IN THE MATTER of the Resource Management Act 1991

A N D

IN THE MATTER of submissions and further submissions by Rangitata Diversion Race Management Limited (**RDRML**) on proposed Variation 2 to the proposed Canterbury Land & Water Regional Plan

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STATEMENT OF EVIDENCE OF GREGORY IAN RYDER

Introduction

1. My full name is Gregory Ian Ryder.

2. I hold BSc. (First Class Honours) (1984) and PhD. (1989) degrees in Zoology from the University of Otago. For both my honours dissertation and PhD. thesis I studied stream ecology with particular emphasis on benthic macroinvertebrates.

3. I am a member of the following professional societies:
   (a) New Zealand Freshwater Society;
   (b) New Zealand Water and Wastes Association;
   (c) Royal Society of New Zealand;
   (d) Society for Freshwater Science (North America).

4. I am a Director and Environmental Scientist at Ryder Consulting Limited, a company I established 20 years ago. Prior to this, I held positions at the Otago Regional Council and the University of Otago. I work largely in the field of water quality aquatic ecology.

5. My work covers the whole of New Zealand but primarily in the South Island. Private industries, utility companies, local and regional councils and government departments engage me to provide advice on a wide range of activities affecting surface waters. I have previously provided advice in relation to land use activities including those relating to existing and proposed irrigation schemes.

6. I have presented evidence at the Rangitata River Water Conservation Order hearing, the proposed Land and Water Regional Plan hearing and the hearing on Variation 1 to that plan.

7. 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.

Scope of evidence

8. RDRML have asked me to comment on their submission to Variation 2 in respect of the following matters:

   (a) Table 13(a) and the achievability of freshwater outcomes;
   (b) the appropriateness of the limits/targets in Table 13(j) for surface water;
   (c) the water quality and ecological ramifications of RDRML's recommended replacement date for 2035 in Table 13(j) for surface water limits/targets to be met;
   (d) whether the RDRML relief sought will enable surface water quality limits/targets to be met by the RDRML replacement date; and
   (e) whether the RDRML relief sought will enable minimum flows to be met by the RDRML replacement date (Policy 13.4.19).

9. In preparing my evidence I have read proposed Variation 2, the RDRML submission and further submissions, and the submissions of a number of other parties. I have also reviewed technical information relating to the Environment Canterbury assessment of surface water quality and aquatic ecology within the Hinds/Hekeao Plains Area, contained within the following reports:

   (a) Bower, R. 2014. Hinds/Hekeao Plains Technical Overview – Subregional Plan Development Process. ECan Report No. R14/79.
   (b) Hinds/Hekeao Plains Compendium - Technical reports and memorandums. ECan Report No. R14/87.
   (c) Summary of ecological data for Hinds River land and water planning. Golder Associates report to ECan. April 2013.
   (d) Meredith, A. and Lessard, J. 2014a. Ecological assessment of scenarios and mitigations for Hinds Catchment streams and waterways. ECan Report No. R14/72.
   (e) Meredith, A. and Lessard, J. 2014b. Local scale mitigations for Hinds catchment streams and waterways. ECan Report No. R14/70.
   (f) Meredith, A. *et al*. 2006. Mid-Canterbury Coastal Streams: assessment of water quality and ecosystem monitoring, 2000 to 2005. ECan Report No. R06/19.
   (g) Lower Hinds River- Habitat Observations. Golder Associates report to ECan. June 2013.
   (h) Scott, L. 2013. Hinds Plains water quality modelling for the limit setting process. ECan Report No. R13/93.
   (i) Cultural values & water management issues for the Hekeao/Hinds Catchment. Report No. R14/84. Tipa & Associates report to ECan. July 2013.
   (j) Ashburton Zone Implementation Programme.
   (k) Various documents presented to the Ashburton Zone Committee.

10. I have also read relevant parts of the Officers section 42A report ('Officer's Report') prepared by McCallum-Clark *et al* (2015).

Executive summary

11. I have assessed the freshwater outcomes and surface water nitrate toxicity targets/limits proposed under Variation 2 in relation to RDRML's submission. The freshwater outcomes as currently worded in under Table 13(a) are in my opinion mostly appropriate and achievable by 2035 provided the additional mitigation measures identified under Variation 2, including MAR and/or TSA, are fully implemented.

12. With respect to surface water nitrate toxicity management I consider that, on balance, extending the timeframe for meeting nitrate toxicity targets under Table 13(j) is unlikely to result in significant ecological consequences given the projected concentration levels in shallow groundwater over the next ten years or so. I recommend that tables 13(a) and 13(j) be merged into a single table for freshwater outcomes.

Table 13(a): Freshwater Outcomes for Hinds/Hekeao Plains Area Rivers

13. RDRML have not sought to change the numerical outcomes associated with Table 13(a). However, RDRML have asked me to comment on the achievability of freshwater outcomes listed within Table 13(a).

14. The freshwater outcomes contained in Table 13(a), as stated in the Section 32 Report, do not differ greatly from Table 1a of the proposed LWRP. There have been some relatively minor changes to Table 13(a) recommended in the Officer's Report largely to do with maintaining consistency with Variation 1 (see Appendix One of my evidence) and these were identified by RDRML in its submission.

15. Table 13(a) consists of outcomes for three surface water units in the Hinds/Hekeao Plains Area. I comment on the units of relevance to RDRML's operation as follows:

Hill-fed Upland rivers (upper Hinds/Hekeao River)

16. Having examined the surface water quality data and ecological reports that address this section of the catchment, in general, I consider the freshwater outcomes for the upper Hinds River are appropriate and achievable under the current plan provisions, with the exception of temperature.

17. Given the outcome for temperature is specified as a maximum, and could conceivably be a one-off event, in my experience, a maximum temperature of 20°C in hill-fed rivers is relatively low and unlikely to be met now or in the future for these types of rivers.

18. Notwithstanding my comments above, the ecological consequences of temperatures occasionally exceeding 20°C are in my opinion relatively minor and I am familiar with many rivers and streams throughout the South Island where summer temperatures regularly exceed this level, yet they support healthy benthic invertebrate and fish communities.

Hill-fed Lowland rivers (lower Hinds/Hekeao River)

19. The middle reach of the Hinds/Hekeao River typically runs dry in summer, but regains water from groundwater recharge and has continuous flow in the lower section. This presents an issue for water quality targets in Table 13(a) as Table 13(a) treats the lower Hinds River differently from the lowland spring-fed drains, despite probably being fed by the same groundwater-sourced water as the drains. Yet Table 13(a) has more stringent water quality outcomes for the lower Hinds/Hekeao River than for spring-fed lowland drains. This seems to me to be an artificial differentiation. and I cannot see how the lower Hinds River outcomes can be met one that cannot be met unless the same outcomes are met in the drains over the same time frame. Targeted stream augmentation (TSA) may be the only way that the lower Hinds River could achieve a higher level of water quality relative to the lowland drains. I comment on TSA later in my evidence.

Spring-fed Plains (lowland drains)

20. These waterbodies are highly modified physically and generally have poor water quality. Their physical modifications have no doubt affected the diversity, quality and possibly

quantity of aquatic species they support. Despite these largely negative attributes, Meredith and Lessard (2013) report that they still support native fish populations, plant communities and invertebrates of ecological and cultural value.

21. Table 13(a) freshwater outcomes for spring-fed streams and drains on the lower plains are on the whole more lenient than those for hill-fed rivers, which I consider to be appropriate. This reflects the nature of these largely modified (and arguably artificial at least in physical character) waterbodies.

22. However, even though these outcomes are relatively lenient by most surface water quality criteria, it may be difficult to achieve some of the ecological outcomes by 2035 if any of the mitigation measures identified in Variation 2 fail to be effective or cannot be fully implemented. I hold similar concerns for the lower Hinds/Hekeao River given its flow under low flow conditions is dominated by lowland groundwater.

23. Variation 2 also includes a cultural indicator relating to mahinga kai for customary gathering. I do not consider myself fully qualified to comment in detail on its achievability except to say that it differs from the other outcomes in Table 13(a) in that it is qualitative not quantitative. Consequently, it is not clear how it would be decided that "… *species are sufficiently abundant for customary gathering* …". I note that part of the proposed cultural indicator in Table 13(a) is already included in Policy 4.3 of the pL&WRP, which requires that " … *fish are not rendered unsuitable for human consumption by contaminants* …".

Appropriateness of the limits/targets in Table 13(j) for surface water

24. Table 13(j) (Limits/Targets for the Hinds/Hekeao Plains Area surface waterbodies) lists nitrate concentration targets for the three surface waterbody units described above. These are solely for the purposes of protecting against the potential effects of nitrate toxicity to freshwater aquatic life. Two target concentrations are stated for each unit; an annual median and an annual 95th percentile. I note that there appears to be minor grammatical errors in the footnote at the bottom of Table 13(j) as presented in the Officer's Report. The wording as presented in the Officer's Report is:

<u>*Waterbodies are to meet both (annual and median and 95th percentile) limits/targets.*</u>

25. In my opinion, the first 'and' in this sentence should be removed and a second 'annual' should be inserted before 95th percentile, to read:

<u>*Waterbodies are to meet both (annual median and annual 95th percentile) limits/targets.*</u>

26. The nitrate toxicity limits/targets have been derived from the work by Hickey and Martin (2009)[1], which was recently reviewed (Hickey 2013)[2]. Hickey (2013) noted that the available data for chronic toxicity to nitrate indicates that fish are markedly more sensitive than invertebrates. Consequently he considered it may be appropriate to base site-specific limits on protection of a key fish species resident in a catchment, providing supporting data are available for protection of other resident fish species. Inanga (a whitebait species) is the only

[1] Hickey, C.W. and Martin, M.L. 2009. A review of nitrate toxicity to freshwater aquatic species. Prepared for ECan. Report No. R09/57.
[2] Hickey, C.W. 2013. Site-specific nitrate guidelines for Hawke's Bay. Prepared for Hawke's Bay Regional Council. NIWA Client Report No: HAM2012-127.

fish species, of those likely to be found in the lowland spring-fed and drain network of the Hinds/Hekeao Plains Area, that has been directly subjected to nitrate toxicity testing (Hickey 2013). It's sensitivity to nitrate was found to vary with water hardness. Hickey (2013) considered that, in general, inanga are expected to be well protected by the nitrate toxicity guidelines which factor in more sensitive fish species.

27. Hickey (2013) qualitatively describes the risk associated with this level of protection against nitrate toxicity as being 'negligible/insignificant' for fish eggs and benthic invertebrates. For native fish (larvae, fry and mature fish) he also provides a qualitative risk of 'negligible/insignificant', but with questions marks, meaning there is only minimal or insufficient data for these groups.

28. Consequently, based on the above qualitative assessment, I consider that the lowest level of protection provided for freshwater aquatic life under the proposed target nitrate concentrations in Table 13(j) appears to be relatively conservative with respect to nitrate toxicity for lowland waters with these ecological values. This level of conservatism is appropriate in my opinion, given the relatively sparse amount of data on the sensitivity of New Zealand species to nitrate toxicity.

29. There is a view from some quarters that nitrogen or at least nitrate should be managed for ecological health levels not toxicity, the rationale being that significant adverse effects on life supporting capacity will occur long before the toxic effects of nitrates will be observed[3,4]. However, in the case of the lower Hinds River and lowland spring-fed drains, the existing nitrate levels are well in excess of what is typically deemed necessary to, for example, reduce nuisance algae growths (i.e., much less than 1 mg/L). In such situations, aiming to ensure phosphorus remains as the nutrient limiting the potential for nuisance algae and plant growths is, in my opinion, the most logical approach for managing algae and plant growth in lowland waterways of the Hinds/Hekeao Plains Area (currently, phosphorus concentrations in the lower catchment waterways are fairly low (Meredith & Lessard 2014)). Variation 2 contains policies to manage and reduce phosphorus in waterways by encouraging land use practices that minimize phosphorus losses (e.g., Policy 13.4.10). As such, I consider that Variation 2 contains adequate measures to meet freshwater outcomes relating to the management of nuisance algae and plant growths.

Water quality and ecological ramifications of RDRML's recommended dates for 2035 in Table 13(a) and Table 13(j) for surface water limits/targets to be met

30. RDRML have sought, based on the advice of Mr Ford, to extend the date for meeting freshwater outcomes and surface water nitrate toxicity limits/targets from 2035 to 2055 (see Appendix One). A key question is; what are the water quality and ecological ramifications of this proposed extension to the timeframes for these surface water quality outcomes/targets to be met?

31. I see the greatest potential risk associated with extending the timeframe for meeting freshwater outcomes is that relating to nitrate toxicity (Table 13(j)). I consider the levels of other key surface water contaminants identified in the Hinds/Hekeao Plains Area

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[3] Death, R.G. 2013. Statement Of Evidence Of Associate Professor Russell George Death On Behalf Of Hawkes Bay Fish And Game Freshwater ecology, October 2013. In The Matter of submissions by Hawkes Bay and Eastern Fish and Game Councils to a Board of Inquiry appointed under section 149J of the Resource Management Act 1991.

[4] Submission of Central South Island Fish and Game to Variation 2.

(phosphorus, sediment and faecal bacteria) should able to be curbed relatively quickly through commonly accepted, and adopted mitigation practices.

32. Extending the timeframe to meet nitrate toxicity targets will be an issue if nitrate concentrations in surface waters continue to increase over a prolonged period of time. However this does not appear to be the case if the modelling of mitigation measures is reasonable. The evidence of Mr Callander and Mr Ford indicates that nitrate concentrations in spring-fed drains should not increase much more than the current elevated levels, but could remain at these levels for the next 5 - 10 years before the land improvement measures to reduce soil leaching concentrations actually show up in the groundwater and spring flows. Under this scenario, therefore, it would seem that the risks associated with nitrate toxicity to aquatic biota would remain the same (and greatest over the next 5 – 10 years), regardless of the extended timeframe to meet surface water nitrate toxicity limits/targets. Based on the work of Hickey (2013), nor do I expect current or future levels to pose a barrier to migratory fish. As such, extending the timeframe for nitrate toxicity limits/targets to be met by 2055 may have little meaningful ecological consequence.

33. As I discuss in the next section of my evidence, targeted stream augmentation (TSA) is a potential measure that could alleviate any immediate issues relating to unacceptably high seasonal nitrate levels in specific surface waters, and could be viewed as a 'stop gap' measure while the ecological effects of various nitrate levels in local surface waters are better understood and as land use activities change to minimise nitrate losses.

34. I see no strong reason why trials involving TSA cannot be implemented relatively quickly to determine more precisely the ecological benefits of lower nitrate levels in surface waters.

35. I my opinion, the mitigation measures proposed under Variation 2 can be viewed as potentially acting at two speeds with respect to surface water quality. The quicker speed relates to measures that reduce sediment, phosphorus and faecal bacteria (or microbial contaminants), and applies to all surface waters within the catchment. These three contaminants are derived primarily from overland flow (runoff), accelerated sub-surface drainage (e.g., tile drains or mole drains), direct stock access to water and other instream activities (e.g., drain maintenance operations). I consider there is reasonable justification to prioritise and fast track these mitigation measures within Variation 2 as benefits to water quality and aquatic ecology can occur relatively quickly, within months in some cases. For example, stream fencing with adequate buffer zones, vegetation cover along riparian margins and stock exclusion. With respect to these contaminants, it may not be necessary to seek an extension to the recommended dates for surface water limits/targets to be met. That is, 2035 should in my opinion remain as the target date to meet the existing freshwater outcomes in Table 13(a).

36. I note that RDRML did not submit on the responses that Variation 2 advances to address these mitigation measures. Further, as detailed in the evidence of Sue Cumberworth, irrigation schemes associated with RDRML are already implementing many of these measures via the Audited Self Management / Farm Environment Plan processes that they have been implementing since 2011.

37. The slower speed mitigation relates to the measures required to curb nitrate concentrations in shallow groundwater and surface waters. In my opinion, whatever measures are adopted in relation to this issue, the process of improvement will be slow relative to what can be achieved in dealing with the other three contaminants.

38. I note that some submitters have sought to include the surface water nitrate toxicity targets of Table 13(j) into the freshwater outcomes under Table 13(a). While this amendment has not been sought by RDRML in its submission, this seems to me to be a sensible and pragmatic move given the current 13(a) outcomes and the current 13(j) targets both aim to protect surface water quality and aquatic ecology using the same waterbody units to differentiate where outcomes are to apply. The nitrate toxicity outcomes would in my opinion sit comfortably under the 'Ecological health indicators' sub-heading of Table 13(a) as I have drafted in my Appendix Two.

MAR & TSA

39. I note that the water quality outcomes in Variation 2 rely heavily on the use of managed aquifer recharge (MAR) and also consideration of TSA. In my opinion, I consider TSA can produce a superior and more guaranteed outcome for surface water quality and aquatic ecology than MAR.

40. Mr Callander in his evidence expresses a similar view in respect of the benefits of TSA over MAR. He notes that while TSA is mentioned in Variation 2 (i.e. Policy 13.4.14) it has not been quantified to the same extent as MAR in the Officer's Report.

41. Particular benefits of TSA over MAR that I can see are:

(a) the ability to target specific streams and so target streams with particular water quality issues;
(b) able to accurately control the rate of flow to match a desired outcome (which may be a water quality outcome, a instream physical outcome such as a particular water depth, wetted width or water velocity);
(c) ability to control flow releases for particular times of the year (e.g., to coincide with spawning seasons, upstream or downstream fish migration, contact recreation, etc).

42. One of the benefits of TSA-type mitigation measures is that they offer immediate relief to streams suffering from poor water quality. They also lend themselves to experimenting with dilution to assess the effects of water quality on aquatic ecology. For example, it would be useful to conduct an *in situ* experiment to determine whether diluting nitrate levels in a stream suffering from high nitrate levels resulted in measurable benefits to the local aquatic community. I would expect any changes would be able to be detected within 6-12 months for benthic invertebrates and macrophytes, and 1-3 years for fish. Information from such trials would provide valuable feed back into the plan review process to determine whether timeframes for reducing nitrate levels in ground and surface waters need to revisited in the context of the ecological outcomes that are sought in Variation 2.

43. Of course the effectiveness of both MAR and TSA is dependant on an available source of water that is of good quality. It is my understanding that the source of this water has not been determined. Further, while potentially good quality water (i.e., low nutrients and low faecal bacteria) exists in the form of alpine-sourced water (e.g., the upper Ashburton – South Branch and Rangitata rivers), it is my understanding that these rivers contain the nuisance alga Didymo which could potentially be introduced into lowland rivers and drains if it is not already there. I do not know how invasive and widespread Didymo might become in these waterbodies (it does not always flourish in all river systems when introduced), but the issue demonstrates the complexities and possible ecological trade-offs associated with potential

mitigation measures. I am aware of two cases (one in Canterbury[5] and one in Otago[6]) where TSA has resulted in the establishment of didymo in the recipient waterbody.

Will the RDRML relief sought on the key decisions enable these limits/targets to be met by the replacement date?

44. It is difficult to predict with any certainty the likely water quality decades out. However based on the existing water quality information and the predictions of future water quality assuming various mitigation measures are adopted throughout the catchment, I see no reason why surface water quality targets/limits will not be achieved within the timeframes sought by RDRML in its submission on Variation 2. However, in my opinion, it seems almost imperative that either MAR and/or TSA initiatives will be required in order for the surface water quality and ecological targets to be met in the lower sections of Hinds/Hekeao Plains Area, regardless of the timeframe.

45. Ongoing monitoring will be required to determine water quality trends in surface and groundwater, and monitoring information will need to feed back into the review components of Variation 2.

Conclusion

46. I largely endorse the Variation 2 provisions relating the surface water quality and ecology as currently framed in the Officer's Report. The freshwater outcomes are in my opinion mostly appropriate and achievable by 2035, particularly given outcomes to manage and reduce phosphorus sediment and microbial contaminants should be seen relatively quickly.

47. With respect to surface water nitrate toxicity management I consider that, on balance, extending the timeframe for meeting nitrate toxicity targets under Table 13(j) is unlikely to result in significant ecological consequences given the projected concentration levels in shallow groundwater over the next ten years or so.

48. However, meeting nitrate toxicity limits, and possibly other freshwater outcomes, will probably require MAR and/or TSA initiatives to be effective.

Gregory Ian Ryder

15th May 2015

[5] ECan consent CRC091998. To take and use water from the Waitaki River for augmentation of flows in the Waihao River outside of the irrigation season. Water shall be used only for the augmentation of the Waihao River flow, for environmental purposes, outside the irrigation season.

[6] ORC consent 98268-V1. To discharge up to 1 cumec of water into the Fraser River. To maintain a residual flow to provide a reasonable level of enhancement of the fisheries of the Fraser River.

APPENDIX ONE: Table 13(a) and Table 13(j)

Versions Showing Officer s42A Report

Recommendations as red Tracked Changes and RDRML's proposed relief in blue Tracked Changes

Table 13(a): Freshwater Outcomes for Hinds/Hekeao Plains Area Rivers

Management Unit	River	Ecological health indicators			Macrophyte indicators		Periphyton indicators			Siltation indicator	Microbial indicator	Cultural Indicator
		QMCI [min Score 80% of samples in a 5yr period][129]	Dissolved oxygen [min saturation %][129]	Temperature [max] (°c)	Emergent Macrophytes [max cover of bed] (%)	Total Macrophytes [max cover of bed] (%)	Chlorophyll a [max biomass] (mg/m³)	Filamentous algae > 20mm [max cover of bed] (%)	Cyanobacteria [max cover of bed] (%)	Fine sediment, 2 mm diameter [max cover of bed] (%)	Microbial indicator for contact recreation [S~~E~~F[130] FG]	
Hill-fed – Upland	Upper Hinds River/Hekeao	6[1]	90	20	No value set	No value set	50	10	~~15~~ 20	~~20~~ 15	Good	Freshwater mahinga kai species are sufficiently abundant for customary gathering, water quality is suitable for their safe harvesting, and they are safe to eat.
Hill-fed - Lower	Lower Hinds River/Hekeao	6	90	20	No value set	No value set	200	30	~~15~~ 50	~~50~~ 15	Good-Fair	
Spring-fed Plains	Including but not limited to: Blees Drain Flemington Drain Parakanoi Drain Windermere Drain Boundary Drain Stormy Drain Spicers Creek Dawson Drain Home Paddock Drain Deals Drain O'Shaughnessys Drain Taylors Drain Northern Drain Griggs Drain Dobsons Drain Twenty One Drain Crows Drain Harris Drain Yeatmans Drain Oakdale Drain McLeans Swamp Road Drain Montgomerys Drain Pyes Drain	5	70	20	30	50	200[2]	30	~~20~~ 50	~~50~~ 20[131]	No value set	

129 Cl16 – minor correction to make consistent with Variation 1

130 Cl16 – minor correction of a typo

131 2pLWRP-213 – Ashburton DC, V2pLWRP-593 – Dairy NZ, V2pLWRP-708 – RDRML, V2pLWRP-805 – Fonterra, V2pLWRP-1058 – CDHB.

Key:
QMCI = Quantitative Macroinvertebrate Community Index
SFRG = Suitability for Recreation Grade – from Microbiological water quality guidelines for Marine and Freshwater Recreational Areas 2003[132]

Footnotes:
(1) Upstream of the Rangitata Diversion Race siphon on both North and South branches of the Hinds River.[133]
(2) In reaches with gravel or hard bottom substrates; in all other areas no value set.[134]

Table 13(j): ~~Limits/~~Targets[152] for the Hinds/Hekeao Plains Area surface waterbodies[(1)]

Surface Waterbody type	Type	Measurement	Target to be met by ~~2035~~ 2055 Nitrate-nitrogen concentration (mg/L)
Hill-fed Upland	Nitrate toxicity	Annual median	1.0
		Annual 95th percentile	1.5
Hill-fed Lower	Nitrate toxicity	Annual median	3.8
		Annual 95th percentile	5.6
Spring-fed Plains	Nitrate toxicity	Annual median	6.9
		Annual 95th percentile	9.8

1. Waterbodies are to meet both (annual and median and 95th percentile) limits/targets

[132] CI16 – minor correction to make consistent with Table 1a
[133] V2 pLWRP 981 – Upper Hinds Plains Land User Group
[134] CI16 – minor correction to make consistent with Variation 1
[152] V2pLWRP-711 – RDRML

APPENDIX TWO: G. Ryder suggested amendments to Table 13(a) to include provisions of Table 13(j)

Table 13(a): Freshwater Outcomes for Hinds/Hekeao Plains Area Rivers

Management Unit	River	Ecological health indicators				Macrophyte indicators		Periphyton indicators			Siltation indicator	Microbial indicator	Cultural Indicator
		QMCI [min Score 80% of samples in a 5yr period][129]	Dissolved oxygen [min saturation %]	Temperature [max] (°c)	Nitrate toxicity [annual median] & [annual 95th percentile] [3, 4] (mg/L)	Emergent Macrophytes [max cover of bed] (%)	Total Macrophytes [max cover of bed] (%)	Chlorophyll a [max biomass] (mg/m³)	Filamentous algae > 20mm [max cover of bed] (%)	Cyanobacteria [max cover of bed] (%)	Fine sediment, 2 mm diameter [max cover of bed] (%)	Microbial indicator for contact recreation [S~~E~~F[130]FG]	
Hill-fed – Upland	Upper Hinds River/Hekeao	6[1]	90	20	1.0 1.5	No value set	No value set	50	10	~~15~~ 20	~~20~~ 15	Good	Freshwater mahinga kai species are sufficiently abundant fo customary gathering, water qualit is suitable fo their safe harvesting, and they are safe to eat.
Hill-fed - Lower	Lower Hinds River/Hekeao	6	90	20	3.8 5.6	No value set	No value set	200	30	~~15~~ 50	~~50~~ 15	Good-Fair	
Spring-fed Plains	Including but not limited to: Blees Drain Flemington Drain Parakanoi Drain Windermere Drain Boundary Drain Stormy Drain Spicers Creek Dawson Drain Home Paddock Drain Deals Drain O'Shaughnessys Drain Taylors Drain Northern Drain Griggs Drain Dobsons Drain Twenty One Drain Crows Drain Harris Drain Yeatmans Drain Oakdale Drain McLeans Swamp Road Drain Montgomerys Drain Pyes Drain	5	70	20	6.9 9.8	30	50	200[2]	30	~~20~~ 50	~~50~~ 20[131]	No value set	

129 Cl16 – minor correction to make consistent with Variation 1

130 Cl16 – minor correction of a typo

131 V2pLWRP-213 – Ashburton DC, V2pLWRP-593 – Dairy NZ, V2pLWRP-708 – RDRML, V2pLWRP-805 – Fonterra, V2pLWRP-1058 – CDHB.

Key:

QMCI = Quantitative Macroinvertebrate Community Index

SFRG = Suitability for Recreation Grade – from Microbiological water quality guidelines for Marine and Freshwater Recreational Areas 2003[132]

Footnotes:

(1) Upstream of the Rangitata Diversion Race siphon on both North and South branches of the Hinds River.[133]

(2) In reaches with gravel or hard bottom substrates; in all other areas no value set.[134]

(3) Target to be met by ~~2035~~ 2055 for Nitrate-nitrogen concentration (mg/L).[7]

(4) Waterbodies are to meet both (annual median and annual 95th percentile) limits/targets.

[132] Cl16 – minor correction to make consistent with Table 1a

[133] V2 pLWRP 981 – Upper Hinds Plains Land User Group

[134] Cl16 – minor correction to make consistent with Variation 1

[7] Suggested amended wording to table 13(j) in RDRML's submission included here under Table 13(j) by G. Ryder