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:	**Fonterra Co-operative Group Limited** *Submitter*
and:	**DairyNZ** *Submitter*

Rebuttal evidence of Shirley Ann Hayward (farming)

Dated: 8 September 2014

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REBUTTAL EVIDENCE OF SHIRLEY ANN HAYWARD

INTRODUCTION

1 My full name is Shirley Ann Hayward.

2 My qualifications and experience are set out in my statement of evidence (*EIC*) dated 29 August 2014.

SCOPE OF EVIDENCE

3 In this statement of evidence, I respond to the evidence of Dr Alison Dewes, Mr Brett Stansfield and Dr Cooke who have been called by the North Canterbury Fish and Game Council and the Royal Forest and Bird Society.

4 As with my EIC, I confirm that I have read the Environment Court practice note and have complied with it in preparing this rebuttal evidence.

FARMING NITROGEN LOAD

5 Dr Dewes states in paragraph 22 of her EIC that the current load for established farms is 3,366 tonnes nitrogen/year (tN/Yr). This is incorrect. This figure is further quoted by Mr Pearson as the current load (in the final page of his EIC).

6 In Appendix 1 I summarise my current understanding of the components of the catchment nitrogen load as modelled by Environment Canterbury. This data is derived from an Excel spreadsheet[1] supplied by Environment Canterbury to Central Plains Water (CPW) at the time of notification of Variation 1 (Susan Goodfellow, CPW, pers comm.).

7 Based on the data from Environment Canterbury, farming losses for the 'current' (2011) land use scenario is 4,529 tN/yr, which includes an assumption that all rural land users are implementing good management practices (GMPs). The figure of 3,366 tN/yr quoted in Dr Dewes evidence is actually the modelled 2017 nitrogen (N) load for the farming area excluding the CPW command area and assumes that farms currently losing less than 15 kgN/ha/yr have increased their N losses up to that permitted threshold.

8 The change in the farming N load from current (2011+GMP) to that set in Table 11(j) is a 7% overall increase in nitrogen load. However, the effects of this are in the context of CPW development resulting in dilution of groundwater and stream nitrogen

[1] Spreadsheet from Environment Canterbury – file name 'load_summary_partition_solpak2_4Feb14 (2)'

concentrations, and improved stream flows resulting in overall improvements to stream health (section 32 – Appendix 5).

WATER QUALITY LIMITS FOR RIVERS AND STREAMS

9 Mr Stansfield recommended that Table 11(k) be amended so that nitrate limits are set based on current state and progressively reduced by 30% by 2022, and 50% by 2037. In addition, he recommended that phosphorus limits be included in this table on the same basis as his proposed nitrate limits (30% reduction from current state by 2022, and 50% reduction by 2037).

10 My understanding of the nitrate limits in Table 11(k) are that they were assessed based on the considering appropriate levels of protection from chronic (non-lethal) toxicity risks to aquatic fauna based on the Hickey (2013) guidelines (Kelly 2014). In that sense they appropriately set expectations for the level of protection from nitrate toxicity for the different river management units established for the Selwyn Te Waihora zone (not withstanding my recommended changes for the lower Selwyn River in my EIC).

11 I do not believe the nitrate limits set in Table 11(k) are intended as upper limits for which rivers and streams would be permitted to reach (as suggested by Dr Dewes, paragraph 57). This is because other provisions in Variation 1, namely the farming, community sewerage and industrial or trade processing nitrogen limits in Table 11(i) impose tight controls on nitrogen losses within the catchment. Based on these controls, I do not consider further amendments to the nitrate limits for rivers and streams is necessary.

12 I have some sympathy with Mr Stansfield's suggestion that phosphorus limits for rivers and streams should be included in Variation 1. However, the outcomes for periphyton and macrophyte indicators set out in Table 11(a) implicitly require management of controlling factors on instream plant production that include nutrients, particularly phosphorus, flows and habitat quality (e.g., management of sediment inputs, stream shading).

13 Requirements in Variation 1 for farm environment plans are likely to be a key tool in managing and reducing phosphorus losses from farms. In particular, focussing on high risk areas (critical source areas) on farm is likely to have greatest benefit in reducing losses of phosphorus, sediment and faecal material (McDowell 2012). Other non-regulatory measures that are currently in progress as outlined in the section 42 report are also likely to contribute to instream P reductions and improved aquatic ecological health.

14 Given the outcomes for periphyton and macrophytes are clearly set out in Table 11(a), and the range of provisions set out in Variation 1 that aim to control both nitrogen and phosphorus inputs to receiving waters, improve flows and habitat quality, in my view specific further nutrient limits are not critical to successful achievement of the outcomes.

15 Furthermore, I do not support Mr Stansfield approach of setting nutrient limits for specific monitoring stations, nor for applying broad percent reductions across these sites. Setting of numeric outcomes or limits needs to be established at the scale of appropriate management units (water bodies) rather than specific current monitoring stations, which may change over time. This is consistent with approaches for setting water quality objectives in the National Policy Statement for Freshwater Management.

16 Applying a broad brush percent reduction to all sites does not consider the variable sensitivities of the water bodies, any trends, extent of degradation and opportunities for improvements that vary across waterways. Establishing phosphorus limits for Selwyn Te Waihora rivers management units requires evaluation of both their needs for protecting instream values as well as assessing the combined impact on Te Waihora/Lake Ellesmere.

WATER QUALITY LIMITS FOR TE WAIHORA/LAKE ELLESMERE

17 Mr Stansfield recommends changes to Table 11(l) (limits for lakes) such that total nitrogen (TN) and chlorophyll a concentrations remain at current levels by 2037, and TP reduces to 0.07 mg/L and the trophic level index (TLI) reduces to 6.0 by 2037. He proposes further reductions in total phosphorus (TP), TN and TLI for 2050.

18 This contrasts with Variation 1 proposed limits for lakes, particularly for TN which Variation 1 sets at a level higher than current state (as illustrated in Appendix 3 of my EIC). An explanation for the selection of TN, TP and Chlorophyll a limits are not provided in the section 32 report nor in supporting technical documents. I presume the proposed increase in TN limit compared to current state is based on an anticipated increase in nitrogen to the lake because of the groundwater nitrogen lag (nitrogen that is still in transit within the groundwater system from current land uses).Norton et al. (2014) anticipated a 35 - 40% increase in loads to the lake from nitrogen lags within the groundwater system.

19 As stated in my EIC, there is considerable uncertainty in the magnitude of this ‘nitrogen load to come’, and whether TN concentrations in the lake will similarly increase. Therefore, I am of the view that there is considerable uncertainty about whether the

in-lake TN limits in fact need to be increased and by how much to recognise this lag effect.

20 Mr Stansfield refers to an informative literature review by Dr Marc Schallenberg (Appendix 4 in Norton et al., 2014), in which Dr Schallenberg suggested a TN concentration of 1000 µg/L (=1 mg/L) as threshold above which macrophytes are unlikely to dominate in shallow coastal lakes and lagoons. However, he also cautions that:

> These potential thresholds should be further validated before applying them directly to specific ICOLLs like Lake Ellesmere/Te Waihora or Waituna Lagoon. After careful consideration of other important environmental drivers specific to these ICOLLs, the thresholds might provide useful initial targets for management or restoration.

21 While the limit for Te Waihora/Lake Ellesmere of 1 mg/L TN proposed by Mr Stansfield is consistent with this threshold, in my view further understanding of the interaction of various drivers in Te Waihora/Lake Ellesmere is needed before such a threshold could be verified as appropriate. As discussed in my EIC, some of the current areas of uncertainty are likely to improve with improved quantification of catchment nitrogen losses, resulting in improved understanding of relationships between current water quality and likely effects of any lags in the system.

22 In my view the critical indicator for the trophic condition of the lake is the amount of phytoplankton biomass, as indicated by chlorophyll a concentrations. It is phytoplankton growth rates, biomass, and community composition (including cyanobacterial risks) that are key drivers of (or risks to) many of the lake outcomes sought in Variation 1. Any significant long-term increases in phytoplankton production are likely to have a range of detrimental effects on lake ecology and community values for the lake.

23 Table 11(l) proposes a chlorophyll a limit of 74 µg/L, which is about the 5 year average for 2008-2013. The current 5 year average (2009-2013) is slightly lower at 69 µg/L. I support the notion that, as a minimum limit, chlorophyll a concentrations should not increase above current levels, and depending on the success of lake interventions such as those described by Gibbs and Norton (2014), in the long term will ideally decrease. Therefore I agree with Mr Stansfield that the chlorophyll a limit for Te Waihora should be set as proposed in Variation 1 Table 11(l).

24 I reiterate that I also support the need for controls on (and ultimately reduction in) in-lake nutrients, via mechanisms that control loads to the lake along with interventions that control internal processes affecting nutrient availability (e.g., P release from

sediment, denitrification). These measures along with other interventions such as lake level manipulation, ultimately aim to decrease the production of phytoplankton, decrease risks of cyanobacterial blooms, and increase the likely success of macrophyte restoration.

INCREASES IN NITROGEN LOADS TO TE WAIHORA/LAKE ELLESMERE

25 Dr Cooke expresses his concerns that increasing flows to lowland streams as a result of CPW development will also increase nitrogen loads to Te Waihora/Lake Ellesmere. Increases in stream flows are an important component of achieving improved instream water quality and biodiversity outcomes sought in Variation 1. I do not agree with Dr Cooke that increasing stream flows will necessarily increase instream nitrogen *concentrations*. Whether instream nitrogen concentrations change as a result of increase flows will depend on the mechanism by which flows have increased. For example, managed aquifer recharge is intended to dilute groundwater nitrates with low nitrate water, which is consequently expected to result in reduced stream nitrate concentrations. On the other hand, raised groundwater levels, without dilution may increase the proportion of nitrate rich groundwater entering spring-fed streams.

26 I do agree in general that as flows increase so do nutrient *loads* because nutrient loads are the product of concentration times flow volume. However, as I indicated in my EIC, I do not agree that increases in nitrogen loads to Te Waihora/Lake Ellesmere will necessarily coincide with increased nitrogen concentrations within the lake.

27 I illustrate this point in Appendix 2. I have used the same methodology as Dr Cooke to calculate N loads for the Selwyn River at Coes Ford and for the Halswell River at McCartney's bridge monitoring site (but used a July-June hydrological year). I included the Halswell River as a comparsion to the Selwyn River. Halswell River flows are predominately fed by groundwater springs, while the lower Selwyn River flows are fed by a combination of groundwater inflows, and upper catchment inflows when the river is fully connected.

28 The graphs in Appendix 2 simply illustrate the variability in annual flow volume resulting in a similar variability in annual nitrogen loads. I have also included annual TN concentrations (from my EIC) for the same period. What this illustrates is that the nitrogen concentrations within Te Waihora/Lake Ellesmere do not respond in a similar manner to annual variations in load inputs.

29 Furthermore, increases in freshwater inflows to Te Waihora are likely to have benefits for lake, particularly if it enables higher lake levels. Higher lake levels can help reduce wind induced bed sediment re-suspension and therefore improve clarity, and potentially reduce P release from sediments. Other benefits include increase lake openings increasing fish migration opportunities, although lake openings may also have risks associated with increase lake salinity.

Dated: 8 September 2014

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Shirley Hayward

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Hickey, C.W. 2013: Updating nitrate toxicity effects on freshwater aquatic species. NIWA client report prepared for Ministry of Building, Innovation and Employment.

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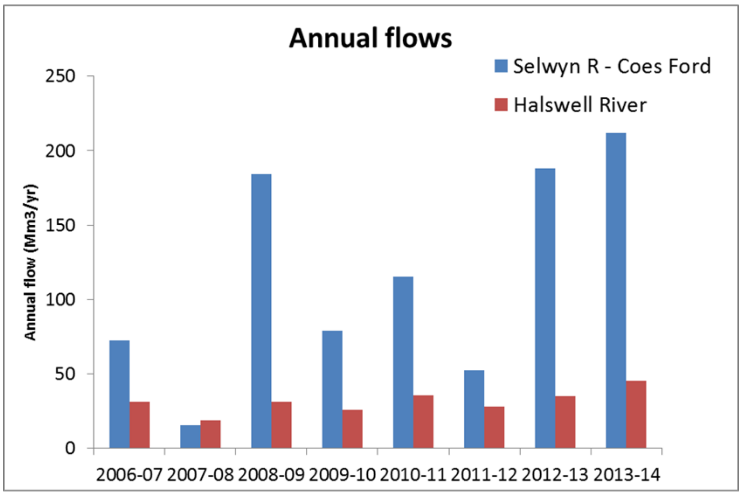
McDowall, R. 2012. Challenges and opportunities to decrease phosphorus losses from land to water. In: *Advanced Nutrient Management: Gains from the Past - Goals for the Future*. (Eds L.D. Currie and C L. Christensen). http://flrc.massey.ac.nz/publications.html. Occasional Report No. 25. Fertilizer and Lime Research Centre, Massey University, Palmerston North, New Zealand.

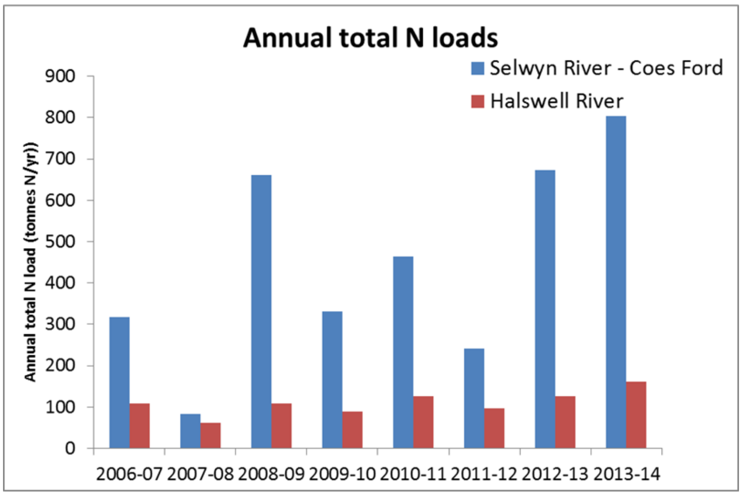
Norton, N., Allan, M., Hamilton, D., Horrell, G., Sutherland, D., Meredith, A. 2014: Technical report to support water quality and water quantity limit setting process in Selwyn Waihora catchment. Predicting consequences of future scenarios: Te Waihora/Lake Ellesmere. Environment Canterbury report R14/14.

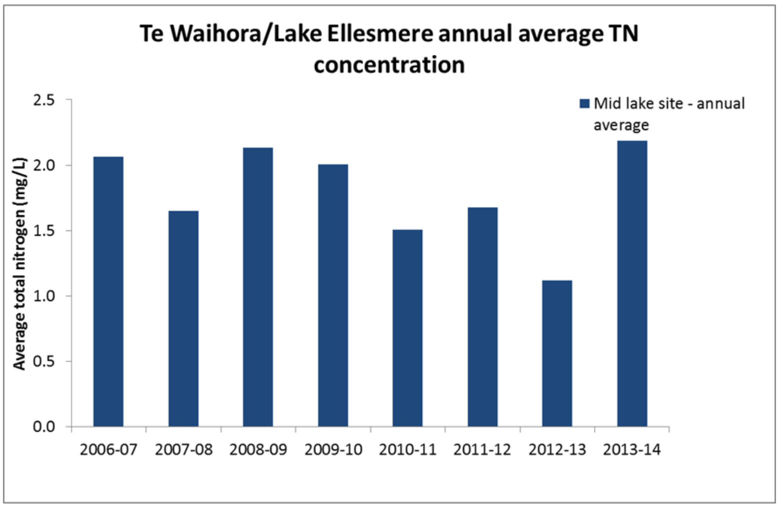
Appendix 1: Summary of the catchment nitrogen load for farming land in Selwyn Te Waihora zone

Breakdown of farming nitrogen load	area (ha)	2011 assumes: ⇒ GMP, N load (t N/yr)	2017 assumes: ⇒ GMP, ⇒ low emitters intensify up to 15 kgN/ha/yr, ⇒ CPW irrigation of additional 30,000 ha N load (t N/yr)	2022 assumes: ⇒ GMP, ⇒ low emitters intensify up to 15 kgN/ha/yr, ⇒ CPW irrigation of additional 30,000 ha ⇒ % reductions achieved as per Policy 11.4.14 N load (t N/yr)	Explanatory notes
CPW Command area					
Existing irrigated area	30,000	1,033	1,043	840	1033 tN is the baseline for current (2011) land use at GMP. 1043 tN assumes that lower emitters (<15 kgN/ha/yr) increase to up to 15 kgN/ha/yr 840 tN assumes existing irrigators make reductions as per policy 11.4.14(b)
% change in load in existing CPW irrigated area			*1%*	*-19%*	
Existing dryland -to be converted to irrigated	30,000	467	901	901	901 = 467 (2011 baseline+GMP) + 434 (additional load allowed for conversion to irrigated land)
% change in load in CPW area that will be converted to new irrigated area			93%	93%	
Total CPW	60,000	1,500	**1,944**	**1,742**	**Load as allocated for CPW in Table 11(j) in Variation 1**
% change in CPW load from 2011			*30%*	*16%*	
Non CPW farming area					
Plains (mostly east of SH1)	150,771	2,910	3,366	2,970	The 2017 load assumes the low emitters increase up to 15kgN/ha/yr - which is about half of the non-CPW farming area. The 2022 load assumes that low emitters have increased up to 15kgN/ha/yr and those above 15kgN/ha/yr have reduced N loss accoring to Policy 11.4.14
% changes in non-CPW area			*16%*	*2%*	
N load from hill area	29,680	119	119	119	Assumes no change to N losses from the foothill/Banks Peninsula hill area - ie grandparented to current baseline)
Total non CPW farming area	**180,451**	**3,029**	**3,485**	**3,089**	
Total Selwyn Te Waihora zone					
Non allocable area (roads, rivers, urban etc)	14,952				
Area of Te Waihora/Lake Ellesmere	17,303				
Total area of Selwyn Te Waihora zone	**272,706**				
Total farming load (CPW + nonCPW + Hill)	**240,451**	**4,529**	**5,429**	**4,830**	**Total farming load in Table 11(i) in Variation 1**
% change in total farming load from current (2011)			*20%*	*7%*	

Appendix 2


Annual flows
Selwyn R - Coes Ford
Halswell River
Annual flow (Mm3/yr)
250
200
150
100
50
0
2006-07 2007-08 2008-09 2009-10 2010-11 2011-12 2012-13 2013-14


Annual total N loads
Selwyn River - Coes Ford
Halswell River
Annual total N load (tonnes N/yr))
900
800
700
600
500
400
300
200
100
0
2006-07 2007-08 2008-09 2009-10 2010-11 2011-12 2012-13 2013-14


Te Waihora/Lake Ellesmere annual average TN concentration
Mid lake site - annual average
Average total nitrogen (mg/L)
2.5
2.0
1.5
1.0
0.5
0.0
2006-07 2007-08 2008-09 2009-10 2010-11 2011-12 2012-13 2013-14