BEFORE THE ENVIRONMENT COURT

Under:	the Resource Management Act 1991 ("the Act")
In the matter of:	appeals under clause 14 of the First Schedule to the Act concerning the Proposed One Plan for the Manawatu-Whanganui Region and the topic of Surface Water Quality
Between:	**MINISTER OF CONSERVATION** **ENV-2010-WGL-000150** **FEDERATED FARMERS OF NEW ZEALAND** **ENV-2010-WLG-000148** **MR ANDREW DAY** **ENV-2010-WLG-000158** **HORTICULTURE NEW ZEALAND** **ENV-2010-WLG-000155** **WELLINGTON FISH & GAME COUNCIL** **ENV-2010-WLG-000157** Appellants
And:	**MANAWATU-WHANGANUI REGIONAL COUNCIL** Respondent

STATEMENT OF REBUTTAL EVIDENCE OF DAVID JOHN KELLY ON BEHALF OF THE MINISTER OF CONSERVATION

Dated: 17 April 2012

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STATEMENT OF REBUTTAL EVIDENCE OF DAVID JOHN KELLY

1. My full name is David John Kelly. My qualifications and experience are set out in my Evidence in Chief dated 15th March 2012.

2. I attended the first expert caucusing session for ecological experts (21st March 2012). My rebuttal evidence responds to matters in the Records of technical conferencing on nitrogen limits and water quality sub topic in relation to surface water quality –non-point source discharges held on 21st March 2012 and 29th March 2012. It also responds to one matter in the record of planner conferencing on the topic of surface water quality - non-point source discharges held on 4th and 5th April 2012.

3. In particular my rebuttal evidence covers the following:

    a. Predictive nutrient state modelling for dune lakes from water management subzones West_6 and West_7 which I have undertaken in accordance with agreements made during technical expert conferencing;

    b. Water quality limits for lakes set out is Schedule D of the Proposed One Plan (POP);

    c. The relationship between non-point source contaminant sources and water quality state of dune lakes.

4. I have read the Environment Court's Code of Conduct for Expert Witnesses 2011, and I agree to comply with it. I confirm that the issues addressed in this brief of evidence are 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. I have specified where my opinion is based on limited or partial information and identified any assumptions I have made in forming my opinions.

Predictive nutrient state modelling for dune lakes from water management subzones West 6 and West 7

5. As a point of background, the water quality expert group conferencing session held on 21st March 2012 spent considerable time focusing on assessing the areas of agreement and disagreement on current state of water quality in the water management zones or subzones that were either specified in the Council's hearing decision or contended by an appellant for inclusion in Table 13.1 (Topic 4 - Conferencing notes). The protocol agreed to by all parties in the expert group for the purpose of evaluating whether the current water quality conditions within the water management zones would meet the values of the water users (e.g., ecosystem, human use) was to evaluate if the current measured or modelled water quality state would meet the limits set out in Schedule D of the DV POP. For dune lakes, this was predominantly focused on water quality status as measured by the lake trophic level indicator (TLI3) constituents, which include total nitrogen and phosphorus, and chlorophyll a concentration.

6. While there was clear consensus among the experts that dune lakes within water management zones West_4, West_5, West_8, and Hoki_1 would presently not meet the Schedule D limits for TLI3 constituents, there was insufficient information to inform the expert group in regards to dune lakes within water management subzones West_6 and West_7. There has been no historical water quality monitoring conducted in dune lakes from either of these two subzones (eight lakes total, four in each water management zone) to inform such assessments.

7. In the absence of available field monitoring data, the expert group noted that the best way of informing the Court on water quality state in West_6 and West_7 was to undertake predictive modelling of water quality for individual lakes within these water management zones using the National CLUES model (see Topic 4- Water Quality Expert Conferencing notes 21st March 2012).

This is the methodology employed in my Evidence in Chief (paragraphs 63-74) to estimate the current nutrient status of some lakes within water management subzones West_4 and West_5 where field monitoring data was unavailable. In this exercise, predictions of water quality state from the CLUES model were validated against field water quality data from six lakes within the Manawatu-Whanganui region, as well as 16 dune lakes monitored nationally.

8. I have now completed the analysis for West_6 and West_7. For these water management zones, in-lake TN concentration and TLn (the nitrogen component of TLI3) were predicted for five lakes in total, four within West_6 and one in West_7 (Table 1). Three other dune lakes within West_7 did not have any direct tributary inflows so were unable to be modelled as the CLUES model only predicts loading from stream inflows.

9. Concentrations of in-lake TN for all five lakes were predicted to currently exceed the TN concentrations in the POP Schedule D limits for shallow lakes (735 mg/m3 TN), with concentrations on average being 4185 mg/m^3 TN in West_6 and 7758 mg/m^3 for the single lake in West_7. Most lakes (saving Omanuka Lagoon) were predicted to be hypertrophic, or highly nutrient enriched.

10. I also calculated, as I did for my Evidence in Chief, the predicted TN loading and percent change required to achieve the relevant POP Schedule D standard. This can be seen in the second last row in Table 1. N loading would need to be reduced by between 32-92% in West_6 to achieve the POP TN standard, and by 90% for the single lake in West_7. In comparison to lakes reported in Table 3 of my Evidence in Chief, lakes from West_6 and West_7 had higher predicted nutrient concentrations than lakes in West_4 or West_5, or Hoki_1. Thus from this analysis my expectation would be that lakes within water management zones West_6 and West_7 would require an even greater effort in terms of nutrient management to achieve the POP standards.

11. This is supported by Ms McArthur's section 42A report (paragraphs 451-454) which noted a high degree of intensive pastoral agriculture land-use within West_6 Water Management Zone (50% dairy) and the occurrence of algal blooms within some of the lakes such as Lake Kaikokopu. Prediction of higher nutrient concentrations for West_6 are not unexpected, as the proportion of intensive agricultural land use in West_6 (e.g., dairy) exceeded that of other regions such as West_4 (4% dairy) and West_5 (9% dairy), where water quality state had also been shown to exceed the POP Schedule D limits, both through field observational data and predictive modelling.

Table 1: Summary of predictions of in-Lake average annual total nitrogen concentration using the CLUES N model loading predictions for Lakes in West_6 and West_7 water management zones. Calculation of in-lake mean annual total nitrogen concentration was made using Vollenweider models for nitrogen retention (Harrison et al. 2009), and TLn calculations was based on Protocol for Monitoring Trophic Levels of New Zealand Lakes and Reservoirs (Burns et al., 2000).

Zone	Lake name	Lake Area (HA)	Catchment Area (HA)	Present Predicted CLUES N Loading (T/yr)	Predicted in-Lake TN (mg/m^3)	Predicted TLn	Measured TLn	Loading to meet One Plan standards (T/yr)	Loading to meet mid Eutrophic TLn (T/yr)
West_6	Lake Koputara	9.4	1066	2.1	4872	7.5 (hypertrophic)	n/a	0.3[1] (-86%)	0.2 (-91%)
	Lake Kaikokopu	14.7	883	0.5	2206	6.5 (hypertrophic)	n/a	0.2[1] (-72%)	0.1 (-81%)
	Pukepuke Lagoon	17.9	8674	23.9	8633	8.2 (hypertrophic)	n/a	2.0[1] (-92%)	1.3 (-95%)
	Omanuka Lagoon	11.0	681	1.8	1029	5.5 (supertrophic)	n/a	1.2[1] (-32%)	0.8 (-55%)
West_7	Unnamed Lake	3.2	817	6.2	7758	8.1 (hypertrophic)	n/a	0.6[1] (-90%)	0.4 (-94%)

12. As discussed in paragraph 69 of my Evidence in Chief, the size of the surface water catchment for the lake influences overall magnitude of nutrient loading to lakes, and thus lakes with larger drainage areas tend to have greater nutrient loading. Lakes within West_6 have significantly larger catchment areas than lakes from West_4 and West_5, being on average 2.5 and 5 times greater in catchment area respectively. Pukepuke Lagoon has an extremely large catchment (8674 Ha), nearly 40% larger than that of Lake Horowhenua which is approximately 17 times greater in lake area. Thus lakes within West_6 tended to have higher predicted TN concentrations than lakes from neighbouring water management zones, and are likely to be more sensitive to land-use practices within their catchments because they focus runoff over much larger areas.

13. Predictions of in-lake TN concentrations in lakes within West_6 and West_7 should be taken as indicative values only due to a lack of supporting field data to validate the model predictions. For other lakes in the region where TN was predicted using CLUES model data, (i.e., West_4, West_5 and Hoki_1) we also had in-lake field measurements of TN concentration at several of the lakes in the region to support and validate modelling predictions. This data was unfortunately not available for any lakes in West_6 and West_7 so modelling predictions cannot be verified in the same manner. As such, some caution is recommended in interpreting these predictions.

14. My experience in assessing water quality in lowland lakes from around the country would suggest that some of the predicted values of TN for lakes in Table 1 (below) will likely exceed actual field measured values, and thus it is recommended that field monitoring is pursued by the regional council to validate these predictions. This is particularly probable for Pukepuke Lagoon which had a predicted TN concentration of 8633 mg/m^3. In my experience even the most highly nutrient enriched coastal lakes would normally not exceed 5000 mg/m^3 TN (see Drake, Kelly and Schallenberg 2010). An elevated predicted TN level can occur for a number of reasons including quite

complex in-lake nitrogen cycling processes such as denitrification, thus lakes can have nitrogen concentrations lower than those predicted by more simple loading model calculation methods (Klapper 1991). However, because the modelling exercise I have undertaken is focused predominantly around assessing whether lakes within the water management zones of interest might currently meet the Schedule D limits (e.g., 735 mg/m^3 TN), a high degree of precision around the exact nutrient concentration is less important than assessing the concentration in relation to the proposed limit, and in this case the TN concentrations are predicted to exceed the limit by a significant degree.

15. In summary, dune lakes from the West_6 and West_7 water management zones are predicted to presently exceed nitrogen Schedule D limits in the POP. Five of the six lakes for which modelling predictions were made were hypertrophic, the highest nutrient status for New Zealand lakes. Field monitoring data from these lakes would be useful to support predictions made through modelling, but even without such field validation data, the large degree to which nitrogen concentrations are predicted to exceed the proposed limits strongly supports the findings obtained from other neighbouring water management zones (where field data is available) that nutrient reductions will be required to meet the proposed limits.

Water quality limits for lakes set out is Schedule D of the Proposed One Plan

16. In paragraph 70 of my Evidence in Chief, I raised the point that the proposed Schedule D limits for nutrient concentrations in shallow lakes were in my opinion are too high to safeguard the ecological and recreational uses of the lakes, being set at the boundary of the Eutrophic/Supertrophic TLI ranges (i.e., 735 mg/m^3 TN, 43 mg/m^3 TP). The reasoning behind this concern was that some lakes which presently have nutrient concentrations in this range (e.g., Lake Wiritoa) undergo algal blooms which result in closures of the lake to recreation, and unknown consequences for the resident aquatic communities.

17. In Topic 4 of the water quality expert conferencing, parties agreed that Mr Gibbs and myself would discuss Schedule D nutrient limits in shallow lakes, and present a recommendation as to any changes suggested. Mr Gibbs and I exchanged phone calls and e-mail dialogue and came to the following joint communication that we both support:

> *"The point made in Dr Kelly's evidence in chief Paragraph 70 in relation to nutrient standards in shallow lakes. We are in agreement that while the 337 mg/m^3 for total nitrogen originally proposed is too aspirational, the 735 mg/m^3 adopted in the hearing decision may not be aspirational enough to protect the values the lakes. As these values were based on upper threshold values for lake trophic classifications of mesotrophic and eutrophic conditions, they had a valid basis for their justification. If a limit was imposed, it would be best to be defined in terms of the trophic level classification. The most sensible option would be to establish a limit at the "mid-eutrophic" classification range, giving TN, TP, and Chla limits of 490 mg/m^3, 30mg/m^3, and 8mg/m^3, respectively, with a combined TLI3 at the mid-point of the eutrophic range of 4.5. This would accommodate our concerns about the limited protection of the 735 mg/m^3 TN and 43 mg/m^3 TP thresholds adopted in the hearing decision, and provide a basis to justify the lower threshold."*

18. Thus I would recommend the Schedule D limits for TLI3 constituents should be changed to a mid-eutrophic classification range equating to 490 mg/m3 TN, 30 mg/m3 TP, 8 mg/m3 Chlorophyll a. These limits are at the mid-point of the "eutrophic" TLI3 range and would more adequately provide a level of protection for the values of dune lakes, while still allowing some level of nutrient enrichment above natural background concentrations. This will mean that more substantive reductions in nutrient loading would be required to meet the more stringent limits, and these numbers for TN are presented in the far right column in Table 1 above, and Table 3 of my Evidence in Chief.

The relationship between non-point source contaminant sources and water quality state of dune lakes

19. Within the record of planner conferencing on the topic of surface water quality - non-point source discharges held on 4th and 5th April 2012 point 17 discusses the cause of degradation in certain water management zones noting

the views of some participants that there was “less certainty in respect to lake catchments” regarding non-point sources being the primary cause of degraded water quality. It is my opinion that while other nutrient sources (e.g., historical point source discharge) can contribute to elevated nutrient sources in lakes, it is predominantly non-point sources that are responsible for water quality conditions in nearly all lakes within the water management zones I examined in the region (West_4, West_5, West_6, West_8, Hoki_1), which I discuss in the following sections.

20. In my Evidence in Chief, I statistically compared the relationship between in-lake TN concentration measured from field observations to those predicted in a loading model which only accounted for diffuse riverine sources of TN (the CLUES N loading model). In Table 3 of my evidence, the predicted TN concentration for was in most cases close to or slightly lower than observed in-lake measurements, suggesting other nutrient sources (e.g., in-lake recycling from nutrient rich sediments, groundwater nutrient sources) could account for at least some part of the in-lake TN concentration. However, this amount was typically quite a small amount of the total fraction, and if only diffuse TN sources were taken into account, 12 of 13 lakes were still predicted to be in excess of the POP Schedule D limits for TN.

21. The most obvious case for the potential of historical point source discharges to affect in-lake nutrient status is for Lake Horowhenua, and could be considered the worst-case scenario for lakes in this region. Looking at the predicted in-lake TN concentration from just the diffuse N source loading model, Lake Horowhenua would be predicted to have an in-lake TN concentration of 2333 mg/m^3, well in excess of the POP TN limit. Whereas in-lake concentrations from field observations were, on average, 3580 mg/m^3 during 2010. Thus approximately 33% of the lake TN in Lake Horowhenua could come from “other” nutrient sources. The magnitude of this source does signal a significant need to manage these sources, and this was articulated in the section 42A report of Mr Gibbs and my Evidence in Chief (Paragraphs 72-73, 82-85, 92-95), and could possibly be achieved through a range of riparian and

in lake (e.g., sediment capping, dredging) restoration measures. However, even with "other" nutrient sources addressed, Lake Horowhenua would still require management of diffuse N sources. In all the examples of lakes I have looked at in the region, managing the diffuse nutrient source component of nutrient inputs would be a critical component for managing in-lake water quality in order to meet the Schedule D limits for nutrients in the POP

22. In summary, the diffuse source component of N typically comprises the largest component of N inputs to dune lakes. Other nutrient sources (e.g., in-lake recycling of nutrient rich sediment, groundwater) can be important to the overall nutrient status of some lakes, and will need to be managed in cases where historical (or present) point source discharges occur such as Lake Horowhenua. However, without exception diffuse source pollution will need to be managed in the dune lakes I have examined that exceed the nutrient limits set out in Schedule D to the POP.

References

Drake D.C.; Kelly D.; Schallenberg M. 2011. Shallow coastal lakes in New Zealand: current conditions, catchment-scale human disturbance and determination of ecological integrity. Hydrobiologia, 658, 87–101.

Klapper, H. 1991. Chapter 6- The Use of Models, pages 85-113 in "Control of Eutrophication in Inland Waters". Ellis Horwood, London, 337p.