IN THE MATTER OF:	**The Resource Management Act 1991**
AND:	**Submissions and further submissions in relation to Proposed Variation 2 to the Proposed Canterbury Land and Water Regional Plan – Section 13 Ashburton (Hinds/Hekeao Plains)**
AND:	**VALETTA IRRIGATION LIMITED** **Submitter**

STATEMENT OF EVIDENCE OF IAN MCINDOE

DATED 15 MAY 2015

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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 38 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 Diploma of Business Studies (Finance) from Massey University. I am a board member of Irrigation New Zealand and a member of the New Zealand Hydrological Society.

5 Although this is a Council hearing, I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2014. 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.

6 I have been engaged by Valetta Irrigation Ltd (**VIL**), to provide technical evidence relating to two issues:

(a) On-farm allocation of groundwater and its use to supplement shortfalls in surplus water reliability.

(b) The provisions of Variation 2 to the Proposed Canterbury Land and Water Regional Plan (and how they may need to change to accommodate the use of groundwater in the Valetta Irrigation Scheme (**scheme**) command area.

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

(a) Proposed Variation 2 to the Proposed Canterbury Land and Water Regional Plan – Section 13 Ashburton (Hinds/Hekeao Plains) (**Variation 2**);

(b) Canterbury Regional Council (**CRC**) s42A Report;

(c) The evidence of Dr Peter Brown on behalf of Dairy NZ; and

(d) CRC Report R14/51: Water resources of the Hinds/Hekeao catchment: modelling scenarios for the load setting process.

SUMMARY

8 VIL takes water from the Rangitata Diversion Race (**RDR**) and distributes it to its shareholder members for irrigation. VIL has recently upgraded its distribution system, which has improved the delivery efficiency of the scheme and released water for scheme expansion.

9 The contracted area of irrigation has increased from 7400 ha to 11000 ha. VIL now wishes to supply water to a further 2245 ha within the scheme command area.

10 As the existing run-of-river RDR water is fully contracted, VIL proposes to supply the additional 2245 ha using unused, surplus RDR supplied water. The reliability of the unused water is very low; 45% in an average year and 23% in a 1 in 10 year event. VIL proposes to use groundwater to improve reliability to bring it up to at least 95%.

11 Groundwater is currently used in the scheme to irrigate land not supplied by the scheme and to improve the on-farm flow rates and reliability of irrigation for land supplied with scheme water.

12 The amount of groundwater currently consented within the scheme command area is approximately 28 million m^3/year. This is a very similar volume to that required to supply the needs of the 100% groundwater-supplied areas and to improve the reliability of supply for both existing shareholders and for the 2245 ha proposed expansion area.

13 Because surface water from a source external to the VIL command area is being used to irrigate land in the scheme, additional recharge compared to dryland or groundwater-supplied irrigation occurs. Most of that recharge occurs under the existing irrigated area.

14 Expansion of irrigation onto an additional 2245 ha within the scheme using low reliability surplus surface water and using groundwater will also result in additional recharge to the aquifers. Our calculations show this to be a volumetric gain of water of approximately 5 million m^3/year on average and not less than 3 million m^3/year in 1 in 10 year events.

15 I can conclude from these findings that the VIL proposal will work hydrologically, that is, there is demand for water and sufficient supply to meet demand. The proposal will also increase the volume of water in the aquifers and contribute to the outcomes for the Hinds/Hekeao Plains Area.

16 Implementation of a combined surface-groundwater supply system will require the ability to fully transfer flow, volume and location of the current groundwater consents. This is critical to the success of the proposal.

17 In my view, allocation of groundwater within the VIL command area will be best achieved by setting up a separate 'B' allocation block for groundwater used for supplementation purposes.

18 Based on current information, the allocation limit for the 'B' block should be in the order of 10 million m^3/year. This volume should be transferred out of the current Valetta groundwater zone volume into the 'B' block.

19 Use of the 'B' block allocation should be subject to conditions including:

a) Surface water should always be used first.

b) The 'B' groundwater should only be used to meet surface water shortfalls.

c) The combined surface-groundwater supply must result in a net volumetric gain of water to the aquifer.

d) The supply must be provided via the VIL piped infrastructure.

e) The users must be shareholders of VIL.

BACKGROUND

20 VIL submitted on Variation 2

21 VIL takes water from the Rangitata Diversion Race (**RDR**) and distributes it to its shareholder members for irrigation. VIL has recently upgraded its distribution system from open race to a pressurised pipe system. Water is now delivered to farms under pressure for spray irrigation. Water previously lost through leakage, evaporation and by-wash has been eliminated. That water is now available for irrigation.

22 The rate of water flow delivered to the VIL scheme is 4.466 cubic metres per second (cumecs), and subject to RDR restrictions. Piping the delivery system

has provided opportunities to better use saved water to irrigate additional areas. One opportunity is to use surplus surface water during low/mid demand periods in conjunction with groundwater during high/peak demand periods. Surplus water is water that is supplied to the scheme but not required by existing irrigators on any given day during the irrigation season. It is available for use for irrigation by other shareholders or irrigators on that day. Currently, that water is by-washed, or not taken by VIL from the RDR.

23 Surplus water is unreliable, as its availability depends on both the demand for water from existing shareholders on any given day and restrictions on surface water due to low flows. It is essentially 'B' contracted water, with existing shareholders receiving the higher priority, more reliable 'A' share water.

24 Because the surplus water is unreliable, shareholders who take and use it need to improve its reliability to make it viable for irrigation. An attractive option is to use groundwater to make up shortfalls when the surplus RDR water is not available. This is usually during high/peak demand periods when the 'A' contracts are using all or most of it, or during restrictions. Groundwater is generally reliable and available to make up the shortfalls.

25 The volume of groundwater required each season will vary depending on seasonal demand, operational requirements and the availability of surface water, and for that reason the volume required to make up surface water shortfalls is different to a normal groundwater supply, where demand depends on seasonal demand only.

26 I understand that VIL have initiated a 'pilot' scheme to see how much surplus surface water might be available throughout the season and to assess its reliability. However, at the time VIL made its submission, the amount of groundwater that may be required to make up surface water shortfalls was unknown.

THE VIL SUBMISSION

27 As stated in its submission on Variation 2, VIL wish to promote the use of surface water as a primary source of water for irrigation, using groundwater as a supplementary source of water for groundwater users connected to the distribution network. They wish to ensure that groundwater continues to be available for that purpose, to achieve a reasonable level of reliability.

28 A number of VIL shareholders currently hold groundwater consents for supplementary irrigation within the scheme command area. VIL wish to reserve the ability to transfer the groundwater permits to the irrigation scheme

and to transfer groundwater permits (whether in part or whole) from existing bores to new bores within the scheme.

29 A key point of VIL's submission is that the proposed policies and rules limit the allocation of the volume and rate of abstraction of groundwater for irrigation via Method 1 in Schedule 10 when existing consents are replaced or existing allocations of shallow stream depleting groundwater is "switched" to deep groundwater. Method 1 does not allow for dual water sources where the sum of the allocation required from both sources exceeds the Method 1 allocation, even though the amount of water proposed to be used remains within the Method 1 limit for a single water source.

BASIS OF MY EVIDENCE

30 The key points I have taken from the VIL submission and from discussions with VIL personnel are that:

(a) Upgrading of the VIL Scheme has resulted in surplus irrigation water being available during low/mid demand periods, but this water is inherently unreliable, and on its own cannot realistically be used to justify investment in irrigation.

(b) VIL wish to have the option to utilise groundwater to improve that reliability, so that the use of surplus water is realistically feasible.

(c) The provisions of Variation 2, particularly those that make reference to Method 1 in Schedule 10, or constrain the ability to transfer groundwater, limit the ability to use surface and groundwater in a complementary manner.

31 At the time the VIL submission was made, the reliability of the surplus surface water or the amount of groundwater allocation that might be required to make up any surface water shortfall had not been determined. To support VIL's submission and the changes it seeks to Variation 2 to accommodate concurrent allocation for surface and groundwater, I have considered the following:

(a) Current on-farm irrigation demand within the VIL scheme;

(b) Current reliability of surface water supplied to existing shareholders;

(c) Volume and reliability of surplus surface water available to new shareholders;

(d) On-farm irrigation demand for new shareholders;

(e) Groundwater volumes to provide required surface water/groundwater reliability for new shareholders; and

(f) How concurrent use might work.

32 To provide the data for the analysis, I have asked Rose Edkins, who is an Aqualinc Senior Water Resources Engineer, to model irrigation supply and demand for the current and proposed areas. The evidence that follows is based on that analysis.

33 The methodology that was used to determine irrigated areas and irrigation demand is described in the evidence of Dr Peter Brown. Dr Brown is also an Aqualinc Senior Water Resources Engineer. The VIL scheme area is a subset of the area described by Dr Brown.

SUMMARY OF AREAS

34 A summary of the relevant areas in the VIL scheme command area is provided in **Table 1**.

Table 1: Breakdown of sub-areas within the VIL scheme command area

Area description	**Area (ha)**
Gross area covered by 'A' shares	11,590
Approximate area of 'A' shares contracted	11,000
Actual 'A' share irrigated area	10,000
Gross area for 'B' share expansion	3185
Proposed irrigated area for 'B' shares	2245
Barrhill Chertsey irrigation within VIL command area	1050
Unidentified area	465
Gross scheme area	16,290
Proposed VIL 'A' and 'B' share contracted area	13,245

35 The current areas are presented in Figure 1. The boundaries of the command area are approximate and may vary slightly in the future. However, the areas are expected to remain as shown in Table 1.

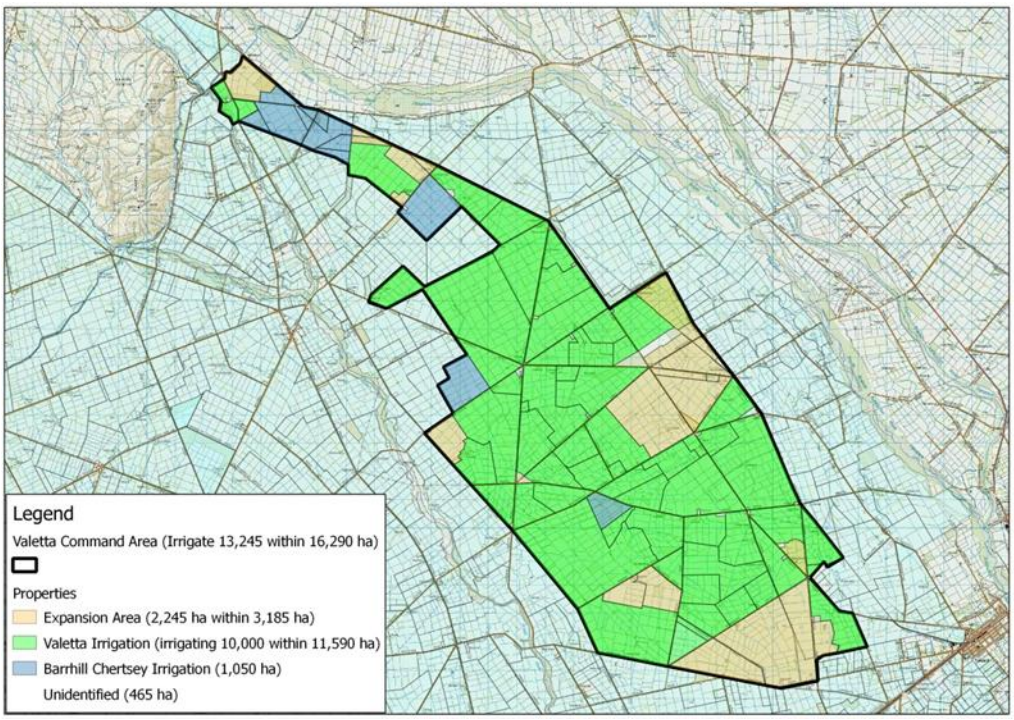


Figure 1: Location of irrigated areas within VIL scheme command area.

36 In summary, there is 11,000 ha contracted to take RDR surface water within the VIL Scheme, which I refer to as 'A shares'. 10,000 ha of the 11,000 ha is currently estimated to be actually irrigated. I have assumed that the additional 1000 ha will be irrigated as part of the 'A shares' in due course.

37 VIL proposes to create 'B shares' with the surplus water that is currently allocated but not taken. An additional 2245 ha is available for expansion/ future development using that water. The total potential shared-up area within the scheme is therefore 13,245 ha.

38 Within the overall 16,290 ha scheme command area, there is some land that is irrigated with water from the Barrhill Chertsey irrigation scheme (**BCI**). That will remain. There is also 465 ha that we have labelled "unidentified", as the status of this land is unclear at this time.

IRRIGATION DEMAND

39 As the key issue with respect to the VIL submission is to provide for 'B' share water, the demand for both 'A' and 'B' water has been modelled and the 'A' water demand from the RDR surface water supply subtracted to determine the volume of available 'surplus' water. At this time, we have not taken into account effects that future Ashburton minimum flows may have on water supply or how the RDR water supply with proposed storage will affect surplus flow.

40 Irrigation demand has been determined using our in-house irrigation demand model (Ausfarm) using historical climate data, as described by Dr Brown. Existing demand has been ground-truthed with actual water use data from the VIL Scheme for the 2013/14 and 2014/15 irrigation seasons i.e. post piping the scheme, to ensure that the modelling is realistic.

41 Always coincide area of 2245 ha is summarised in **Table 2** below. The notes (a) and (b) below illustrate that the years of high irrigation demand and low water supply availability do not always coincide.

Table 2: Irrigation demand for existing and proposed areas

	Existing 10,000 ha	**Expansion 2,245 ha**
Average demand (m3)	48,008,300[1]	10,673,000[2]
1 in 10 year demand (m3) (a)	63,271,875[3]	14,102,900[4]
Demand during 1 in 10 year low scheme supply (m3) (b)	61,978,000[5]	13,822,000[6]

(a) Highest irrigation demand year (average of seasons 1981/82, 1982/83, 1984/85 and 1988/89).

(b) Irrigation demand during 1 in 10 year low scheme supply year (average of seasons 1981/82, 1988/89, 1997/98 and 2014/15).

42 To calculate the water available for 'B' shares, the modelled scheme water supply has been compared to the modelled scheme demand on a year to year basis. **Figure 2** shows the average monthly irrigation demand, average monthly scheme supply and the water available to 'B' shares' (derived from daily time-series data). The average monthly flow available to 'B' shares' ranges from 0.8 to 3.0 m^3/s, with an average of 1.6 m^3/s.

43 Figures showing the modelled VIL supply, VIL demand and the water available for 'B' shares on a year to year basis are included in **Appendix A**. These show that for some years 'B' shares' are without a supply of water for extended periods.

44 **Figure 3** shows the number of days within a month that water is not available for 'B' shares', for both an average year, 1 in 5 year and 1 in10 year event.[7] This clearly shows that 'B' shares will have poor reliability, with several days within each month being without water. VIL wishes to use groundwater to improve the overall reliability of the 'B' shares.

[1] Based on a weighted average of 480 mm/year
[2] Based on a weighted average of 475mm/year
[3] Based on a weighted average of 632 mm/year
[4] Based on a weighted average of 628 mm/year
[5] Based on a weighted average of 619 mm/year
[6] Based on a weighted average of 616 mm/year
[7] I have assumed that where available water supply is less than 0.2 m^3/s that water is unable to be supplied for operational reasons. On that basis, it has been counted as a day that water is not available for 'B Shares'.

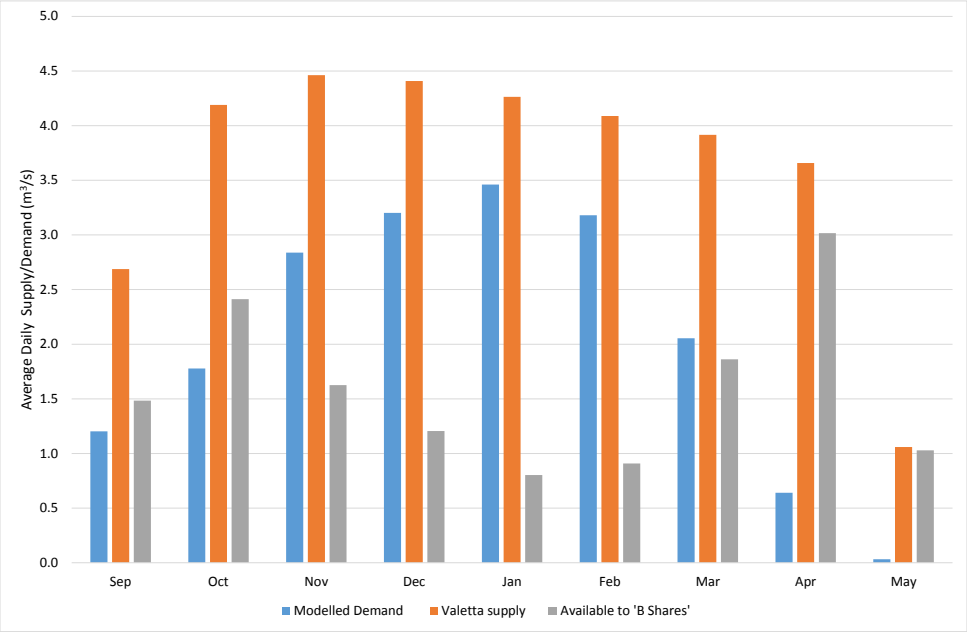


Figure 2: Average monthly modelled supply, modelled demand and water available to 'B' shares

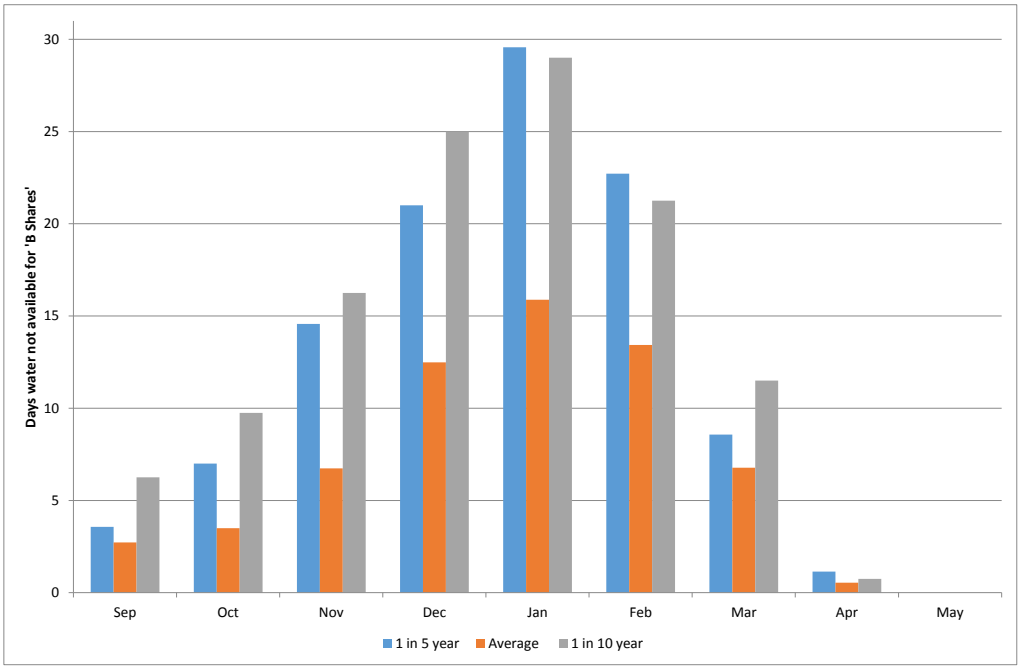


Figure 3: Number of days water is not available for 'B' shares – average, 1 in 5 year and 1 in 10 year events

45 The target area for the 'B' shares is 2,245 ha. Based on supplying a system capacity of 4.0 mm/d for PAW 60 soils (assumed area of 1309 ha) and 3.5

mm/d on PAW 80 soils (assumed area of 936 ha), based on a weighted average, the total flow required is 1 m^3/s (as set out in **Table 3**) [8].

Table 3: Flow requirements for 'B' share area of 2,245 ha

	System capacity (mm/d)	Demand (m3/s)	Demand (mm/y)	Demand (m^3/y)	Area (ha)
PAW 60 mm	4.0	0.6	-	-	1,309
PAW 80 mm	3.5	0.4	-	-	936
Total	-	1.0	475	10,673,000	2,245

'B' SHARE RELIABILITY

46 Using the parameters given in **Table 3**, a daily demand time-series has been created for comparison with the water available for 'B' shares and their reliability determined.

47 **Table 4** summarises the average and 1 and 5 year consecutive days that 'B' shares would not have water available.[9]

Table 4: 'B' shares consecutive days with no water supply

Total flow (m3/s)	1.0
Irrigated area (ha)	2,445
Average - consecutive days with no water	**35**
1 in 5 year - consecutive days with no water	76
1 in 10 year - consecutive days with no water	84

48 **Table 5** summarises the average, 1 and 5 year and 1 in 10 year supply, demand and shortfall of 'B' shares. Tables showing the yearly summaries are included in **Appendix B**. The supply/demand ratio represents overall

[8] The predominant soil within the Valetta command area is Lismore shallow, well drained, silty loam, with average plant available water in the first 60 cm of 62 mm and 77 mm. Irrigation requirements were calculated for two PAW classes (PAW 60 mm and 80 mm) and a maximum rooting depth of 60 cm was assumed.

[9] Again I have assumed where flow is less than 0.2 m^3/s that water is unable to be supplied for operational reasons.

reliability taking into account the magnitude and timing of both the supply and demand for water and can be compared to the Plan target of 95%.

Table 5: Supply, demand and shortfall of water for 'B Shares'

	Supply	Demand	Shortfall	Supply/ demand ratio
Average (mm)	212	475	263	45%
Average (m^3)	4,776,400	10,673,300	5,907,000	
1 in 5 year low scheme supply (mm) (a)	167	603	437	28%
1 in 5 year low scheme supply (m^3) (a)	3,745,600	13,538,600	9,793,000	
1 in 10 year high demand (mm) (b)	180	628	448	29%
1 in 10 year high demand (m^3) (b)	4,041,400	14,102,900	10,061,500	
1 in 10 year low scheme supply (mm) (c)	143	616	473	23%
1 in 10 year low scheme supply (m^3) (c)	3,204,000	13,822,100	10,618,100	

(a) Average of irrigation seasons 1981/82, 1982/83, 1988/89, 1997/98, 2000/01, 2007/08 and 2014/15.

(b) Average of irrigation seasons of irrigation seasons 1981/82, 1982/83, 1984/85 and 1988/1989.

(c) Average of irrigation seasons 1981/82, 1988/89, 1997/98 and 2014/15.

49 Table 5 shows that 'B' shares have poor reliability, with long periods without water. VIL wish to have the option to use groundwater to supplement surface water supply to improve overall reliability of these shares.

GROUNDWATER VOLUME REQUIREMENTS

50 **Figure 4** summarises average monthly demand, average Valetta water supply and average monthly shortfall. **Appendix B** contains summaries of yearly volume (m^3) data and yearly depth (mm) data.

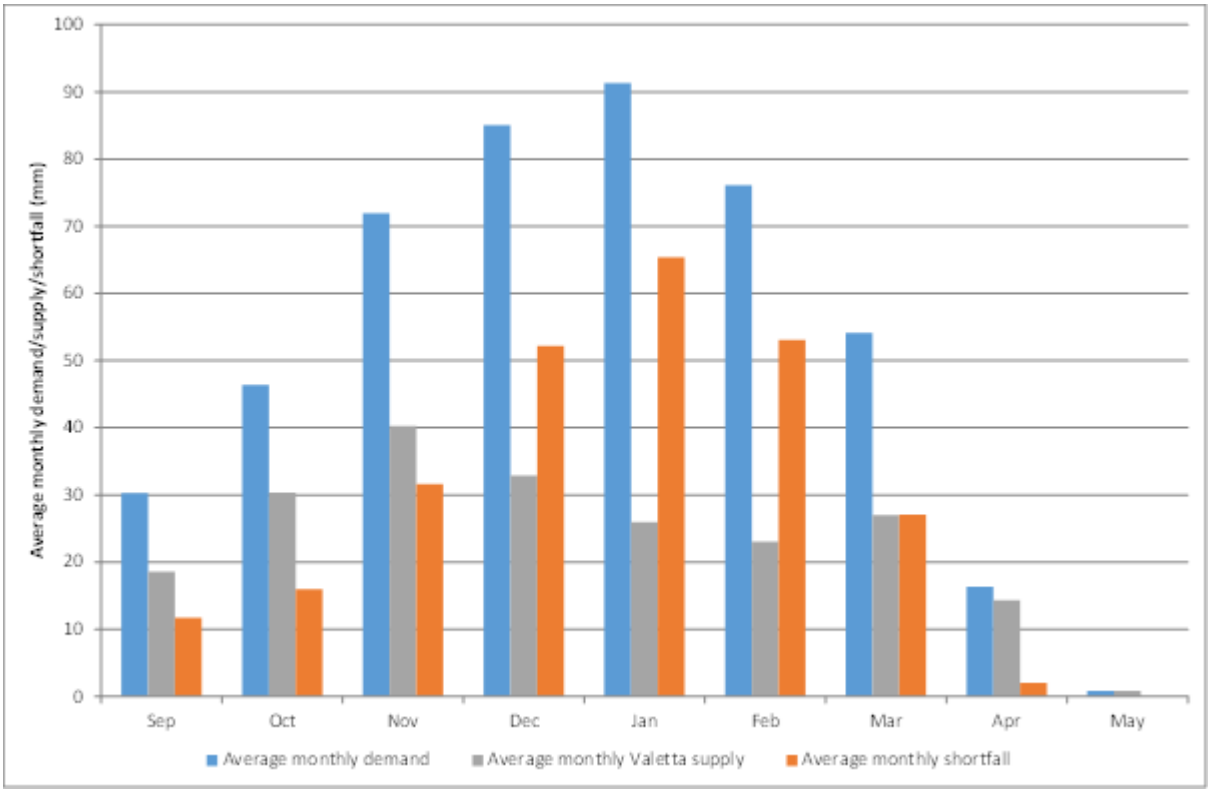


Figure 4: Average monthly demand and shortfall for 'B Shares'

51 **Table 6** summarises 'B' Share groundwater requirements for average, 1 in 5 year and 1 in 10 year events. **Appendix B** contains the related data summaries.

Table 6: 'B' share groundwater requirements

Frequency	m3/year	mm/year
1 out of 10 year high scheme supply	1,791,100	80
1 out of 5 year high scheme supply	2,136,400	95
Average groundwater required	5,907,000	263
1 out of 5 year low scheme supply	9,793,000	436
1 out of 10 year high irrigation demand	10,061,500	448
1 out of 10 year low scheme supply	10,618,100	473

52 The month with the highest groundwater requirements on average occurs in January, with a shortfall of 1,500,200 m^3. This is an average flow rate of 560 l/s. The 1 in 10 year January required flow rate from groundwater is 934 l/s. On average, assuming bore flows of 60 l/s, 10 bores would be required, and

during a 1 in 10 year event, 16 bores would be required, to make up the shortfalls.

53 Based on a 1 on 10 year event, the irrigation demand for the 'B' area is 13,822,000 m^3/year. The scheme (surface water) supply in the same year is 3,203,975 m^3. So, a total allocation of 10,618,100 m^3/year from groundwater is required to meet the demand for the 'B' area.

EXISTING GROUNDWATER CONSENTS

54 A number of irrigators hold consents to take groundwater for irrigation within the VIL scheme command area. Some of the consents are used to maintain reliability of 'A' share supply during restrictions. Some are used to irrigate specific areas that were not supplied by the scheme. Some are carry overs from the pre-piped scheme. These consents could be used to supply the groundwater need.

55 The key questions are, is there enough groundwater consented, and from a planning sense, can they be arranged or configured in a way to meet the need.

56 Within the Valetta Scheme command area, there are currently 35 active and 7 inactive groundwater consents. Details of these consents are included in **Appendix C**. Where there are adaptive management conditions on the groundwater consents, I have included the base allocation rather than full allocation, so have taken a conservative approach to total groundwater allocation.

57 I understand that Canterbury Regional Council uses the full allocation for the adaptive management consents in their assessments for determining allocation in the Variation 2 area. However, the adaptive management consents are for a groundwater supply alone and can be unreliable. In my opinion, it is inappropriate to determine allocation shortfalls to make up surface water supply reliability using the full adaptive management allocations, as they cannot be relied on.

58 The location of the groundwater consents within the VIL Scheme command area is shown in **Figure 5**.

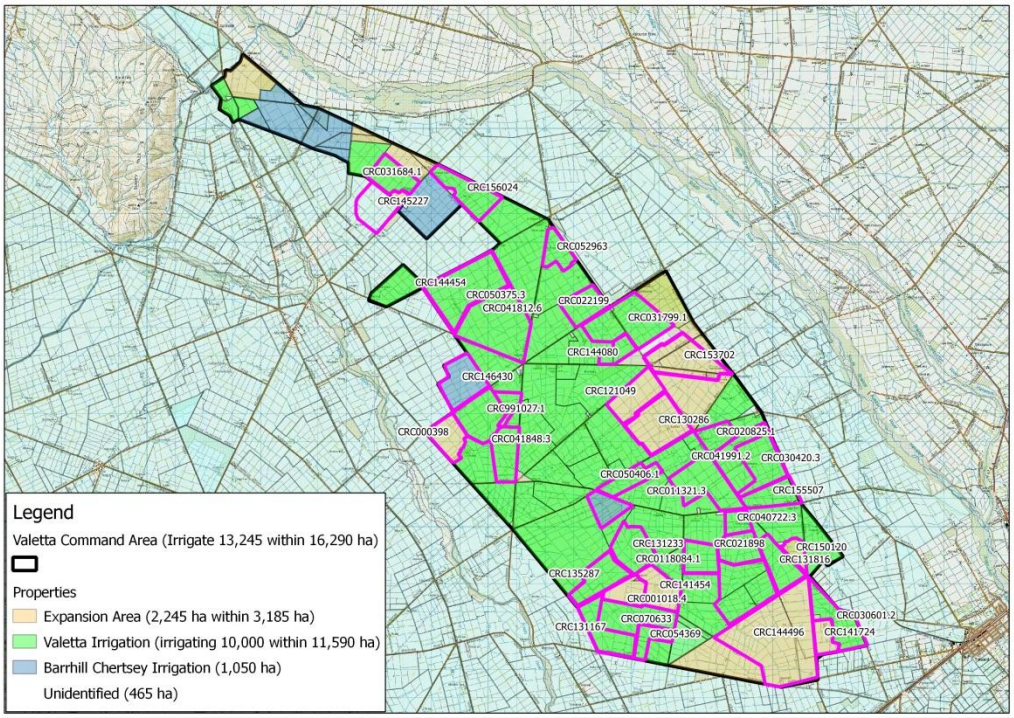


Figure 5: Location of groundwater consents within VIL command area.

59 There are 11 groundwater consents located within the expansion area, and 43 consents over the full scheme. Three consents have conditions relating to the use of groundwater with surface water.

60 Over the full scheme, the total flow rate for active consents adds up to 3,238 l/s. The total flow rate for the inactive consents adds to 1,073 l/s. The annual volume[10] for the active consents adds to 27,503,788m^3, and the inactive consents adds to 1,035,147 m^3. Total annual volume of groundwater consented is 28,538,935 m^3.

61 Within the expansion area, the annual volume for active consents adds to 8,856,189 m^3, and inactive consents adds to 839,051 m^3. The total annual volume is therefore 9,695,240 m^3. **Table 7** summarises the groundwater allocation within the full VIL scheme area and within the proposed expansion area alone. On average, the total groundwater consented volume provides a depth of 394 mm/year over 7,428 ha, and the groundwater consented volume in the expansion area provides 432 mm over the proposed 2245 ha.

[10] Where available annual volume from consents has been used, otherwise have used CRC estimated annual volume.

Table 7: Total groundwater allocated in VIL command area

Total Area (ha)	7,428
Total groundwater allocation (m^3/year)	28,538,935[(a)]
Proposed expansion area (ha)	2245
Groundwater allocation in proposed expansion area (m^3/year)	9,695,240

(a). If annual volume from one shallow bore consent is excluded, this volume is 28,058,900 m^3.

62 As the 'B' share 1 in 10 year groundwater demand to make up shortfalls is 10,618,100 m^3/year, there is a small shortfall (922,860 m^3/year) in groundwater allocation for the 'B' share area, assuming the groundwater could be transferred and redistributed as needed.

63 Although a much greater groundwater volume is allocated within the VIL command area, some of that groundwater is currently used to irrigate other areas while some is required to make up 'A' share water supply flow rates.

64 The groundwater requirements for the entire command area have been determined, that is, to supply existing groundwater areas where groundwater is used to irrigate land not currently connected to the piped scheme and to make up water supply shortfalls for the 'A' and 'B' shares. For areas not covered by the piped Valetta irrigation, we have assumed that a demand of 480 mm on average and 620 mm in a 1 in 10 year (low scheme supply) event is required, consistent with the approach described earlier in my evidence. I have assumed that no further irrigation is required for the BCI supplied area and that it is, and will remain, fully irrigated by BCI water. The unidentified area of 465 ha has not been included in the calculations. Overall, 97% of the entire scheme command area of 16,290 is assumed to be irrigated.

65 A summary of supply and demand requirements is summarised in **Table 8**.

Table 8: Overall groundwater requirements for the VIL scheme

Zone	**Average Volume (m^3/year)**	**Average Depth (mm)**	**1:10 year Volume (m^3/year)**	**1:10 year Depth (mm)**
Valetta 'A' shares (10,000 ha)	1,049,100	10	2,482,200	25
'A' shares not yet irrigated (1590 ha)	7,630,000	480	9,860,000	620
Proposed net expansion area (2245 ha)	5,926800	264	10,618,100,	473
Balance of expansion area (940 ha)	4,510,000	480	5,830,000	620
BCI (1050 ha)	0	0	0	0
Unidentified (465 ha)	-	-	-	-
TOTAL 16,920 ha)	19,115,900		28,790,200	

66 This now shows that there is a shortfall of approximately 731,265 m^3 (28,058,935 (excluding shallow bore consent) – 28,790,200 m^3) for a 1 in 10 year event. This is equivalent to 100 ha fully irrigated in the scheme, which is insignificant. In my view, there is sufficient groundwater consented within the scheme command area to meet the scheme needs.

THE EFFECT ON GROUNDWATER VOLUMES OF IMPLEMENTING THE 'B' PERMITS AND REARRANGING THE GROUNDWATER CONSENTS

67 VIL's proposal is to expand the irrigated area using surplus surface water not required by 'A' shareholders and provide for the 'B' share shortfalls using existing consented groundwater.

68 Bringing additional surface water into the scheme command area will increase recharge to groundwater and therefore the volume of water in the aquifers. Using existing groundwater to make up supply shortfalls will decrease the volume of water in the aquifers, but using surface water will decrease groundwater abstraction relative to the current situation.

69 To quantify the difference between the proposed "with 'B' share irrigation" and the existing "without 'B' share irrigation" scenarios, the abstraction and recharge has been analysed for each option.

70 For the purposes of this assessment, we have assumed that the full area to be irrigated, where groundwater could have an impact, is 14,755 ha. The BCI area of 1,050 ha and the unidentified 465 ha has not been included in the analysis, as it is assumed that supply to these will not change between the existing and proposed scenarios.

71 Although there is no change between the existing and proposed scenario for the Valetta Scheme existing 'A' share area, this has been included in the analysis to demonstrate the benefits to groundwater resulting from surface water irrigation supply in total.

72 The recharge from the surface water irrigation will have a positive effect on the aquifers. Net scheme groundwater contribution resulting from surface water irrigation has been determined as follows:

Drainage under irrigation minus drainage under dryland.

73 The abstraction by groundwater irrigation will have a negative effect on the aquifers. However, the effect is not equal to the gross groundwater

abstraction as there will be some recharge as a result of irrigation. Net use for groundwater abstraction has been calculated as:

AET under irrigation minus AET under dryland.

74 AET is actual evapotranspiration. The only water removed from the groundwater system due to irrigation is determined by calculating the difference between AET under irrigation and AET under dryland.

Existing Scenario

75 Groundwater consents within the VIL command area have an annual allocation of 28.54 million m^3/year and an irrigated area of 7,428 ha. However, according to our calculations, this area cannot be assumed to be fully irrigated by groundwater alone. Assuming a 1 in 10 year demand of 620 mm, the volume provides sufficient volume to fully irrigate 4,603 ha.

76 Within the expansion area, groundwater irrigation consents are currently held for 1,947 ha. In my opinion, it is reasonable to assume that these consents are fully utilised, as they don't currently have a reliable surface water supply.

77 The remaining groundwater consents are within the Valetta Scheme irrigation area. However, the irrigated area assessments indicate that of the existing total area of 11,590 ha, only 10,000 ha is actually irrigated using surface water from the scheme. Therefore, we have assumed that the remaining area of 1,590 ha is fully irrigated by groundwater. On that basis, the total area assumed to be fully irrigated by groundwater within the scheme command area is 3,537 ha (1,590 ha +1,947 ha).

78 In addition, as outlined earlier in my evidence, 242 ha is irrigated by both BCI water and groundwater. This would suggest that the remaining 996 ha is irrigated by a combination of groundwater and Valetta scheme surface water. On that basis, it has been assumed that currently 3,537 ha is solely irrigated with groundwater and that the remaining 996 ha is mostly supplied by surface water and minimal groundwater.

79 The impact of existing irrigation on the groundwater system is summarised in **Table 9**. Further details on how the data shown in Table 9 was calculated is set out in **Appendix D**.

Table 9: Overall combined effect of existing VIL irrigation on groundwater volumes.

Overall Effect	Groundwater net use (m^3)	Surface Water Net Contribution (m^3)	Effect on Aquifer (m^3)
1 in 10 year groundwater demand	14,761,714	18,368,375	-3,606,661
1 in 10 year irrigation demand	14,420,544	22,981,800	-8,561,256
Average year	9,185,454	20,932,936	-11,747,481

80 The 1 in 10 year groundwater demand refers to groundwater required in a 1 in 10 year event due to shortfalls in the surplus surface water supply. The 1 in 10 year irrigation demand refers to irrigation water required by the crop in a 1 in 10 year event due to climate (rainfall and evapotranspiration). These events do not normally occur in the same year.

81 Table 9 shows that the combined use of surface water and groundwater under the existing irrigation scenario is resulting in a net gain on average to the aquifers of 11.7 million m^3/year. In a 1:10 demand year, this reduces to 8.5 million m^3/year. In a 1:10 demand year with a surface water supply shortfall (which primarily drives the demand for groundwater), it reduces to a net gain of 3.6 million m^3/year.

Proposed Scenario

82 As before, we have assumed that 10,000 ha is currently irrigated using VIL scheme surface water. In the expansion area, we have assumed that 2,245 ha will be irrigated. We have determined the proportion of water that is supplied by the scheme versus groundwater, as shown in **Table 10**. This is consistent with my Table 4.

Table 10: Surface water vs groundwater contribution

	Surface Water	Groundwater
Average year	45%	55%
1 in 10 year high demand	29%	71%
1 in 10 year (low scheme supply) demand with high groundwater requirements	23%	77%

83 For the remaining groundwater area, we have assumed that 1,292 ha is fully irrigated (3,537 ha[11] less 2,245 ha).

[11] From para 65 above.

84 The impact of the proposed 'B' share irrigation implementation on the groundwater system is summarised in **Table 11**. Further detail on how the data shown in Table 11 was determined is given in **Appendix D**.

Table 11: Effect on groundwater volumes post expansion area development.

Overall Effect	Surface Water Net Contribution – existing area (m^3)	Surface Water Net Contribution – expansion area (m^3)	Groundwater net use – expansion area (m^3)	Groundwater net use – remaining area (m^3)	Effect on Aquifer (m^3) (negative value indicates recharge to the aquifer
1 in 10 year groundwater demand	18,368,375	948,451	7,214,542	5,392,178	- 6,710,106
1 in 10 year irrigation demand	22,981,800	1,496,230	6,498,622	5,267,555	-12,711,853
Average year	20,932,936	2,114,750	3,206,599	3,355,275	-16,485,812

85 Table 11 shows that the combined use of surface water and groundwater under the proposed irrigation scenario is resulting in a net gain on average to the aquifers of 16.5 million m^3/year. In a 1:10 demand year, this reduces to 12.7 million m^3/year. In a 1:10 irrigation demand year with a supply shortfall in the same year (which primarily drives the demand for groundwater), it reduces to a net gain of 6.7 million m^3/year.

86 The data presented in Table 11 includes the combined impact of existing irrigation and the proposed expansion on groundwater volumes. The overall impact of implementing the combined surface water/groundwater expansion is represented by the difference between the effect under existing irrigation (Table 10) and under the existing plus new scenario (Table 11). This is presented in Table 12.

Table 12: Overall effect on groundwater volumes of implementing the VIL proposal

Overall Effect	Existing net effect on groundwater	Proposed net effect on groundwater (m^3)	Change in effect (m^3) (negative value indicates recharge to the aquifer)
1 in 10 year groundwater demand	-3,606,661	- 6,710,106	- 3,103,444
1 in 10 year irrigation demand	-8,561,256	- 12,711,853	- 4,150,597
Average year	-11,747,481	- 16,485,812	- 4,738,331

87 **Table 12** shows that as a result of the proposed scenario, there will be an increase in the volume of water recharging the aquifer. The overall effect of

the combined use of surface water and groundwater under the proposed irrigation scenario is resulting in a net gain on average to the aquifers of 4.7 million m^3/year. In a 1:10 demand year, this falls slightly to 4.1 million m^3/year. In a 1:10 demand year with a surface water supply shortfall, it provides a net gain of 3.1 million m^3/year.

88 VIL's proposal will therefore increase the volume of water passing through the aquifers thereby increasing lowland streamflow. Groundwater will only be taken when it is needed to maintain reliability of supply, which is a completely different situation to irrigation 100% supplied by groundwater. If the proposal was not implemented, the benefit of increasing flow in the aquifers would not occur.

89 The ability to transfer groundwater within the scheme is critical to the success of the VIL proposal. If transfers were possible (i.e. to the irrigation scheme or from existing bores to new bores within the scheme) , it would be feasible to transfer the consents in a way that would be needed to enable both 'A' and 'B' shareholders to supplement their surface water with groundwater.

90 If transfers were prohibited, or 50% of transferred water was required to be given up, more new groundwater allocation would be required to make the VIL proposal viable. That is not VIL's preferred option.

B ALLOCATION BLOCK

91 To effectively manage groundwater allocation that is intended to be used to improve the reliability of a surface water supply, I recommend that the required groundwater allocation volume be transferred from the current Valetta groundwater allocation block into a new 'B' allocation block. Water used for 100% groundwater irrigation should remain in the current Valetta groundwater allocation block (the 'A' block).

92 The use of different allocation blocks for groundwater zones has not been implemented in Canterbury to date. In principle, it is similar in concept to allocation of water from rivers such as the Rakaia River, with different conditions applying to each allocation block.

93 Conditions should be applied to the 'B' water. For example, surface water should always be used first. The 'B' groundwater should only be used to meet surface water shortfalls. The combined surface-groundwater supply must result in a net volumetric gain of water to the aquifer. In addition, I

recommend that the supply must be provided via the VIL piped infrastructure and the users must be shareholders of VIL.

94 In the case of the VIL proposal, on average, 45% of the supply will come from RDR sourced water and 55% from groundwater. In more reliable surface water years, more surface water and less groundwater will be required. In less reliable surface water years, less surface water and more groundwater will be required.

95 The allocation limit for the proposed 'B' block for the Valetta Scheme should be based on a 1 in 10 year (low scheme supply) demand with high groundwater requirements, where the use abides by the suggested conditions. Although an exact figure for the 'B' block limit has not been finalised, I expect it to be in the order of 10 million m^3/year.

96 I also recommend that the existing groundwater consents required for surface water supplementation be amalgamated into a global scheme consent and managed by VIL. That would provide VIL the flexibility it needs to achieve optimum use of both surface water and groundwater within the scheme command area.

SECTION 42A REPORT

Valetta Groundwater Allocation Zone – Allocation Limit

97 The S 42A report (at paragraph 10.128, page 213) states:

> "*The Hinds/Hekeao Plains Area solutions package involves a number of measures to address the over-allocation of surface and ground water. The most pressing concern in addressing over-allocation is to stop more water being granted by way of resource consents. Second, it is important to establish a mechanism to limit the ability to use allocated, but unused water. Third, it is necessary to find a way to reduce the over allocation."*

98 While I agree that over-allocation needs to be addressed via Variation 2, I am of the opinion that Council's proposed approach is too narrow in its scope.

99 One of the problems is that Council's approach applies a fixed allocation volume limit and most of the measures proposed (the exceptions being Managed Aquifer Recharge and Targeted Stream Augmentation) are focussed on reducing the allocated volume to less than the single allocation limit.

100 While Council's approach is a simple approach, in my opinion the Variation should allow for other approaches that achieve increased groundwater throughflow in the aquifers. VIL's proposal to implement an 'A' and 'B' block approach with a set of conditions for each block that reduces impacts on the aquifers is an alternative approach which, as the analysis set out in my evidence confirms, will achieve that outcome.

101 With respect to the statement at paragraph 10.128 of the s 42A report, I note that, firstly, VIL is not asking for additional allocation provided that existing groundwater consents can be utilised by the scheme.

102 Secondly, VIL is not increasing the groundwater use compared to existing.

103 Thirdly, while VIL will not be reducing the groundwater allocation in total, if they can group the existing consents into a 'B' block with a separate limit for that while showing that it benefits the groundwater system, it will contribute positively to the desired outcomes.

104 The S 42A report (at paragraph 10.132, page 213) states:

> "*During the collaborative process, a precautionary approach was proposed, at least until long term monitoring information becomes available to show that the groundwater system has stabilised. Furthermore, if allowed any new allocation from the system will put more pressure on the proposed MAR project*."

105 In response, I make the comment that the groundwater system is very dynamic and will continue to change as the inputs and outputs change. Converting borderdyke to spray has had quite a significant effect, by reducing and changing the timing of groundwater recharge. There will be further borderdyke to spray conversion, although the remaining border area is relatively small according to Dr Brown and Mr Dewhirst. Similarly, increasing the irrigated area using surplus RDR water will increase groundwater recharge. Groundwater levels will never be stable.

Rules 13.5.31 and 13.5.32

106 The S 42A report (paragraph 10.225 to 10.226, page 228) addresses prohibited activity Rule 13.5.32. The effect of this rule is to preclude the granting of consents for groundwater takes over and above the Valetta Groundwater Allocation Zone allocation limit.

107 In relation to this rule, I note that all of the groundwater consents that VIL is proposing to use have been granted. Some of the groundwater consents in the scheme were granted outside of the allocation limit. Others were within the limit. What VIL is proposing is to utilise those existing consents, so that would not contravene this rule.

108 The rule also precludes the switching of existing shallow groundwater takes or surface water takes to deep groundwater other than in accordance with Rule 13.5.31 (i.e. they must be on the same property as the existing consent, have no increase in annual volume; not have direct or high stream depletion effect; bore interference effects must be acceptable, as determined in accordance with Schedule 12).

109 In relation to that matter, I note that none of the existing consents in the scheme area that would be included in a 'B' share allocation have high or direct stream depletion effects (we have excluded the one shallow bore present in the scheme area). The rule therefore offers no benefit to VIL or its shareholders.

110 What VIL needs, and it is critical for the proposal to succeed, is the flexibility to move the point of groundwater take from one property to another, and to change the individual flows and volumes while maintaining the existing total flows and volumes. In my view, a global groundwater consent that was exercised and implemented by VIL would be the most efficient and appropriate way to manage 'B' block groundwater use.

111 The S 42A report makes the point that the NPSFM is particularly relevant, especially with respect to quantity issues, in that it specifically requires the adherence to limits.

112 In this regard, I note that currently, CRC has implemented a single limit for the Valetta zone. What VIL is proposing is two limits, an 'A' limit and a 'B' limit, with the 'B' limit applying to groundwater allocation used for improving the reliability of surface water irrigation where its use results in a net gain to the groundwater system. In concept, this is similar to the minimum flow banding system used for abstraction from rivers such as the Rakaia River.

Water Permit Transfers

113 The S 42A report (at paragraph11.54, page 241) states:

> "*Valetta Irrigation has recently upgraded their water distribution system from open races to a piped system. The efficiency gains*

> *through piping will help the company provide more water for irrigation. Some of the shareholders obtained groundwater consents in the past to supplement their irrigation demand, especially when scheme water was under restrictions during the summer."*

114 It is correct that the piping of the scheme has provided efficiency gains and allowed more land to be irrigated. That has already happened. The scheme contracted area has increased from 7400 ha to 11,000 ha.

115 Much of the groundwater was originally used to expand the irrigated area and to provide a higher supply rate, (typically 0.58 l/s/ha) as the old open race scheme had a lower supply rate (around 0.43 l/s/ha). As the RDR-supplied water for existing irrigation is of relatively high reliability, the main purpose of using groundwater was not to improve reliability. Now that the supply rate issue has largely been solved through piping of the scheme, some groundwater is used to maintain high reliability as well as irrigate more area.

116 The S42a report (at paragraph 11.55, page 241) states:

> "*Overall, it is considered that the Valetta Irrigation suggestion will not help to achieve the Hinds/Hekeao Plains Area outcomes and does not give effect to the NPSFM, as it is anticipated that by pooling water in this way, more will actually be abstracted*."

117 I am not sure on what basis this statement was made, as no information is provided to support it. On the contrary, my evidence supports my view that pooling groundwater and making optimal use of surface water at the same time will help to achieve the Hinds/Hekeao Plains Area outcomes (as summarised in the s42A Report at 10.128. It appears that Council has looked at the use of groundwater independently, rather than considering its use in the context of an hydrological system.

118 The piping of the VIL irrigation scheme was never intended to simply replace the original open race scheme with pipes. It had to involve expansion of the irrigated area to make it financially viable. Some of that expansion has occurred. The use of surplus off-peak RDR-supplied surface water is the next step in the expansion plans.

119 The S 42A report (at paragraphs 11.12 and 11.13) discusses the possible future use of unused groundwater allocation and comments that its use, enabled through transfers, particularly to areas outside of schemes, will compromise Council's ability to meet the Zone Committee's outcomes for the

Hinds/Hekeao Plains Area. Information is provided in the report to show that actual groundwater use in 2013/14 was 63% of allocation (illustrated in Figure 10.1), in support of that position.

120 Clearly the use is well below the allowable take. In a system with a large number of users, that is always the case. Diversity of use always exists. I do not know what the maximum future use will be, but what I do know is that actual use will always be less than allocation. In irrigation scheme design, 80% is commonly assumed. Research into diversity is underway, but until it is completed, I don't have any definitive numbers to put forward.

121 VIL's proposal is to utilise groundwater using the piped scheme infrastructure. Some of the demand on each property will be met with scheme-supplied surface water and some with scheme-supplied groundwater. There is no intention to transfer groundwater to areas not connected to the scheme infrastructure. If the Valetta groundwater is assigned a 'B' block limit with appropriate conditions that improve groundwater volumes, the VIL proposal will reduce the 'A' block over-allocation situation, as the 'B' block volume will be taken out of the 'A' block.

122 The S 42A report (at paragraph 11.16) states

> "*The submissions which oppose the Policy do not provide any alternatives to address the over-allocation issue. Moreover, it is not clear from those submissions how it is possible to allow transfers in an over-allocated catchment or aquifer while ensuring that no additional water is used*."

123 VIL has provided a proposal to improve the groundwater system. However, again, in my view Council is not considering the system as a whole, so is not accounting for the additional recharge or the reduction in groundwater use that will occur as a result of VIL's proposal.

124 The S 42A report (at paragraph 11.13) goes on to state:

> "*The Zone Committee's solutions package for the Hinds/Hekeao Plains Area requires stopping the use of unused water to help achieve the outcomes for the Hinds/Hekeao Plains Area*."

125 While I agree that stopping the future use of unused consented water will contribute to the outcomes for the Hinds/Hekeao Plains Area, any action that increases recharge, such as the VIL proposal, will also contribute to the outcomes.

Method 1 of Schedule 10

126 I note that the S42a report at paragraph 10.27 (page 195) recommends the deletion of the reference to Method 1 in Policy 13.4.16 and at paragraph 10.191 (page 222) recommends the deletion of Rule 13.5.30.

127 I agree with these recommendations. In my opinion, the deletion of Method 1 from Policy 13.4.16 and the deletion of Rule 13.5.30 will address the concerns expressed by VIL in its submission on Variation 2 regarding the limitations of Method 1, as summarised earlier in my evidence.

CONCLUSIONS

128 VIL has additional land (2245 ha) that it wishes to irrigate using currently unused surface water supplied from the RDR.

129 The reliability of the surface water is low; 45% in an average year and 23% in a 1 in 10 year event. VIL wishes to use groundwater to improve reliability up to at least 95%.

130 Groundwater is currently used in the scheme to irrigate land not supplied by the scheme and to improve the on-farm flow rates and reliability of irrigation for land supplied with scheme water.

131 The amount of groundwater currently consented within the scheme command area is sufficient to supply the needs of 100% groundwater-supplied areas and to improve the reliability of supply for existing shareholders and for the proposed expansion area.

132 Expansion of irrigation onto an additional 2245 ha within the scheme using low reliability surplus surface water and using groundwater will result in a volumetric gain of water to the aquifers of approximately 5 million m^3/year on average and not less than 3 million m^3/year in 1 in 10 year events.

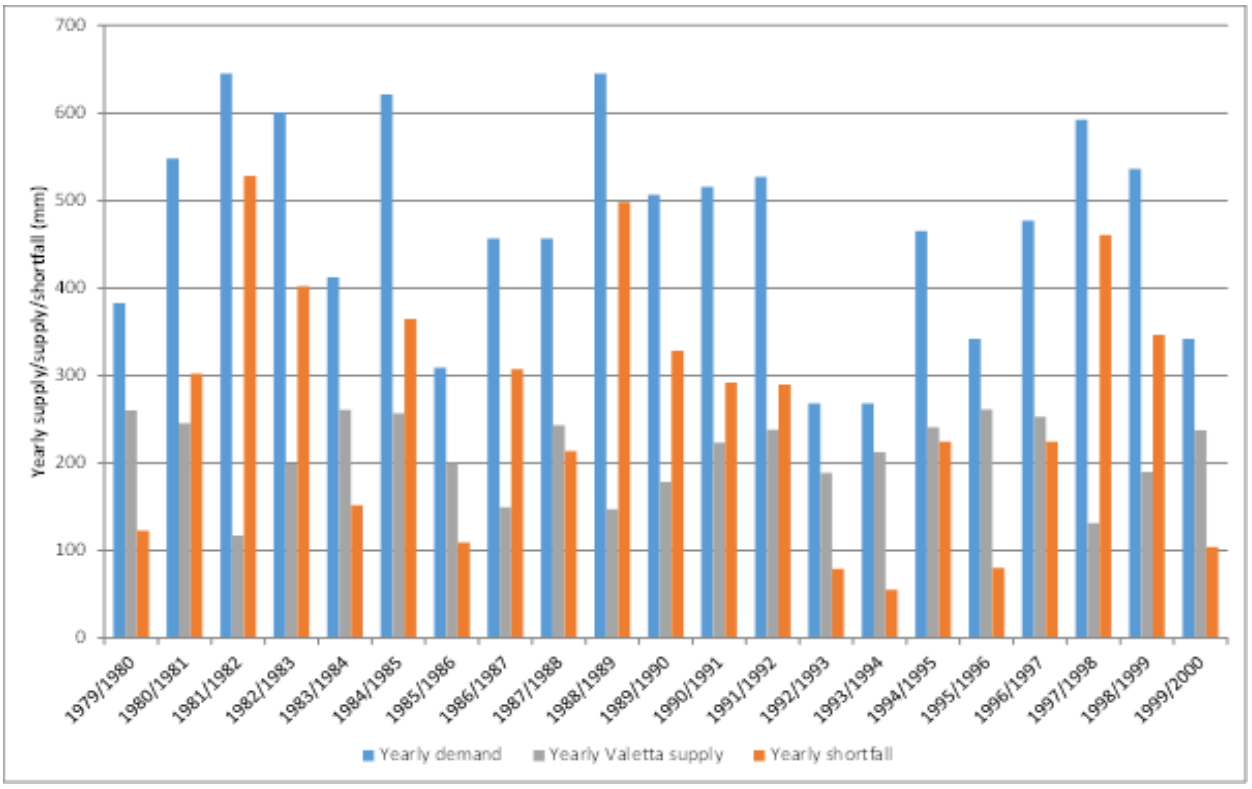
133 Implementation of a combined surface-groundwater supply system will require the ability to fully transfer flow, volume and location of the current groundwater consents. Prohibiting transfers in the Valetta groundwater zone, as proposed by the Variation, therefore precludes VIL's proposal. Even if the Variation required the return of 50% of the transferred water to the Valetta groundwater zone, it would result in a shortfall of groundwater for VIL and threaten the workability of the proposal.

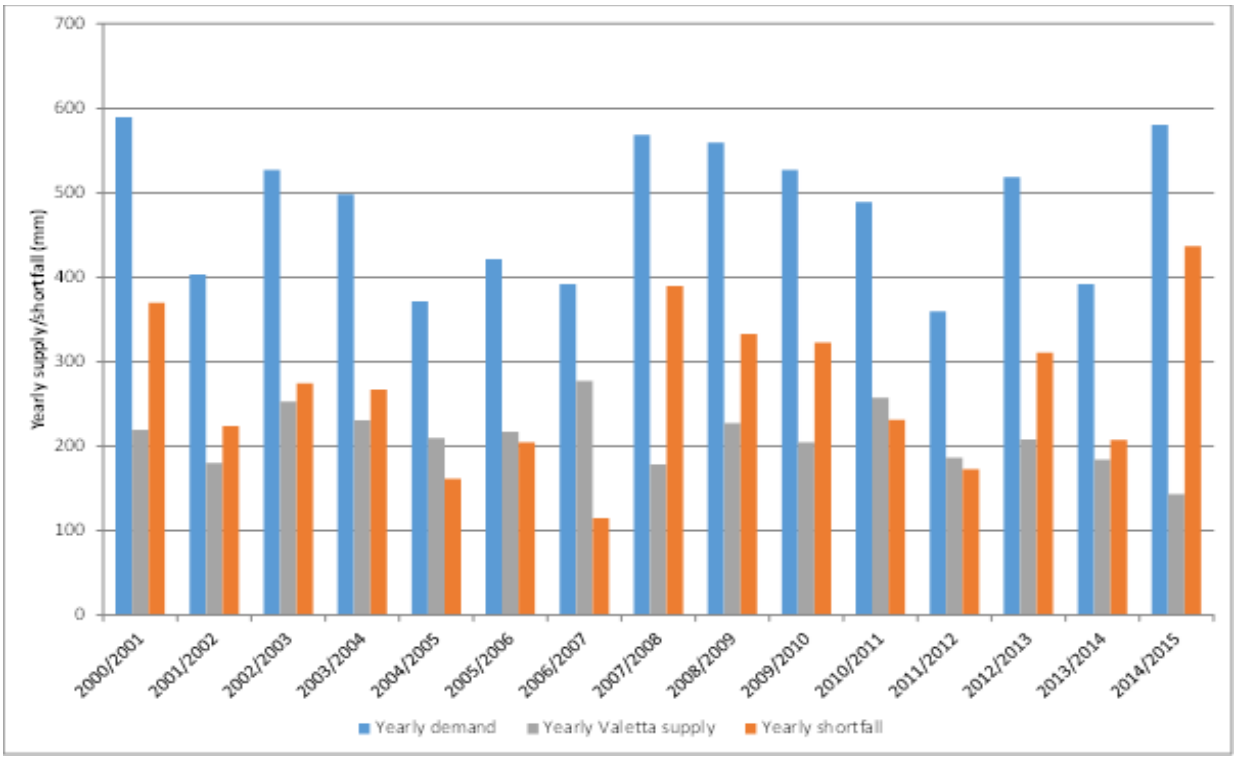
134 In my view, allocation of groundwater within the VIL command area will be best achieved by setting up a separate 'B' allocation block for groundwater used for supplementation purposes.

135 Management of 'B' block groundwater will best achieved through the use of a scheme global consent held and managed by VIL.

Ian McIndoe
15 May 2015

Appendix A – Yearly summaries of Supply, Demand and Shortfalls





Appendix B

Yearly summaries of Supply, Demand and Shortfall for 'B Shares

	Supply	Demand	Shortfall
1979/80	5,838,900	8,597,400	2,758,500
1980/81	5,512,000	12,301,000	6,788,900
1981/82	2,625,200	14,483,000	11,857,800
1982/83	4,467,000	13,491,300	9,024,300
1983/84	5,854,500	9,258,900	3,404,300
1984/85	5,770,300	13,954,200	8,183,900
1985/86	4,490,800	6,944,200	2,453,400
1986/87	3,358,000	10,250,700	6,892,700
1987/88	5,459,600	10,250,700	4,791,100
1988/89	3,303,200	14,483,000	11,179,800
1989/90	4,004,100	11,375,100	7,370,900
1990/91	5,016,300	11,573,600	6,557,200
1991/92	5,341,800	11,838,000	6,496,300
1992/93	4,240,100	6,018,300	1,778,200
1993/94	4,773,900	6,018,300	1,244,300
1994/95	5,405,100	10,449,200	5,044,000
1995/96	5,869,800	7,671,500	1,801,800
1996/97	5,677,900	10,713,600	5,035,700
1997/98	2,955,400	13,292,700	10,337,300
1998/99	4,264,400	12,036,500	7,772,100
1999/00	5,331,200	7,671,500	2,340,300
2000/01	4,928,100	13,226,800	8,298,700
2001/02	4,038,300	9,060,300	5,022,000
2002/03	5,674,700	11,838,000	6,163,300
2003/04	5,183,200	11,176,500	5,993,300

2004/05	4,707,500	8,333,000	3,625,500
2005/06	4,870,600	9,457,400	4,586,800
2006/07	6,217,300	8,795,900	2,578,600
2007/08	4,008,200	12,763,900	8,755,700
2008/09	5,098,600	12,565,400	7,466,800
2009/10	4,595,200	11,838,000	7,242,800
2010/11	5,785,400	10,978,000	5,192,600
2011/12	4,184,900	8,068,600	3,883,700
2012/13	4,667,200	11,639,500	6,972,300
2013/14	4,137,800	8,795,900	4,658,200
2014/15	3,932,100	13,029,700	9,097,600
Average	4,766,350	10,673,300	5,907,000
1 in 5 year (1)	3,745,600	13,538,600	9,793,000
1 in 10 year (2)	3,204,000	13,822,100	10,618,100

(1) Based on seasons 1981/82, 1982/83, 1988/89, 1997/98, 2000/01, 2007/08 and 2014/15.
(2) Based on seasons 1981/82, 1988/89, 1997/98 and 2014/15.

Average monthly demand, average Valetta supply and average monthly shortfall

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
Average Demand (m^3)	**690,995**	**1,054,466**	**1,635,599**	**1,912,030**	**2,067,331**	**1,723,036**	**1,214,208**	**357,230**	**18425**	**10,673,320**
Average Demand (mm)	**31**	**47**	**73**	**85**	**92**	**77**	**54**	**16**	**1**	**475**
Average Valetta supply (m^3)	**426,277**	**685,055**	**887,733**	**735,071**	**567,110**	**504,939**	**609,286**	**312,648**	**18425**	**4,746,544**
Average Demand (mm)	**19**	**31**	**40**	**33**	**25**	**22**	**27**	**14**	**1**	**211**
Average Shortfall (m^3)	**264,719**	**369,411**	**747,866**	**1,176,959**	**1,500,221**	**1,218,096**	**604,922**	**44,582**	**0**	**5,926,776**
Average Shortfall (mm)	**12**	**16**	**33**	**52**	**67**	**54**	**27**	**2**	**-**	**264**

Appendix C – Groundwater Consents

Full Scheme

	Scheme Total		3,757	1,546,307	240	26,243,655	32,570,103	33,384,937	-	-	7,241
	Inactive Consents		615	477,226	65	1,035,147	4,524,380	4,524,380	-	-	1,024
	Active Consents		3,142	1,069,081	175	25,208,508	28,045,723	28,860,557			
ConsentNo	ConsentSta	HolderName	MaxRate	MaxVolume	ReturnPeri	Base Allocation		FullEffect		InAllocati	Irrigati_2_area
CRC031684.1	Issued - Active	Mr C M & Mrs C J Mould	55	44,194	10	433,000	433,000	433,000	Ecan Estimated	Yes	100
CRC145227	Issued - Active	Valetta Pastures Limited	119	10,282	1	8,000.00	8,000	822,834	Consented	Yes	18
CRC050375.3	Issued - Inactive	Moonshine Farms Limited	100	34,560	4	28,760	57,519	57,519	Consented	Yes	
CRC144454	Issued - Active	Moonshine Farms Limited	170	14,688	1	1,626,893	1,626,893	1,626,893	Consented	Yes	825
CRC041812.6	Issued - Active	Moonshine Farms Limited	150	103,680	8	1,487,807	1,487,807	1,487,807	Consented	Yes	
CRC052963	Issued - Inactive	Mr D J & Mrs B J Quigley	45	27,216	7	19,711	394,221	394,221	Consented	Yes	99
CRC022199	Issued - Active	Mr & Mrs W M & A M Vessey	50	4,140	1	476,000	476,000	476,000	Ecan Estimated	Yes	136
CRC146430	Issued - Active	Stoneridge Holdings Ltd	40			669,200	669,200	669,200	Ecan Estimated	Yes	140
CRC000398	Issued - Active	Mr & Mrs P & E K Gardner	42	46,570	14	480,000	480,000	480,000	Ecan Estimated	Yes	100
CRC991027.1	Issued - Active	Mr A & Mrs B M Morrison	30	30,240	14	361,500	361,500	361,500	Ecan Estimated	Yes	75
CRC041848.3	Issued - Active	Mr A & Mrs B M Morrison	100	69,120	8	929,900	929,900	929,900	Consented	Yes	170
CRC031799.1	Issued - Active	Chudleigh Holdings Limited	20	628	1	54,270	54,270	54,270	Consented	Yes	344
CRC144080	Issued - Active	Hackthorne Dairy Company Limited	35	2,898	1	336,000	336,000	336,000	Consented	Yes	60
CRC153702	Issued - Inactive	C G & H K Rapsey	45	77,760	20	824,256	824,256	824,256	Consented	No	160
CRC072748	Issued - Inactive	Mr C Gordon & Ms H K Rapsey	80	55,296	8	14,795	295,900	295,900	Consented	Yes	55
CRC130286	Issued - Active	Mr & Mrs C E & M E Ross	83	7,171	1	200,000	400,000	400,000	Consented	Yes	
CRC042709.3	Issued - Active	Mr & Mrs C E & M E Ross	156	13,478	1	959,850	959,850	959,850	Consented	Yes	485
CRC121049	Issued - Active	Mr & Mrs C E & M E Ross	113	9,742	1	1,045,612	1,045,612	1,045,612	Consented	Yes	
CRC135287	Issued - Active	Landcorp Farming Limited	112	48,385	5	733,614	733,614	733,614	Consented	Yes	194
CRC072224	Issued - Inactive	Mr M J Spence & Ms S J Dyer	112	48,384	5	54,136	1,082,714	1,082,714	Consented	Yes	194
CRC040185.2	Issued - Active	Marwin Land Ltd	65	28,080	6	571,200	571,200	571,200	consented	Yes	102
CRC050406.1	Issued - Active	Mr P G Stocker & Cookstin Dairies Limi	38	28,314	9	218,010	436,020	436,020	Consented	Yes	78
CRC020825.1	Issued - Active	Mr & Mrs D W & G D Bryant	30	2,592	1	221,400	221,400	221,400	Ecan Estimated	Yes	60
CRC131233	Issued - Active	Landcorp Farming Limited	84	7,258	1	815,850	815,850	815,850	Consented	Yes	186
CRC011321.3	Issued - Active	Lacmor Dairies 2013 Limited	158	13,651	1	1,338,740	1,338,740	1,338,740	Ecan Estimated	Yes	283
CRC041991.2	Issued - Active	Waioto Farm Limited	107	64,713	7	1,724,590	1,724,590	1,724,590	Ecan Estimated	Yes	347
CRC030420.3	Issued - Active	Waioto Farm Limited	108	93,312	10	1,083,460	1,083,460	1,083,460	Ecan Estimated	Yes	218
CRC155507	Issued - Active	Ross Tait Limited	61	31,622	6	744,810	744,810	744,810	Consented	Yes	135
CRC001018.4	Issued - Active	Lobblinn Farms Limited	57	75,513	16	565,000	565,000	565,000	consented	Yes	100
CRC141454	Issued - Active	S M K & C M Hay & Hubbard Churcher T	100	51,408	7	881,400	881,400	881,400	Consented	No	157
CRC070633	Issued - Inactive	Intersouthern Deer Limited	160	193,536	14	65,160	1,303,200	1,303,200	Consented	Yes	410
CRC131167	Issued - Active	Coringa Park Dairies Limited	80	66,240	10	481,300	962,600	962,600	Consented	Yes	179
CRC054369	Issued - Inactive	Loretta Dobbs	73	40,474	7	28,329	566,570	566,570	Consented	Yes	106
CRC011084.1	Issued - Active	Ma Taua Dairies Limited	65	28,080	5	575,280	575,280	575,280	Ecan Estimated	No	102
CRC021959.1	Issued - Active	Ma Taua Dairies Limited	161	13,910	1	1,746,500	1,746,500	1,746,500	Ecan Estimated	Yes	350
CRC040722.3	Issued - Active	Mangin Dairying Limited	12	7,000	7	93,600	93,600	93,600	Consented	Yes	25
CRC021898	Issued - Active	Mangin Dairying Limited	55	33,264	7	475,950	475,950	475,950	Ecan Estimated	Yes	95
CRC131816	Issued - Active	Guyon Farm Limited	88	22,810	3	333,350	333,350	333,350	Consented	Yes	140
CRC150120	Issued - Active	Mr & Mrs G K & G F Paisley	29	2,506	1	132,537	132,537	132,537	consented	Yes	58
CRC144496	Issued - Active	Cloverdale Dairies Limited	448	38,707	1	2,348,285	4,286,190	4,286,190	Ecan Estimated	Yes	752
CRC030601.2	Issued - Active	Keeley Farming Company Limited	77	54,885	9	750,000	750,000	750,000	Consented	Yes	123
CRC141724	Issued - Active	Cloverdale Dairies Limited	45			305,600	305,600	305,600	Ecan Estimated		80

Expansion Area

	Total		**1,198**	**378,151**	**70**	**9,695,240**	**10,176,345**	**-**	**-**	**1,947**	
	Inactive Consents		**125**	**133,056**	**28**	**839,051**	**1,120,156**	**-**	**-**	**215**	
	Active Consents		**1,073**	**245,095**	**42**	**8,856,189**	**9,056,189**	**-**	**-**	**1,732**	
ConsentNo	ConsentSta	HolderName	MaxRate	MaxVolume	ReturnPeri	Base Allocation	FullEffect		InAllocati	Irrigati_2_area	
CRC000398	Issued - Active	Mr & Mrs P & E K Gardner	42	46,570	14	480,000	480,000	Ecan Estimated	Yes	100	
CRC130286	Issued - Active	Mr & Mrs C E & M E Ross	83	7,171	1	200,000	400,000	Consented	Yes		Appears to be same area as CRC042709.3, but topup
CRC042709.3	Issued - Active	Mr & Mrs C E & M E Ross	156	13,478	1	959,850	959,850	Consented	Yes	485	Appears to be same area as CRC0130286
CRC121049	Issued - Active	Mr & Mrs C E & M E Ross	113	9,742	1	1,045,612	1,045,612	Consented	Yes		Apeears to be separate land
CRC153702	Issued - Inactive	C G & H K Rapsey	45	77,760	20	824,256	824,256	Consented	No	160	Combined annual volume of 1156700
CRC072748	Issued - Inactive	Mr C Gordon & Ms H K Rap	80	55,296	8	14,795	295,900	Consented	Yes	55	Combined annual volume of 1156701
CRC001018.4	Issued - Active	Lobblinn Farms Limited	57	75,513	16	565,000	565,000	consented	Yes	100	
CRC141454	Issued - Active	S M K & C M Hay & Hubbar	100	51,408	7	881,400	881,400	Consented	No	157	
CRC150120	Issued - Active	Mr & Mrs G K & G F Paisley	29	2,506	1	132,537	132,537	consented	Yes	58	
CRC144496	Issued - Active	Cloverdale Dairies Limited	448	38,707	1	4,286,190	4,286,190	Ecan Estimated	Yes	752	
CRC141724	Issued - Active	Cloverdale Dairies Limited	45			305,600	305,600	Ecan Estimated		80	

Appendix D – Effect of proposal on groundwater volumes

Current Irrigation

Surface water recharge volume contribution to groundwater

Surface Water Net Contribution	Irrigated Drainage (mm)	Dryland Drainage (mm)	Surface Water Net Contribution (mm)	Surface Water Net Contribution (m^3)
1 in 10 year groundwater demand	284	100	184	18,368,375
1 in 10 year irrigation demand	317	87	230	22,981,800
Average year	423	214	209	20,932,936

Groundwater abstractive effect on groundwater volumes.

Groundwater Net Use	Irrigated AET (mm)	Dryland AET (mm)	Groundwater net use (mm)	Groundwater net use (m^3)
1 in 10 year groundwater demand	851	434	417	14,761,714
1 in 10 year irrigation demand	869	461	408	14,420,544
Average year	822	562	260	9,185,454

Proposed Irrigation

Surface water recharge volume contribution to groundwater in the existing area

Surface Water Net Contribution -existing area	Irrigated Drainage (mm)	Dryland Drainage (mm)	Surface Water Net Contribution (mm)	Surface Water Net Contribution (m^3)
1 in 10 year groundwater demand	284	100	184	18,368,375
1 in 10 year irrigation demand	317	87	230	22,981,800
Average year	423	214	209	20,932,936

Surface water recharge volume contribution to groundwater in the expansion area

Surface Water Net Contribution -expansion area	Irrigated Drainage (mm)	Dryland Drainage (mm)	Surface Water Net Contribution (mm)	factor	Surface Water Net Contribution (m^3)
1 in 10 year groundwater demand	284	100	184	0.23	948,451
1 in 10 year irrigation demand	317	87	230	0.29	1,496,230
Average year	423	214	209	0.45	2,114,750

Groundwater abstractive effect on groundwater volumes in the expansion area

Groundwater Net Use -expansion area	Irrigated Drainage (mm)	Dryland Drainage (mm)	Surface Water Net Contribution (mm)	factor	Surface Water Net Contribution (m^3)
1 in 10 year groundwater demand	851	434	417	0.77	7,214,542
1 in 10 year irrigation demand	869	461	408	0.71	6,498,622
Average year	822	562	260	0.55	3,206,599

Groundwater abstractive effect on groundwater volumes in the expansion area

Groundwater Net Use – remaining area	Irrigated AET (mm)	Dryland AET (mm)	Ground water net use (mm)	Groundwater net use (m^3)
1 in 10 year groundwater demand	851	434	417	5,392,178
1 in 10 year irrigation demand	869	461	408	5,267,555
Average year	822	562	260	3,355,275