Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Date 27/11/2014

MEMORANDUM

File Reference:

FROM : **DAN CLARK**

TO : **MATTHEW MCCALLUM-CLARK**
cc

SUBJECT : **SELWYN RIVER DRY REACHES RESPONSE**

In regard to the question from Commissioner Solomon at the Variation 1 hearing on 26/11/2014:

What would be the effect of using all of the allocated water on the drying reaches of the Selwyn River?

The portion of the allocated water that is used varies from year to year, with the average use being estimated as 40-60%[1] of the allocation. This means that in some years more of the allocation is used and this combined with reduced rainfall can lead to increased drying in the Selwyn River.

As the modelling completed to support variation 1 was focused on the complete package we have not explicitly modelled what would happen to the Selwyn River if all of the allocation was used in every year. Modelling completed to support Clark (2011)[2] indicates that the lower half of the Selwyn River (below the Hororata River confluence) has more variation in drying. With increased use of the allocated water this lower reach is likely to remain drier for longer and extend further downstream before regaining flow.

[1] Williams, H,. 2011. Memorandum on review of water use reports for the Canterbury Region.
[2] Clark, D,. 2011. The surface water resource of the Lake Ellesmere/ Te Waihora catchment. Environment Canterbury technical report R11/26. 76 p.

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Date 27.11.2014

MEMORANDUM

File Reference:

FROM : DUNCAN GRAY – SENIOR WATER QUALITY AND ECOLOGY SCIENTIST

TO :ALASTAIR PICKEN
Cc Mathew McCallum-Clark

SUBJECT : NOTES ON OPTIONAL AMENDMENTS TO VARIATION OUTCOME AND LIMIT TABLES

Note: All additions or changes to the attached tables made by the author are shown in blue text

Amendments to Table 11a.
Periphyton (Chl-a)
The compliance statistic for periphyton could be altered from an annual maximum to percentage exceedance in alignment with NOF (MfE 2014). The NOF includes two stream classes for periphyton. Classes are streams and rivers defined according to types in the River Environment Classification (REC). The 'productive' periphyton class is defined by the combination of REC "Dry" climate categories and REC geology categories that have naturally high levels of nutrient enrichment due to their catchment geology. Banks Peninsula streams are classified as being productive class.

Microbiological indicator
The optional amended table 11a contains an additional column showing suitability for secondary contact recreation. Banks Peninsula streams and spring-fed plains streams are likely to achieve this amended secondary contact grading under the Zone Committee solution package. A further option is to include the note 'not suitable" for Banks Peninsula streams and spring-fed plains streams under the SFRG suitability for primary contact recreation column.

Dissolved Reactive Phosphorus (DRP) in streams
There are no generally accepted DRP thresholds for streams that are analogous to the nitrate toxicity guidelines. Therefore, it is not possible to create a table of phosphorous concentration limits akin to table 11k (nitrate toxicity). Rather the available nodal stream specific phosphorus concentrations are predicted outcomes of the implementation of the Zone Committee solution package (ZCSP). Thus, an appropriate place to record these concentrations would be table 11a. However, in assessing the ZCSP phosphorus concentrations were only available for certain spring-fed plains and Banks Peninsula streams, not the full range of stream types included in table 11a.

Rather than fill out only two rows in a phosphorus column of table 11a I suggest that these phosphorus concentrations could be recorded in an additional table of 'freshwater outcomes for DRP in streams'.

The phosphorus concentration predictions were based on a proportional reduction from current measured mean. Therefore, compliance/plan efficacy should be assessed using an annual mean from each stream.

Table 1. Dissolved Reactive Phosphorus outcomes in nodal sites in the Selwyn Te Waihora zone.

Stream	Dissolved Reactive Phosphorus (mg/l) (Annual mean based on 12 samples)
Halswell	0.015
L11	0.011
Selwyn @ Coes	0.010
Irwell	0.020
Hamner	0.024
Boggy	0.020
Doyelston	0.031
Harts Creek	0.012
Waikekewai	0.009
Kaituna	0.011

Amendments to table 11b

Because Muriwai/Coopers lagoon is considered to be a lake it requires ammonia and *E.coli* limits to be added to table 11L and an adjustment of the compliance statistics and measurement units used in order to align with NOF.

Total Phosphorus, Total Nitrogen and Chl-*a* are included in Table 11L, but the compliance units could be converted to mg/m^3. In addition a more appropriate compliance statistic for these variables in Muriwai/Coopers Lagoon is an annual median. These have been amended in the tables provided.

The NOF requires limits to be set for *E. coli,* Cyanobacteria and ammonia. ECan do not measure cyanobacteria in Muriwai/Coopers Lagoon, but do monitor *E. coli* and ammonia. These parameters were not modelled during the ZCSP assessment process and so our data cannot be considered as outcomes of Variation 1. Thus, the lower bound of the appropriate NOF banding for *E. coli* and ammonia current concentrations could be appended to the lake limits table 11L. In terms of *E. coli* Muriwai/Coopers Lagoon is not currently suitable for primary contact recreation which could be indicated in table 11b.

Comment on the categorisation of the Lower Selwyn River

The Selwyn River is typical of many smaller hill-fed Rivers in Canterbury in that it has an intermittent middle reach (Larned et al. 2008). The morphology, channel structure and bed composition, of the lower river is determined by the large floods which breach the dry middle reach. But the flow and water quality for much of the year, when the dry reach is present, is derived predominantly from groundwater. The lower Selwyn is often a spring-fed stream flowing in the bed of a hill-fed river. As a result it is very difficult to categorise the river for the purposes of setting water quality thresholds or guidelines. In particular the morphology of the river bed is highly conducive to the growth of nuisance algae, being broad and shallow with a stony bed (Biggs 2000).

A submission from DairyNZ suggested that in terms of nitrate toxicity it would be most appropriate to categorise the lower Selwyn River as a spring-fed plains river and set nitrate toxicity limits accordingly. I agree with this assessment and have added an optional footnote to table 11k. My only concern with this change is the potential for increased permissible nitrate levels to increase the risk of nuisance algal growth in the lower Selwyn River. Algal growth in the lower Selwyn will not be managed by table 11a if the river if classed as spring-fed because there is 'no value set'. Ideally I would like to see the algal growth in the lower Selwyn managed/monitored as per a hill-fed lower river. I have added a footnote to table 11a to that affect.

References

Biggs B, 2000. New Zealand periphyton guideline: detecting, monitoring and managing enrichment in streams. Prepared for the Ministry for the Environment, NIWA, Christchurch.

Larned ST, Hicks DM, Schmidt J, Davey AJH, Dey, K, Scarsbrook M, Arscott DB, Woods RA, 2008. The Selwyn River of New Zealand: a benchmark system for alluvial plain rivers. River Research and Applications 24, 1–21.

Ministry for the Environment 2014. National Policy Statement for Freshwater Management 2014, 4 July.

11.6 Fresh Water Outcomes

The following tables set out the freshwater outcomes to be achieved in the Selwyn Te Waihora catchment.

Table 11(a): Freshwater Outcomes for Selwyn Te Waihora Catchment Rivers

Management Unit (see Planning Maps)	River	Ecological health indicators			Macrophyte indicators		Periphyton indicators			Siltation indicator	Microbiological indicator		Cultural indicator (10)
		QMCI [min score]	Dissolved oxygen [min saturation] (%)	Temperature	Emergent macrophytes [max cover of bed] (%)	Total macrophytes [max cover of bed] (%)	Chlorophyll a [Exceeded by no more than 8% samples]~~max~~ biomass~~1~~ (mg/m³)	Filamentous algae >20mm [max cover of bed] (%)	Cyanobacteria mat cover (%)[3]	Fine sediment <2 mm diameter [max cover of bed] (%)	Suitability for primary contact recreation [SFRG](9)	Suitability for secondary contact recreation (based on an annual median *E.coli*/100 ml)	
Natural state	Headwaters of Selwyn/Waikiriri	Rivers are maintained in a natural state											Freshwater mahinga kai specie are sufficiently abundant for customary gathering, water quality is suitable for their safe harvesting,
Alpine - upland	Headwaters of Selwyn/Waikiriri	>6	90	20	No values set	No values set	50	10	20	10	Good to fair		
Hill-fed - upland	Upper Selwyn/Waikirikiri Hawkins	>6(1)	90	20	No values set	No values set	50	10	20	15	Good		
Hill-fed - lower	Hawkins Hororata Selwyn/Waikirikiri Waiāniwaniwa	>5(2)	90	20	No values set	No values set	200~~(6)~~(11)	<30(6)(11)	50	15	Good to fair		
Banks Peninsula	Kaituna Price Stream	>5(3) >6(4)	90	20	No values set	No values set	120[6]	20	30	20	~~No values set~~Not suitable	≥ 260 & ≤540	

[3] V1pLWRP-1245-Canterbury District Health Board

Spring-fed - plains	Birdlings Brook Boggy Creek Doyleston Drain Halswell/Huritini Hanmer Road Drain Harts Creek Hororata Irwell River Jollies Brook Knights Creek Lee LII Lower Selwyn/Waikirikiri Silverstream Snake Creek Taumutu Creek Tent Burn Stream Waikekewaia Creek; and other lowland spring-fed streams.	>5(5)	70	20	30	50	No values set	<30(7) <20(8)	50	20	~~No values set~~Not suitable	≥ 260 & ≤540	and they are safe to eat.
All Rivers	-		Observed minimum river flows of 80 to 90% of the naturalised 7DMALF on average										

Key:

QMCI = Quantitative macro invertebrate community index

SFRG = Suitability for Recreation Grade from Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas 2003

7DMALF = Seven day Mean Annual Low Flow

(1) Selwyn River/Waikirikiri upstream of Whitecliffs

(2) Over a 5 year period: 80 percent of samples for the Selwyn River/Waikirikiri and Hawkins River; and 60 percent of samples for the Waiāniwaniwa River

(3) QMCI ≥ 5 for (1) Kaituna River from Kaituna to Te Waihora/Lake Ellesmere confluence and (2) Prices Stream from 2.5 km upstream of SH75 to Te Waihora/Lake Ellesmere confluence

(4) QMCI ≥ 6 for (1) Kaituna River all reaches upstream of Kaituna (2) Prices Stream all reaches upstream from a point 2.5 km upstream of SH75

(5) 80 percent of samples over a 5 year period

(6) ~~80 percent of samples over a 5 year period~~. Banks Peninsula streams exceed no more than 17 % of samples. Based on a monthly monitoring regime. The minimum record length for grading a site based on periphyton (chl-a) is 3 years

(7) Over a 5 year period: 95 percent of samples for Boggy Creek and the Selwyn River/Waikirikiri at Coes Ford; 90 percent of samples for Doyleston Drain; and 80 percent of samples for Waikekewai Creek and Irwell River

(8) Halswell River, Harts Creek and Hanmer Road Drain

(9) SFRG outcomes for Selwyn River / Waikirikiri contact recreation sites: Glentunnel (Fair); Chamberlains Ford (Good); Coes Ford (Fair); Upper Huts (Fair).

(10) Outcomes relate to the part of any river that passes through the Cultural Landscape/Values Management Area in Table 11(n)

(11) Including the lower Selwyn River downstream of the drying reach

Table 11(b): Freshwater Outcomes for Selwyn Te Waihora Catchment Lakes

Management unit (see Planning Map)	Lake	Ecological health indicators				Eutrophication indicator	Visual quality indicator	Microbiological indicator	Cultural indicator
		Dissolved Oxygen [min] (%)		Temp [max] (ºC)	Lake SPI [min grade]	Trophic Level Index (TLI)(1) [maximum annual average]	Water clarity	Suitability for ~~contact~~ primary contact recreation [SFRG]	
		Hypo-limnion	Epilimnion						
Coastal Lakes	Te Waihora / Lake Ellesmere	70	90	19 (Mid lake)	Moderate	6.6 (Mid lake) 6.0 (Lake margins) (2)	Clarity is greater in the lake margins are than mid lake areas	Good - Fair(3)	Freshwater mahinga kai species sufficiently abundant for customary gathering, water quality is suitable for their safe harvesting, and they are safe to eat.
	Muriwai/ Coopers Lagoon	70	90	19	Moderate	4.0	No value set	~~No value set~~Not suitable	

Key:

Lake SPI = Lake Submerged Plant Indicators from Clayton J, Edwards T, (2002) Lake SPI: a method for monitoring Ecological condition in New Zealand lakes (Technical report version 1 Report by NIWA).

TLI =Trophic Level Index from: Protocol for Monitoring Trophic Levels of New Zealand Lakes and Reservoirs (Report by Lakes Consulting, March 2000) provides a pragmatic and widely used numeric scale for measuring the trophic status of New Zealand lakes. The scale is from less than 1 (very low nutrients) to more than 7 (very high nutrients).

SFRG = Suitability for Recreation Grade from: Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas, Ministry for the Environment, June 2003.

Clarity = Measured using SHMAK tube method.

(1) TLI assumed to be calculated as TLI3 (using TP, TN and chl a).

(2) The TLI of 6.0 at the lake margins reflects the desired outcome where water clarity is improved compared to the mid-lake areas as a result of wave-break created by macrophyte re-establishment.

(3) SFRG outcomes for Te Waihora/Lake Ellesmere contact recreation sites: Te Waihora/ Lake Ellesmere Domain (Good).

Table 11(k): Limits for Rivers

River type	Type	Measurement	Limit Nitrate-nitrogen concentration (mg/l)
Alpine - upland	Nitrate (toxicity)	Annual median	1.0
		Annual 95th percentile	1.5
Hill-fed - upland	Nitrate (toxicity)	Annual median	1.0
		Annual 95th percentile	1.5
Hill-fed - lower(1)	Nitrate (toxicity)	Annual median	2.4
		Annual 95th percentile	3.5
Banks Peninsula	Nitrate (toxicity)	Annual median	1.0
		Annual 95th percentile	1.5
Spring-fed – plains(2)	Nitrate (toxicity)[4]	Annual median	6.9
		Annual 95th percentile	9.8

(1) Excluding Hawkins River which has an annual median limit of 3.8 mg/l and annual 95th percentile of 5.6 mg/l

(2) Excluding Boggy Creek and Doyleston Drain, but including the lower Selwyn River downstream of the drying reach.

Table 11(l): Limits for ~~Lakes~~Te Waihora/ Lake Ellesmere and Muriwai/ Coopers Lagoon

Lake	Location	Target						
		TLI(2)	TP(1)	TN(1)	Chl a(1)	E. Coli (1)(4)	Ammonia	
							Annual median	Annual maximum
Te Waihora/Lake Ellesmere	Mid lake	6.6	0.1	3.4	74	na	na	na
	Margins	6	Not modelled(3)	Not modelled(3)	Not modelled(3)	na	na	na
Coopers Lagoon		4	~~0.02~~020	~~0.~~340	5	<260	≤0.03	>0.05 & ≤0.4
			mg/~~L~~m³	mg/m³~~L~~	m~~u~~g/m³~~L~~	*E. coli* /100 ml	*mg NH_4–N/L*(5)	

(1) As an ~~maximum~~ annual ~~average~~ median

(2) TLI assumed to be calculated as a TLI3 (using TP, TN and chl a).

(3) The anticipated TLI of 6 in the margins of Te Waihora to be driven primarily by improved water clarity in the lake margins as a result of re-establishing macrophyte beds. It is expected that concentrations of TP,

[4] Cl16 Minor correction for clarity and to improve alignment with NPS-FM/NOF

TN and/or Chl a would also reduce in the margins compared to the mid lake, but it is not possible at this time to set numbers for these concentrations.

(4) Suitability for secondary contact recreation.

(5) Based on a pH of 8 and temperature of 20◦C, compliance should be determined after adjustment for pH.

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

Date 27/11/2014

MEMORANDUM

File Reference:

FROM : **MATTHEW MCCALLUM-CLARK**

TO : **HEARING COMMISSIONERS**
cc

SUBJECT : **RESPONSE TO FINAL PLANNING QUESTIONS**

1. Does CPW hold a discharge consent under pLWRP Rule 5.62, or is it a permitted activity under pLWRP Rule 5.61?

   CPW holds no discharge consent under Rule 5.62.

   With respect to Rule 5.61, CPW holds an existing consent, granted prior to the pLWRP being notified. It has not yet been formally tested to determine if that consent has "conditions that specify the maximum amount or rate at which nutrients may be discharged or leached from the subject land". I understand the key condition is condition 20 of consent CRC061973, which states:

> 20) Where the average annual concentration of nitrate nitrogen in the soil drainage water below the plant root zone as calculated for the property in accordance with clause 18(b) or measured:
> (d) is between 8 grams per cubic metre and 16 grams per cubic metre, management practices shall be implemented to reduce the loss of nitrate nitrogen to soil drainage water;
> (e) exceeds 16 grams per cubic metre of nitrate nitrogen, the consent holder shall require the adoption of management practices to reduce the loss of nitrate-nitrogen to soil drainage water, including but not limited to:
> (i) a revision of the Farm Management Plan on that property to ensure best management practices are put in place;
> (ii) a review of the on-farm practices to ensure implementation of the FMP,
> (iii) the management practices specified in condition 12(b); and
> (iv) the average total nitrogen (fertiliser and effluent) application to that property shall be limited to 200 kgN/ha/yr.

   In any event, Rule 5.61 only authorises a discharge until 1 January 2017, and it is also noted that condition 35 of Schedule 2 of CPW's consent conditions requires CPW to apply to vary the conditions [to align with the load in Variation 1] within 6 months of Variation 1 becoming operative.

2. Has any other submitter sought an increase to the industrial or trade processes limit in Table 11(i)?

   The submission of ANZCO, CMP Rakaia and CMP Canterbury seeks deletion of this limit and reliance on application rates. This position is continued through the ANZCO evidence and no alternative limit is advanced.

   The submission of Synlait Milk seeks to remove the table and place it outside the Plan to enable easier updating of the values. This position is modified in the evidence of Hillary Lough at paras 34-38. In this analysis Ms Lough seeks an additional 30 tonnes per annum, to account for sludge authorised by discharge consent CRC084323.

   If there was considered to be scope within the Synlait Milk submission, the industrial or trade processes limit could be increased to 152.4 tonnes per annum.

3. Is there less risk of error if Table 11(j) refers to 'New Irrigation' (902 or 979 tonnes or thereabouts)?

   While the technical answer is provided by Melissa Robson, from a planning and legal perspective, it remains the officers' recommendation that the policy and rule framework included in the Reply Recommendations be adopted. We are of the opinion that the recommended framework is more certain and more effective and efficient with respect to administration by individual farmers and the Canterbury Regional Council.

4. Is it more appropriate to use the term "property or farming enterprise" instead of "property"?

   Possibly. This adjustment could lead to a simpler and slightly more flexible rule framework. Adjustments required would include an additional reservation of control under Rule 11.5.9 to manage the control of nutrients on properties joining or leaving the farming enterprise, and the deletion of Rule 11.5.10.

   However, if farming enterprises become permitted (and to a lesser extent controlled activities), then:
   1. *It would be difficult to know where these activities are occurring; and*
   2. *As land parcels move in and out of the farming enterprise there is an ability (through the change of conditions) to monitor which parcels come in and out of an enterprise and ensure any nutrients are apportioned correctly.*

5. Is it possible to better align the outcomes, targets and limits tables with the NOF?

   The primary technical response on this matter is provided by Duncan Gray. The Officer's provided the original comments as "options" for the Hearings Commissioners to consider, and this remains the Officers' position, rather than recommending the changes be made. This is due to the limited scope in submissions and the generally uncertain nature by which any adjustments to the Tables or NOF alignment were raised in submissions.

Date 26 November 2014

MEMORANDUM

FROM : **MELISSA ROBSON AND CARL HANSON**

TO : **MATTHEW MCCALLUM-CLARK**

SUBJECT : **RESPONSE TO QUESTIONS RAISED BY COMMISSIONERS ON RIGHT OF REPLY EVIDENCE**

In response to questions raised by the commissioners on the Right of Reply evidence for the Variation 1 (Selwyn Waihora) hearing, Melissa Robson was asked to provide comment on the following points:

1. What would be the impact of the nitrogen load of all of the domestic septic tanks in the zone moving to from poorly performing to well performing systems?
2. Does the 1944 t N in Table 11j capture all fully and partially supplied irrigation within CPW?
3. If Table 11j was only to include the N load associated with the new irrigation within CPW what would the N loads be for 2017 and 2022?

An additional question was raised for Carl Hanson which is also addressed in this memo:

4. What should the footnote in Table 11m read to bring the table into line with the content of Mr Hanson's Right of Reply evidence?

1) What would be the impact of the nitrogen load of all of the domestic septic tanks in the zone moving to from poorly performing to well performing systems?

In an assessment of nitrogen and phosphorus losses from consented and permitted activities across Canterbury, Loe (Loe, 2012) assumes that improved technology and design of septic tanks can yield almost a 3-fold reduction in emitted nitrogen. The following is taken from his 2012 report:

"For the purpose of the project on-site sewage systems installed before 2006 are assumed to contribute:

Nitrogen: 55 g/m^3 or 9 kg N/dwelling/year
Phosphorus: 12 g/m^3 or 2 kg P/dwelling/year

Onsite systems installed since 2006 are assumed to contribute:

Nitrogen: 20 g/m^3 or 3 kg N/dwelling/year
Phosphorus: 5 g/m^3 or 1 kg P/dwelling/year"

In Loe (Loe, 2013) the contributions of nitrogen and phosphorus from sewage and industrial wastes specifically in the Selwyn Waihora catchment are assessed. In Table 4-2 of that report, Loe indicates the relative N and P contributions of on-site sewage, community sewerage schemes, milk and meat processes. On-site sewage is estimated to currently contribute 56 t N/ year. This is approximately 1% of the total modelled catchment N load for 2011. If all of the on-site sewage systems operated at post 2006 standards the estimated nitrogen load would be approximately 25 t, or 0.6% of the total modelled catchment load for 2011.

2) **Does the 1944 t N in Table 11j capture all fully and partially supplied irrigation within CPW?**

For the purposes of modelling, the creation of the GIS irrigation layer (existing and new) was done by allocating land polygons (combinations of soil/climate/land use) to either dryland or irrigated status. These polygons are not 'farm' boundaries and a single farm will most likely have more than 1 polygon. The 1944 t N covers all irrigated land parcels (60,000 ha), however there may be part irrigated farms whose dryland portions are not included in the 1944 t N. Until it is known whether farmers have chosen to fully irrigate or only partially irrigate their properties, this cannot be quantified. In any event, this dry-land portion would not increase the overall catchment load, but may increase the proportion that CPW is required to account for.

An improved estimate of the N load could be ascertained with improved information on the location of proposed irrigation, as indicated in the technical memo dated 12th November 2014 (Robson, 2014a)

3) **If Table 11j was only to include the load associated with the new irrigation within CPW what would the loads be for 2017 and 2022?**

Central Plains indicated in their evidence[5], that their additional irrigation load would be 979 tN. This total is based on a simple average of the N losses from 20 irrigated properties in the command area operating at current practice, multiplied by 27,000 ha (the net dryland area remaining of the CPWL consented 60,000 ha).

The ECan calculated load for additional irrigation is 902 t N. This total is based on aggregated leaching losses for soil/climate/land use polygons for 30,000 ha irrigation for a specific land use configuration[6] that has been randomly located and assigned and with farms operating beyond GMP (halfway between GMP and MFM (Maximum feasible mitigation).

Although numerically the loads are quite similar, they have been calculated in different ways. The technical memo dated 12th November indicates four reasons why these two loads are either not directly comparable or why there is insufficient information to know whether or not the CPWL load calculation is an improvement on the ECan one:

- Method of calculation
- Representativeness of information
- Irrigated area
- Level of on farm management

[5] Presented on the whiteboard by S. Goodfellow. Included as appendix 1 in Robson 2014a

[6] 40% dairy/40% arable/20% beef and sheep and dairy support. These land use assumptions are detailed in appendix 5 of the Overview technical report (Robson, M.C., 2014b. Technical report to support water quality and water quantity limit setting process in Selwyn Waihora catchment. Predicting consequences of future scenarios: Overview Report. Environment Canterbury Technical Report.)

The ECan load assumes that new irrigation operates at better than GMP right from the start (compared with existing irrigators and other land uses where there is a staged approach). Therefore the ECan calculated 2017 and 2022 loads for new irrigation are the same.

4) **What should the footnote in Table 11m read to bring the table into line with the content of Mr Hanson's Right of Reply evidence?**

To bring Table 11m into line with the evidence presented in Carl Hanson's Right of Reply evidence (Hanson, 2014), footnote 1 would read "In groundwater sourced from land surface recharge" instead of "In shallow groundwater < 50 metres below groundwater level."

References

Hanson, C., 2014. Technical momorandum to Matthew McCallum-Clark: Response to issues raised in the Vartiation 1 Submitters' evidence - Nitrate limits for deep groundwater.

Loe, B., 2012. Estimating nitrogen and phosphorus contributions to water from discharges that are consented and permitted activities under NRRP. R12/18.

Loe, B., 2013. Selwyn-Waihora Catchment: Estimating nitrogen and phosphorus contributions to water from discharges of sewage effluent from community sewerage systems, and milk processing wastewater.

Robson, M.C., 2014a. Technical momorandum to Matthew McCallum-Clark: Response to issues raised in the Vartiation 1 Submitters' evidence - Catchment loads.

Robson, M.C., 2014b. Technical report to support water quality and water quantity limit setting process in Selwyn Waihora catchment. Predicting consequences of future scenarios: Overview Report. Environment Canterbury Technical Report.