IN THE MATTER	of the Resource Management Act 1991
AND	
IN THE MATTER	of submissions and further submissions by Rangitata Diversion Race Management Limited to the proposed Canterbury Land & Water Regional Plan (pL&WRP)

STATEMENT OF EVIDENCE BY GREGORY IAN RYDER (HEARING 2)

27 March 2013

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1. INTRODUCTION

1.1 My full name is Gregory Ian Ryder.

1.2 I am a Director of Ryder Consulting Limited, an environmental consulting business with offices in Tauranga, Christchurch and Dunedin. Prior to this, I held positions at the Otago Regional Council and the University of Otago.

1.3 I am a water quality scientist and aquatic ecologist and hold BSc. (First Class Honours) (1984) and PhD. (1989) degrees in Zoology from the University of Otago.

1.4 For approximately 25 years, I have conducted a wide variety of studies on freshwater ecology and water quality throughout New Zealand. I have been project manager for major studies on New Zealand river ecosystems and have had a lead role in a number of multidisciplinary studies involving aquatic and terrestrial ecosystems. Regional councils and government departments have engaged me to peer review environmental studies and resource consent applications, and I have held the position of an independent commissioner on a number of major resource consent hearings associated with marine farms, ski-field development, water abstractions and wastewater discharges.

1.5 In 1995 I set up Environment Southland's State of the Environment Freshwater Monitoring Programme and have since been involved in various aspects of its implementation and data analysis. I have assisted both Environment Southland and Otago Regional Council in developing their respective regional water plans, and was the principal author in developing water quality standards for Southland's Draft Regional Water Plan (Ryder 2004). I am currently assisting Environment Southland with developing water quality management zones for Southland.

1.6 I am familiar with surface waters of the Canterbury region and have undertaken assessments in the Ashburton, Hakataramea, Rakaia, Rangitata, Waimakariri and Waitaki catchments. This work included assessments of water quality and surveys of benthic ecology (e.g., macroinvertebrates and periphyton) and fish habitat in relation to abstractions and discharges.

1.7 I have read the Code of Conduct for Expert Witnesses (Rule 330A, High Court Rules and Environment Court Practice Note) and I agree to comply with it. I have complied with it in the preparation of this statement of evidence.

2. SCOPE OF EVIDENCE

2.1 Rangitata Diversion Race Management Limited (RDRML) sought my advice in relation to their submission on the Proposed Canterbury Land and Water Regional Plan (hereafter "the Plan" or pLWRP). In particular, I was asked to assess the appropriateness of nutrient management zones as an interim approach.

2.2 My evidence on this subject has been prepared from the perspective of someone who is familiar with relationships between water quality and freshwater ecology, and in particular relationships between nutrient concentrations and periphyton and plant growths in streams and rivers. While I have avoided making comment on the merits of the planning methods used in the Plan, I have provided comment on the process used by Environment Canterbury to develop and determine the water quality status of nutrient management zones as depicted in the Planning Map on page 4-8 of the pLWRP (and is shown in more detail on the Series A planning maps).

3. THE PROCESS FOR ASSESSING NUTRIENT ZONES

3.1 The plan includes several rules (5.39 – 5.45) with interim provisions that relate to the management of nitrogen loss prior to 1 July 2017. The interim provisions are to be applied while zone committees resolve land and water issues within catchments. As explained in the Section 32 report, this interim approach (5 years) aims to give land owners time to adopt good management practices to avoid or mitigate nutrient losses while at the same time limiting further land use change in those catchments where water quality outcomes are not met. However, as I note in section 4 of my evidence, the Section 42a Officer's Report contains recommendations that reduce the emphasis on the interim approach.

3.2 The process used to assess the existing nutrient status of the zones, and therefore identify where water quality outcomes are not currently met, is explained in Appendix 6[1] of the Section 32 report. Environment Canterbury water quality scientists based their assessment on knowledge of nutrient sensitive values, and their knowledge of the overall state of the predominant receiving environments for each management unit or zone. As I note below (at paragraphs 3.9 to 3.18), the exact method employed by the scientists is not provided, leaving a degree of uncertainty surrounding the robustness and appropriateness of zones and their status.

3.3 The following categories were used to describe the overall nutrient status of catchments:

- *Water quality outcomes not met: where effects on instream values are observed, and a reduction in nutrient loads will be required;*
- *Water quality at risk: effects on instream values are starting to become apparent or the water bodies are at, or close to, water quality limits/outcomes. Control of nutrient inputs into the catchment will be required;*
- *Meets water quality outcomes: effects on instream values are not apparent and/or are unlikely to be exhibited in the near future;*
- *Unclassified: catchments whose nutrient status could not be determined because of poor knowledge/data and/or diffuse nature of receiving environments;*
- *Lake sensitive catchments.*

3.4 A three step process was used to classify catchments:

1. *Selection of zone boundaries to delineate management units;*
2. *Deciding how nutrient status categories would be assigned for different receiving environments – the 'expert opinion' approach;*
3. *Assigning nutrient status categories to the management units based on a range of criteria.*

3.5 <u>Defining management units</u>

3.6 As explained in Appendix 6 of the Section 32 report, management zones were generally based on existing hydrological surface catchments and

[1] Meredith, A., Stevenson, M., and Kelly, D. 2012. Derivation of nutrient status zones in Canterbury. Unpublished memo to P. Constantine and R. Ford, dated 30 June 2012.

groundwater management units used by Environment Canterbury. The size and boundaries of the units was primarily dictated by an understanding of nutrient transport and 'source sink relationships', rather than just relying on hydrological (net water movement). Sensitive lake zones that are vulnerable to nutrient enrichment associated with land intensification were also identified. I agree with the general approach taken in using technical data to define the management zones, however I do note from a closer examination of the planning maps that some surface waters fall within two zones. For example, on Planning Map A-083 the headwaters of a spring-fed creek near Coopers Creek (Orari Nutrient Allocation Zone) are initially within an orange zone, cross to a red zone, and then back to the orange zone within a reach approximately 2.5 km long. The change in the zoning of this creek along its length would not appear to be correctly based on technical water quality. Further, I also note that Planning Map A-073 delineates the boundary between red and green zones using a road boundary (which at reflected on Map B-073 also correlates with the Ashburton and Alpine River Sub Zone boundaries). Again, this does not appear to correlate with a catchment boundary.

3.7 Approach to assigning nutrient status categories

3.8 An expert opinion approach was used to assign nutrient status categories. This consisted of a panel of several Environment Canterbury water quality scientists discussing the nutrient status of each zone and reaching an agreed consensus between criteria and risks of outcome achievement. Initially, it had been intended that zone status would be determined by comparing existing data to water quality guidelines. However this approach resulted in the majority of zones being categorized as "*water quality outcomes not met*", which was considered by the staff to be too conservative and unrealistic. The alternative expert opinion approach was therefore adopted, which looked at both visible instream outcomes and nutrient guidelines. The staff considered that this approach was more pragmatic, as it allowed (i) the magnitude and frequency of guideline exceedance, and (ii) whether or not nutrient sensitive values were still being maintained, to be taken into account. They considered that the expert opinion approach was particularly relevant to river and stream assessment as nutrient concentrations can theoretically suggest that instream criteria are being exceeded, however often visual observations of instream conditions do not indicate this. Also, other factors such as flow or substrate variability may not be taken into account by the criteria.

3.9 The scientific robustness of the expert opinion approached used by Environment Canterbury staff is difficult for an external scientist such as myself to evaluate as Appendix 6 lacks sufficient information to demonstrate how existing data was assessed to determine nutrient status categories, particularly at finer (e.g., sub-catchment, river and river reach) scales.

3.10 Table 2 of Appendix 6 (which I have attached as Appendix one of my evidence) does provide some commentary on the reason for the allocated status to various catchments, however no accompanying data is provided to justify the status given. As a result there is also no 'benchmark' for an applicant to use in assessing whether or not a proposed activity will prevent the water quality outcomes of Policy 4.1 being achieved. Consequently, the science underpinning the policies and rules relating to land use and effects on surface water and ecology is, in my opinion, not sufficiently transparent to give confidence in the process used by the scientists which, in turn, creates doubts surrounding confidence in the assessment process. I recommend that each catchment identified in Table 2 of Appendix 6 of the Section 32 report is accompanied with an inventory of the water quality and stream ecology data used to determine the nutrient status and a decision tree showing how the nutrient status was derived.

3.11 <u>Assigning nutrient status categories</u>

3.12 In order to assess the nutrient categories of each zone, receiving environments were separated into lakes, groundwater[2], or streams and rivers according to their different sensitivities to nutrient loads/accumulation.

3.13 The nutrient status of large lakes was derived from calculation of the Trophic Level Index (TLI). The assessment considered existing TLI data, recent intensification of land uses, extent of catchment development, and recent changes of TLI. For small lakes where there is a risk of land intensification resulting in rapid changes in trophic status, reliance on monitoring was not considered sufficient to detect changes and therefore these lakes were

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[2] Note I have not considered the approach taken to the classification of groundwater zones as it is outside my area of expert knowledge.

assigned to the “Lake sensitive catchment” category. I consider this to be a reasonable and pragmatic approach.

3.14 Several numerical criteria were considered for rivers and streams partly dependent upon the size and type being assessed. Table 1 of Appendix 6 summarises the variety of methods and guidelines that apply to nitrate standards that were considered, and some of the issues with the approach taken. The nutrient objectives considered were the periphyton and macrophyte objectives in NRRP Table WQL5, the water quality discharge standards in NRRP Table WQL16, and chronic nitrate toxicity to aquatic life, and drinking water standards. Issues were identified with all the methods listed, for example the use of Biggs (2000) periphyton relationship, which is based on hill fed rivers and therefore less appropriate for other river types (e.g. alpine rivers). However there is no discussion provided in Appendix 6 as to how these issues were overcome in the assessment.

3.15 My concern with the approach described above is based in part on the uncertainties in the relationship between nutrient concentrations in streams and rivers, and the level of effect as expressed in the form of benthic algae (periphyton) and plant growths (one of the key reasons for managing nuisance macrophyte and periphyton growths is their adverse effects on benthic macroinvertebrate communities). At this point I acknowledge that the authors of the Appendix 6 memo also acknowledge these uncertainties, but they fail to provide detail on how they were addressed when making decisions for individual catchments. For example, it is unclear to me as to the robustness of quantitative data relating to periphyton biomass levels in Canterbury rivers. This information is fundamental for interpreting periphyton guidelines and flow-on effects in river ecosystems.

3.16 The apparent reliance, in part, on models that predict periphyton biomass from nutrient concentrations and flood frequency is of some concern to me. A recent NIWA review of instream plant and nutrient guidelines used in New Zealand, including those used by Environment Canterbury scientists in assessing nutrient zones, has found a number of issues relating to their application throughout New Zealand (Matheson *et al*. 2012). Matheson *et al*. (2012) note that in the NZ periphyton guidelines, development of nutrient thresholds is based on data derived primarily from gravel/cobble bed rivers, and other potentially important regulators of periphyton growth in other river types, in particular availability of light and stable attachment substrates, were not take into account. Matheson *et al*. (2012) concluded that:

3.17 "… *this makes it difficult to apply the* [nutrient] *model to other river types (particularly streams with soft substrates, riparian shading and/or low water clarity). The nutrient thresholds in the New Zealand Periphyton Guideline are essentially a "worst-case scenario", applicable to streams where all regulators other than nutrients and flow are optimal (i.e., no shading, high water clarity, gravel-cobble substrates) and, if applied in other situations, are likely to be conservative. The New Zealand Periphyton Guideline acknowledges that the nutrient guidelines are very restrictive and cautions that they need to be applied sensibly. Further guidance as to when these nutrient guidelines are appropriate to use is needed and alternative approaches developed for situations when they are not.*"

3.18 While the Environment Canterbury scientists acknowledge such limitations in their Appendix 6 memorandum, how they deal with these is not clearly identified and so there lacks a scientific 'paper trail' to audit this important process.

4. SECTION 42A REPORT

4.1 I note that the Section 42A report for Hearing Group 2 recommends that the nutrient zone map be retained without amendment. In making this recommendation, the officer considered the large number of submissions that were received related to the map, including those that requested a substantial technical review of the methodology used to develop the nutrient allocation zone mapping. The officer states that "*The basic criteria and analysis contained in the memo* [Appendix 6] *continues to stand, and Dr Adrian Meredith, as the primary scientist responsible for the mapping continues to stand behind both the methodology and the outcomes*." However, he also predicts that "*There will continue to be debate about the scientific methodology, the broad scale at which the mapping has been undertaken and the appropriateness of individual properties being included within the mapped areas.*" I consider that a lot of the concerns raised and debate about the scientific methodology could be resolved if more detailed information was provided by Environment Canterbury staff to support their classifications in

Table 2 of Appendix 6 (e.g., existing periphyton cover data) and/or independent experts were engaged to review these classifications.

4.2 The officer acknowledges the lack of connection between the mapping and some of the rule frameworks, particularly related to the focus on nitrogen. He has recommend that this focus is broadened and has suggested changes to rules. I have reviewed these changes and am supportive of the removal of the requirement from Rules 4.31, 4.32 and 4.34 to demonstrate that the water quality outcomes of Policy 4.1 will be achieved as I consider that this would have been technically very difficult given the lack of data provided in Appendix 6 to justify the existing status. However, when all matters are considered, I remain supportive of the use of a 'nutrient zones', but urge caution in their implementation until the technical issues I have raised above are addressed. Hence, my support for an interim approach.

5. CONCLUSION

5.1 Given the level of uncertainty associated with the development of nutrient allocation zones and their current status, and the threat of further water quality degradation, it is my opinion that the adoption of an interim approach to nutrient limits is appropriate, indeed essential, in order to provide an opportunity to more rigorously scrutinise and define the current relationships between land use activities and effects on surface water quality and ecology for sub-catchments and, in some cases, for individual water bodies. I also recommend that the data and science underpinning the nutrient allocation zone approach used by Environment Canterbury scientists are made more widely available for individual catchments to enable applicants and their advisors to assess whether or not a proposed activity will prevent the water quality outcomes of Policy 4.1 being achieved.

6. APPENDIX 1

Table 2 from Appendix 6 of the Section 32 Report: Derivation of nutrient status zones in Canterbury. Environment Canterbury internal memorandum from Adrian Meredith, Michele Stevenson and David Kelly to Peter Constantine and Raymond Ford. Dated 30th June 2012.

Table 2: Management units / zones and nutrient status category for each with rationale for assessment

ID	Main Catchment Name	Principle Receiving Environment	Status – based on maintenance of nutrient sensitive values	Reason for status
1	Hurunui/Waiau	Surface water rivers	Sub-regional chapter	. Addressed by new Sub Regional Plan
2	Wainono	Surface water/lagoon	Water quality outcomes not met	Due to observed enrichment of spring-fed streams (algae and macrophytes) and feeding to lowland lake in eutrophic state.
3	Banks Peninsula	Surface water streams	Unclassified	Short steep catchments without appreciable groundwater (N) influence
4	Okana - Lake Forsyth	lake	Water quality outcomes not met	Due to observed enrichment of spring-fed streams (algae and macrophytes) and feeding to lowland lake in excessively eutrophic state.
5	Rangitata	Surface water river	Meets water quality outcomes	Showing some nutrient enrichment, but swift and flashy hydrology with no evidence of regular algal growths.
6	Upper Waitaki - Haldon Arm	Lake	Meets water quality outcomes	Due to increasing enrichment of some spring-fed streams with increasing algal (mat) abundance, and feeding to valued lake with nutrient status trending towards mesotrophic.
7	Valetta-Hinds-Mayfield/Hinds	Spring-fed streams	Water quality outcomes not met	Predominantly a groundwater zone with frequent groundwater results often above nitrate-N MAV and spring-fed streams with very high nutrient concentrations above all guidelines.
8	Orari	Spring-fed streams	At Risk	At threshold of likely effects River with high values (e.g. whitebaiting, salmon spawning sites) and increasingly high nutrient concentrations in lower reach of main-stem and tributaries and ongoing intensification of land use.
9	Rangitata-Orari	Groundwater/ spring-fed streams	Water quality outcomes not met	High groundwater N concentrations often above MAV, and spring-fed streams with very high nutrient concentrations.
10	Hakataramea	Surface water	At Risk	At threshold of likely effects River with high values, exhibiting periods of high algal biomass, and with recent increases in land use intensification.
11	Washdyke	Lake/lagoon	At Risk	At threshold of likely effects Would be 'Above threshold' except that urban and springfed streams bypass the lagoon in ring drains, and high tidal flushing generates nutrient exchange and high salinity.
12	Pareora	Surface water wiver	At Risk	At threshold of likely effects Increasing nutrient concentrations, and

ID	Main Catchment Name	Principle Receiving Environment	Status – based on maintenance of nutrient sensitive values	Reason for status
				presence of excessive algal growths at points at times.
13	Otaio	Surface water river	At Risk	At threshold of likely effects Increasing nutrient concentrations, and presence of excessive algal growths at points at times.
14	Makikihi	Surface water streams	At Risk	At threshold of likely effects Increasing nutrient concentrations, and presence of excessive algal growths at points at times.
15	Lower Waitaki	Surface water river	Meets water quality outcomes	Large surface water flows with low to moderate nutrient concentrations, and apparent absence of algal/macrophyte effects.
16	Morven-Glenavy	Groundwater	Meets water quality outcomes	Groundwater zone with N concentrations below 0.5MAV, without persistent surface water features
17	Upper Selwyn	Surface water	Water quality outcomes not met	Included with Selwyn-Waihora catchment unit as separate upper catchment unit not justified.
18	Christchurch-West Melton	Groundwater/surface water	Special purpose area	A special purpose zone already managed to protect Christchurch drinking water supply and urban spring fed rivers.
19	Medina	Surface water	Unclassified	Inadequate information in that area.
20	Ashley-Waimakariri	Spring-fed streams	Water quality outcomes not met	Area of strong surface water-groundwater interaction with highly valued spring-fed streams with increasing nutrient concentrations above all guidelines.
21	Kaikoura	Spring-fed streams	Water quality outcomes not met	Nutrient enriched streams in shallow groundwater area with intensive land use, high level of biological growths, and downstream hapua as focus of town.
22	Kahutara	Surface water river	Below threshold of likely effects	Hill-fed river with low to moderate nutrient concentrations, moderate land use, and low to moderate evidence of growths/effects except at the mouth.
23	Conway	Surface water river	At risk	At threshold of likely effects Hill-fed river with low to moderate nutrient concentrations, moderate land use, and occasional nuisance growths of periphyton (e.g. filamentous green algae).
24	Opihi	Surface water river	At risk	At threshold of likely effects Hill-fed river with moderate nutrient concentrations, but healthy ecology, despite proliferation of algal mats.
25	Temuka	Surface water river/streams	Water quality outcomes not met	Nutrient rich river with number of high nutrient spring-fed streams, and obvious growths.

ID	Main Catchment Name	Principle Receiving Environment	Status – based on maintenance of nutrient sensitive values	Reason for status
26	Rakaia	Surface water river	Meets water quality outcomes	Showing some nutrient enrichment, but swift and flashy hydrology with no evidence of growths.
27	Waihao	Surface water river	At risk	River with moderate and increasing nutrient concentration and moderate algal growth.
28	Ashburton	Surface water river	At risk	At threshold of likely effects Large hill-fed river with moderate nutrient concentration increasing from groundwater gain in middle reaches.
29	Waiau	Surface water river	Sub-regional chapter	Addressed by new Sub Regional Plan
30	Jed	Surface water river	Sub-regional chapter	Addressed by new Sub Regional Plan
31	Porangara		Unclassified	Low quantity of surface resources in area, and inadequate information.
32	Hapuku	Surface water river	Meets water quality outcomes	Small hill-fed river with low nutrient concentration and no obvious effects
33	Kowhai	Surface water river	Meets water quality outcomes	Small alpine river with low nutrient concentration and no obvious effects
34	Ewelme	Surface water streams	Unclassified	Low quantity of surface resources in area, and inadequate information.
35	Kaikoura Peninsula	No water	Unclassified	Low quantity of surface resources in area, and inadequate information.
36	Omihi	Surface water stream	Unclassified	Low quantity of surface resources in area, and inadequate information.
37	Blythe	Surface water river	Unclassified	Low quantity of surface resources in area, and inadequate information.
38	Waipara	Surface water river	Water quality outcomes not met	High nutrient concentrations with very high algal biomass.
39	Kowai		Unclassified	Low quantity of surface resources in area, and inadequate information.
40	Amberley		Unclassified	Low quantity of surface resources in area, and inadequate information.
41	Ashley	Surface water river	At risk	River at threshold of likely effects with increasing nutrient concentrations and periods of increasing algal growth.
42	Saltwater Creek	Surface water streams	At risk	At threshold of likely effects River with increasing nutrient concentrations and periods of increasing algal growth.
43	Selwyn-Waihora	Lake/ spring-fed streams	Water quality outcomes not met	Nutrient rich streams in intensive landuse area feeding into hypertrophic coastal lake.
44	Little Rakaia	Spring-fed streams	At risk	At threshold of likely effects Spring-fed streams with moderate and increasing nutrients and growths but still supporting high values.

ID	Main Catchment Name	Principle Receiving Environment	Status – based on maintenance of nutrient sensitive values	Reason for status
45	Waimakariri	Surface water river	Meets water quality outcomes	Low but increasing nutrient concentrations. Episodes of algal mat growth more related to flow issues.
46/47	Clarence	Surface water river	Meets water quality outcomes	Low nutrient concentrations, low intensity of land use and no observable effects.
48	Woodside		Unclassified	Low quantity of surface resources in area, and inadequate information.
49	Upper Hinds	Spring-fed streams	Water quality outcomes not met	Included with Valetta-Hinds-Mayfield/Hinds catchment unit as separate upper catchment unit not justified.
50	Ohapi Creek	Spring-fed streams	Water quality outcomes not met	High nutrient concentrations, high level of biological growths and intensive and intensifying landuse.
51	Maerewhenua	Surface water river	Meets water quality outcomes	Increasing nutrient concentrations, but below level of observable effects.
52	Waikakahi	Surface water	Water quality outcomes not met	High and increasing nutrient concentrations, and high degree of macrophyte growths.
53	Upper Waitaki - Ahuriri Arm	Surface water/Lakes	Water quality outcomes not met	Increasing nutrient status of lake, beyond mesotrophic threshold, and degrading tributary streams with intensive land use.
54	Upper Waitaki at Waitaki Dam	Surface water/Lakes	At risk	At threshold of likely effects Lake trophic status increasing.
55	Ashburton-Rakaia	Groundwater	Water quality outcomes not met	Groundwater zone with high nitrogen breaching drinking water standards (MAV) at times.
58	Several upper Rakaia Small Lakes	Surface water/Lakes	Sensitive lakes catchment	Lakes with increasing nutrient status and increasing land use intensity in catchments.
60	Several upper Waimakariri Small Lakes	Surface water/Lakes	Sensitive lakes catchment	Lakes with increasing nutrient status and increasing land use intensity in catchments.
	Several Ashburton Small lakes	Surface water/Lakes	Sensitive lakes catchment	Lakes with increasing nutrient status and increasing land use intensity in catchments.
	Several upper Waitaki small lakes	Surface water/Lakes	Sensitive lakes catchment	Lakes with increasing nutrient status and increasing land use intensity in catchments.