80 Accordingly, additional storage is clearly required for future stages of the Scheme. There is no certainty that CPWL will be able to access more Lake Coleridge water to meet that need.

81 Overall, the main point I am making here is that there is an established need for irrigation water and that for run-of-river supplies, storage of significant quantities of water is required to provide a reliable supply. CPWL will have to consider options to provide the necessary storage, and it would be helpful if the Plan allowed for a range of options

IMPORTANCE OF STAGES 2+ OF THE SCHEME PROCEEDING FOR GROUNDWATER RESOURCES

82 Stage 1 of the CPWL Scheme is highly likely to be operational by the 2015/16 irrigation season. Share uptake has occurred, sufficient storage has been obtained for Stage 1 from Lake Coleridge to provide reliable water in the short-term, finance has been obtained and construction is occurring.

83 As set out in the evidence of **Ms Goodfellow,** the nature and development timeframes for Stages 2+ of the Scheme are not as clear. In addition to the matters discussed by **Ms Goodfellow**, it is however important to ensure Variation 1 continues to accommodate the development of the wider Scheme so that the hydrological benefits sought in respect of the Selwyn-Waihora zone can continue to be met. Under Variation 1, these benefits would include a

reduction in groundwater allocation and an increase lowland stream flows.

84 At present, we estimate that approximately 45,000-47,000 ha is actually irrigated from groundwater within the wider CPWL scheme command area. Of that area, about 30,000 ha relates to irrigators that hold CPWL shares for scheme water. On that basis, we can assume that 30,000 ha of existing groundwater supplied irrigation could be supplied from the Scheme. The actual areas may differ slightly from the above numbers, but for the purposes of illustrating the impact on groundwater allocation, those numbers will suffice.

85 Based on its likely water demand, the 30,000 ha of groundwater supplied irrigation will be abstracting approximately 75 million m^3 of water from the groundwater system on an average net basis. This is the volume of water taken out of the hydrological system due to the increase in evapotranspiration resulting from irrigation (about 250 mm/y). The majority of the balance of water that is irrigated from groundwater or coming from rainfall will go into drainage back to groundwater.

86 If that area is converted to Scheme water and an additional 30,000 ha of the command area is also irrigated from Scheme water making 60,000 ha in total, the gross amount of water brought into the command area from external sources (the Rakaia catchment) would be in the order of 300 million m^3 (at least 500 mm/y), ignoring scheme race losses.

87 The Scheme's 60,000 ha of surface water irrigation (i.e. the existing 30,000 hectares of previous groundwater irrigation and the 30,000 hectares of new irrigation) will lose around 150 million m^3/y to evapotranspiration. That water will be lost from the zone hydrological system. That means that there will be a net inflow of 300 – 150 = 150 million m^3/y of water into the groundwater system. The groundwater system will accordingly be 150 + 75 = 225 million m^3/y better off than it is currently.

88 However, if only Stage 1 proceeds, the numbers change significantly. We estimate that CPWL shareholders have at least 10,000 ha of groundwater supplied irrigation in the Stage 1 command area. That irrigation will reduce the volume of water in the groundwater system by 25 million m^3/y.

89 The Stage 1 20,000 ha area will bring in about 100 million m^3/y of water into the system (not counting race losses). This 20,000 ha will lose 50 million m^3/y to evapotranspiration. So, there will be a net inflow of 50 million m^3/y. The groundwater system will be 75 million m^3/y better off than it is currently.

90 These figures show that development of the full 60,000 ha rather than just 20,000 ha will result in 150 million m^3/y additional water in the groundwater system on top of the Stage 1 water. The development of the full Scheme is therefore necessary if Variation 1 continues to seek a material increase in groundwater volumes and improved lowland stream flows.

91 For completeness I do however note that the assessments relied on in my evidence (and also those relied on by the Council) have not attempted to assess the actual flow improvements in each individual lowland water body (the improvements have rather been assessed at a wider catchment scale). Given the exact timing and location of development within Stages 2+ of the Scheme is not clear, it is important that the appropriateness of the minimum flows under Table 11(c) is kept under review by the Council in the future.

COMMENTS ON THE GROUNDWATER TRANSFER PROVISIONS IN THE PLAN VARIATION

92 The LWRP variation 1, under the heading "Sustainable Use of Water and Improved Flows" states:

> Policy 11.4.22 Restrict the transfer of water permits within the Rakaia-Selwyn and Selwyn-Waimakariri water allocation zones to minimise the cumulative effects on flows in hill-fed lowland and spring-fed plains rivers from the use of allocated but unused water, by requiring that:
>
> (a) Irrigation scheme shareholders within the Irrigation Scheme Area shown on the Planning Maps do not transfer their permits to take and use groundwater; and
>
> (b) No permit to take and use groundwater is transferred from down-plains to up-plains; and
>
> (c) In all other cases 50% of any transferred water is surrendered.
>
> Policy 11.4.23 Only reallocate water to existing resource consent holders at a rate and volume that reflects demonstrated use.

93 I am aware that the clauses in Policy 11.4.22 are intended to be part of the provisions to reduce the current apparent paper allocation of groundwater to the groundwater allocation limit. I have provided evidence on the setting of groundwater allocation limits and the need for reducing current limits in my evidence for the Dunsandel Groundwater Users Group and Irrigation New Zealand.

94 So where does this relate to groundwater transfers in CPWL?

95 Under Variation 1, groundwater consents held by CPWL shareholders cannot be transferred to other shareholders or prospective groundwater users. Those shareholder consent holders will therefore logically hold onto those consents.

96 I note that as a part of its submission that is discussed in more detail by **Ms Goodfellow** and **Mr Peacock**, CPWL also seeks a limited exception to the above whereby a shareholder consent holder should still be able to use their groundwater on other property owned by that shareholder or a related entity (as part of a farming enterprise).

97 CPWL also seeks to have the 'door left open' for the possible transfer of groundwater consents to the scheme where they would only be used for bolstering reliability of a supply in a similar manner to that discussed below.

98 I also note that Variation 1 does not appear to treat 'partially CPWL irrigated' properties any differently than fully irrigated properties. The groundwater transfer provisions apply to shareholders with 1 or more shares. That being the case, there could be issues with shareholders that intend to partly irrigate with Scheme water and partly irrigate with groundwater, which the Plan needs to address.

99 In regard to shareholders continuing to hold groundwater consents, my view is that those shareholders may well wish to retain the use of groundwater to improve their reliability of supply when the CPWL scheme is on restrictions. In this regard, run of river scheme reliability, when the scheme is fully developed, will only be in the order of 40-45% (78% for Stage 1 – acknowledging the option of TrustPower water for that stage until 2031).

100 As discussed in paragraph 76, the supply reliability needs to be around 98%. For Stage 1 of the Scheme, "stored" water will be available (as an option to shareholders) from Lake Coleridge to bring the reliability up to the 98% level. If the 98% reliability is to be achieved, additional water will be needed in most irrigation seasons.

101 Accordingly, for CPWL shareholders, if Lake Coleridge stored water is not available or if the marginal cost of pumping groundwater is less than the cost of buying Lake Coleridge stored water, they will use groundwater. In my view, that situation will apply to many of the CPWL shareholders that have groundwater consents. It means that from an allocation perspective, the allocation on the Council's database may not change for those consent holders.

102 If the marginal cost of pumping groundwater is higher than the cost of Lake Coleridge stored water (that will occur at the top of the

CPWL command area in particular), groundwater consents may be of limited utility in the short-term, assuming sufficient stored water is available to meet supply shortfalls but they may still be necessary to cover future uncertainties around access to stored water.

103 If additional stored water, either from Coleridge or from elsewhere does not become available as the Scheme is developed, groundwater may be required to meet the target reliability.

104 At the time of consent renewals, Variation 1 as notified requires that consent allocations are only renewed on the basis of "*demonstrated use*" (Policy 11.4.23). Where groundwater consents are being used for what is essentially drought insurance or to cover potential issues around alternative storage (that is to make up for Scheme water shortfalls), they will need to be retained with flow rates as per the current consents and annual volumes that provide reliability of an agreed value, such as 98%.

Dated: 29 August 2014

I McIndoe

____

Ian McIndoe