Before Hearing Panel – Proposed Natural Resources Plan for the Wellington Region

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Under	The Resource Management Act 1991 (the Act)
In the matter of	Proposed Natural Resources Plan for the Wellington Region: Hearing Stream Four: *Water quality & Stormwater*
Between	Greater Wellington Regional Council *Local Authority*
And	Masterton / South Wairarapa District Council *Submitter S367 and Further Submitter FS30*

Statement of Keith David Hamill

In response to Minute #57 Panel Direction in response to Issue Raised by Counsel for Masterton District Council and South Wairarapa District Council

Dated 19 September 2018

Qualifications and Experience

1 My full name is Keith David Hamill. I am an Environmental Scientist and Director at River Lake Limited. River Lake Limited is a consultancy that provides research and environmental science advice for understanding and managing rivers, lakes and estuaries. My technical speciality is in water quality and aquatic ecology.

2 I hold a Bachelor of Science degree (Geography) from the University of Auckland (1992) and a Master of Science (1st Class Hons) in Ecology and Resource & Environmental Planning from the University of Waikato (1995).

3 I have 23 years' experience in the area of resource management and environmental science. I have previously worked as a Principal Environmental Scientist at Opus International Consultants Limited, in the United Kingdom as a Senior Environmental Scientist for a consultancy called WRc, and as an Environmental Scientist at Southland Regional Council.

4 I have been responsible for designing and implementing state of the environment monitoring programmes, undertaking environmental investigations, and developing environmental policy in New Zealand and Europe. Examples of projects I have worked on include:

- Member of lakes science panel for developing a National Objectives Framework as part of the National Policy Statement for Freshwater (MfE, 2013 - 2014).
- National Environmental Monitoring and Reporting project (NEMaR). This contributed to the development of a single index for reporting river, lake and recreational water quality and consistent national freshwater monitoring programme for NZ (MfE, 2011 - 2012).
- Palmerston North Waste Water Treatment Plant (WWTP) joint monitoring programme and assessment of effects and hearing (2011-

2015).

- Assessing water quality and ecological effects for numerous small wastewater treatment plants including: Milton, Whitianga, Porangahau, Rotoiti, Rotorua.

5 I have been involved with the resource consent application for the upgraded Featherston Wastewater Treatment Plant (WWTP) in terms of providing water quality and ecological advice to SWDC. As such I am familiar with the environment for the existing and proposed wastewater treatment plan, and the practical application of policies P70 and P71A, and the related Objective O25. I have also provided early (2013) reports to Greater Wellington Regional Council (**GWRC**) that have contributed to setting limits in the proposed regional plan for lakes.

6 I confirm that I have read the 'Code of Conduct' for expert witnesses contained in the Environment Court Practice Note 2014. My evidence has been prepared in compliance with that Code. In particular, unless I state otherwise, this evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

Scope of evidence

7 I have been asked by South Wairarapa District Council ("**SWDC**") to give expert evidence relating to water quality and ecology relating to Masterton District Council's ("**MDC**") submission on the Proposed Natural Resources Plan for the Wellington Region ("**PNRP**"), specific to the issue of Water Quality (Hearing Four) and the Memo discussed in Minute #57.

8 In my evidence I highlight the practical issues with the water quality standards within the officer recommended Right-of-Reply on Policy P71 and P71A.

Identifying significant rivers due to high macroinvertebrate community health

9 Before I address Policies P71 and P71A, I address Objective 25 given the objective is directly referenced within Policy 71. While I understand the officer recommended Right-of-Reply Policy P71 does not apply to wastewater discharges, given the uncertainty as to what policy and provisions will apply to

wastewater discharges going forward, I consider it important to highlight to the panel some issues with Objective 25 Table 3.4 in relation to Donald Creek.

10 Objective 25 Table 3.4 sets numerical objectives for periphyton biomass, periphyton cover, and aquatic macroinvertebrates (MCI). Stricter objectives are set for 'significant rivers', with 'significant rivers' defined as "*rivers or streams with high macroinvertebrate community health, identified in column 2 of Schedule F1 (rivers/lakes)*". Generally, the significance listing also applies to all of the tributaries upstream of the stream section listed in Schedule F.

11 Applying the Schedule F1 significance criteria of '*high macroinvertebrate community health*' to all upstream tributaries is potentially problematic because sometimes streams with high macroinvertebrate health have tributaries which can not realistically meet the numerical objectives for significant rivers set in Table 3.4 of Objective 25. This is because tributaries can have different habitat, stream form and/or hydraulic conditions compared to the mainstem of a river.

12 An example of this is Donald Creek which is a tributary to Abotts Creek/Otauira Stream. The MCI score in Donald Creek upstream of the Featherston WWTP is typically about 90 (range 70 to 98). In contrast, past MCI scores in Abotts Creek (upstream of Donald Creek confluence) range from 98 to 109 – higher than Donald Creek and reflecting differences in water quality, habitat, substrate and hydraulic regime. Note that the samples collected during spring from this reach of Abotts Creek did not meet the MCI values set in objective 25 (i.e. MCI value ≥120). The results are likely to be worse during summer when the reach from Longwood West Road to Donald Creek confluence is often dry.

13 In my view it is appropriate to not classify Donald Creek (and the lowland section of Abotts Creek) as significant due to 'high macroinvertebrate community health'. These streams do not currently meet the Objective 25 criteria of MCI score ≥120 and even with widespread landuse change it is questionable whether this criterion would be met during summer/autumns low flow.

14 There is ambiguity as to whether Schedule F1 lists Donald Creek as having 'high macroinvertebrate community health'. The table in PNRP Schedule F1 shows that the criteria of having 'high macroinvertebrate community health' applies to Abotts Creek and all tributaries (page 367 of the PNRP). In contrast, PNRP map 13a (Schedule F) shows that Abotts Creek/Otauira Stream listed as

'high macroinvertebrate community health' from upstream of its confluence with Donald Creek only. In my view, the information in PNRP Map 13a is more appropriate and for the purposed of Table 3.4 in Objective 25, Donald Creek should fit under the category of 'all rivers'.

15 I recommend that the wording in PNRP Schedule F1 for Abotts Creek (page 367) is changed in column 2 (titled 'high macroinvertebrate community health') to read "*Creek and tributaries upstream of Donald Creek confluence*".

Policy P71 and P71A

16 Policy 71A (Quality of wastewater discharges) as recommended in the officer Right-of-Reply states that:

"*As a minimum point source discharges of wastewater to rivers shall meet the following water quality standards in the receiving water after the zone of reasonable mixing:*

(a) below the discharge point compared to above the discharge point:

(i) a decrease in the Quantitative Macroinvertebrate Community index of no more than 20%, and

(ii) a decrease in water clarity of no more than:

1. 20% in River class, 1 or

2. 33% in River classes 2 to 6, and

(iii) a change in temperature of no more than:

1. 2ºC in River classes 1 or 2, or

2. 2ºC in any river identified as having high macroinvertebrate community health in Schedule F1 (rivers/lakes), or

3. 3ºC in any other river, and

(b) a 7-day mean minimum dissolved oxygen concentration of no lower than 7mg/L, and

(c) a daily minimum dissolved oxygen concentration of no lower than 5mg/L."

17 My principal concern with P71A from an ecological perspective is that there is a high likelihood that some discharges will not comply with the current wording of Policy 71A with respect to QMCI and dissolved oxygen, even if they are causing little or no adverse effects on a river. This is because the current policy wording does not account for natural variability that occurs within many waterbodies. On this basis, I question the merits and appropriateness of the standards within the policy for setting a baseline for ecological effects.

QMCI Standard

18 The first primary issue with P71A relates to the prescriptive QMCI standard within clause (a)(i).

(a) below the discharge point compared to above the discharge point:

(i) a decrease in the Quantitative Macroinvertebrate Community index of no more than 20%, and …

19 The QMCI is a very effective metric for detecting organic enrichment. It is a measure of relative abundance of macroinvertebrate taxa with different tolerances to organic enrichment. The QMCI reduces in response to both a decline in abundance of high scoring species and an increase in abundance of low scoring species. The QMCI is also a communication tool (Stark 1998). The results are often communicated in terms of indicating "clean water" or "polluted water" but in reality, it changes in response to multiple factors including habitat and periphyton. The QMCI is one of multiple metrics that are used together to understand effects on aquatic macroinvertebrate communities. It is good at detecting changes in the structure of invertebrate communities as a result of nutrient enrichment, but there are many ecologically relevant changes it does not capture (such as biodiversity, food available for fish or mayfly abundance) which require the use of other complementary metrics.

20 A percent change in QMCI between upstream and downstream is a convenient way to assess effects but is one step away from actual effects on the macroinvertebrate community. For example, in the Manawatū River a percent change in QMCI had only a weak correlation to mayfly abundance (an important indicator stream health) and occasionally negative correlation to EPT abundance (important with respect to high quality food available for trout) (Figure 1).

21 QMCI scores can have high temporal variation, both seasonally and as a result of flood events. The recovery of the macroinvertebrate community after flood events is influenced by the nutrient regime. It is common to observe a subsidy-stress response downstream of wastewater discharges (e.g. Featherston WWTP) after floods that results in a short-term increase in QMCI scores downstream of a discharge followed by a subsequent decrease. This is due to higher downstream productivity supporting greater abundance of mayfly (a high scoring sensitive species) with a slower increase in abundance of low scoring species that prefer greater periphyton abundance. This type of complex response is important to understand when assessing overall effects, and particularly in the context of short-term, intermittent or flow dependent discharges that occur with partial land treatment systems (as proposed for Featherston WWTP). Under this type of scenario (e.g. short-term or intermittent

discharges associated with wet weather), the positive effects of a discharge on QMCI scores may persist for a similar length of time as the negative effects.

22 QMCI scores can also have high spatial variation along a river. During the hearing for the One Plan (Manawatū-Whanganui Region) one of the targets adopted in was *"[less than] a 20% change QMCI score between appropriately matched habitats upstream and downstream of discharges to water*" (One Plan Schedule D). This level of difference was practical to detect, and is generally more than what occurs naturally between nearby river sites. However, as discussed by Dr Stark (2013) "*Inevitably, a judgement call is required in order to decide whether or not the decrease is entirely due to the effects of the discharge and/or really does have ecological consequences*."

23 It is not uncommon for there to be more than a 20% difference in QMCI between samples of upstream sites with apparently similar habitat. I presented evidence in the Proposed One Plan hearing that the differences in QMCI scores between paired upstream control sites from different river discharges and found the median difference was a 17% (range 0% to 27%) (Hamill 2009). This between-site variation is more than what is found between replicates at a single site because of the different spatial scales.

24 In Donald Creek, upstream of Featherston WWTP discharge, a greater than 20% change in QMCI has been detected between the two upstream sites on two out of five sampling occasions. These occurred in March 2013 (a 39% difference 4.6 and 2.8) and October 2016 (a 25% difference of 3.3 and 4.4), with a different upstream site having the higher QMCI score on each occasion.

25 In summary, while the QMCI is a sensitive way to measure the effects of organic discharges but a short-term decline does not necessarily mean significant adverse effects on aquatic life. Adopting a 20% change in QMCI as a regionwide standard is problematic because this magnitude of change can occur naturally between sites. This level of QMCI change is suitable as a target but requires flexibility to accurately reflect effects. On this basis I do not support the QMCI standard with the officer recommended Right-of-Reply P71A.

26 I understand the evidence of Ms Whitney seeks that P71A not be accepted and that if P71 is amended to provide for guidance and flexibility rather than inflexible bottom lines, then it could be applied to discharges from wastewater treatment

plants. I would support these outcomes, specifically in terms of removal of the absolute nature of the QMCI standard within the policies. In my view, setting a limit using QMCI can be (and is more appropriately) addressed at the resource consent stage and through conditions of consent.

27 From a technical perspective, the above issues might also be addressed by both:

27.1 Moving the QMCI standard to Table 3.4 in Objective 25 so as to change its focus to a target. However, I understand there may be planning implications for such a change; and

27.2 Modifying the wording of the QMCI standard/target to reduce the risk of non-compliance due to natural variability that may not be due to the discharge. In this regard, I recommend the following notes to accompany the standard/target:

- "Differences in QMCI to be compared between upstream and downstream sites with similar habitat".
- "The QMCI standard is based on the median of three samples collected when the stream is flowing at less than median flow".

28 Using the median of three samples is similar to the approach taken for MCI in Objective 25 Table 3.4. I have proposed the criteria of less than median flow to target times when effects are more likely to be apparent. A seasonal criterion could be used instead/as well (e.g. during summer or autumn), but a balance needs to be found between focusing sampling to periods with higher risk of detecting effects while not restricting the application of the standard/target to other times when it may be relevant.

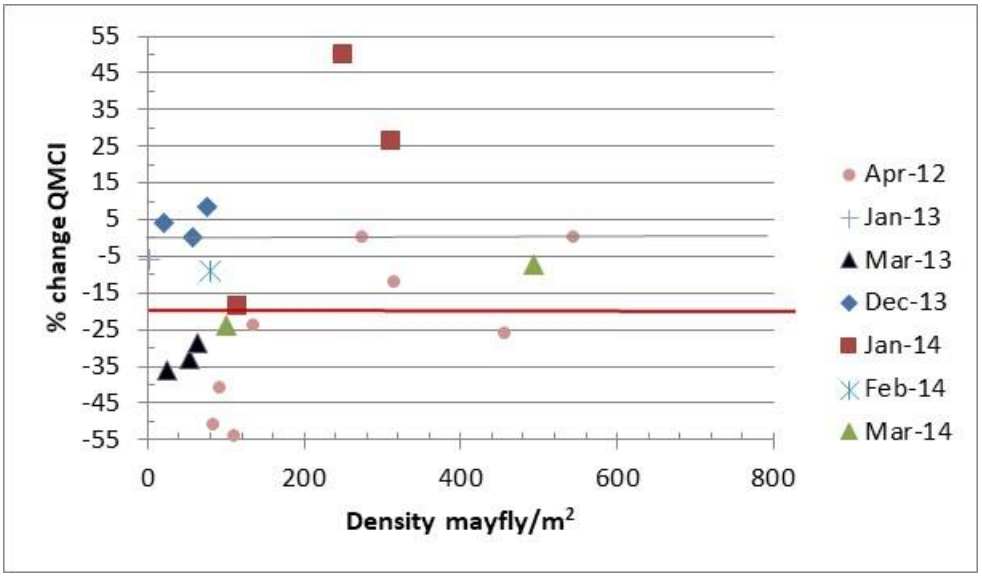

Figure 1: Mayfly density in the Manawatū River downstream of the Palmerston North wastewater treatment plant compared with the percent change in QMCI. The redline indicates a 20% decline in QMCI.

Dissolved oxygen standards

29 The second primary issue with P71A relates to the dissolved oxygen standards within clause (b) and (c):

(b) a 7-day mean minimum dissolved oxygen concentration of no lower than 57mg/L, and

(c) a daily minimum dissolved oxygen concentration of no lower than 4 5mg/L.

30 Oxygen is fundamental for most aquatic organisms and the concentration of dissolved oxygen (DO) is a key aspect of fish habitat quality. Concentrations naturally fluctuate on a diurnal cycle with higher concentrations during the day as a result of photosynthesis and lower concentrations at night due to respiration. Point source discharges can influence the DO regime indirectly by adding nutrients that stimulate periphyton biomass, or directly by having a low DO concentration or by adding contaminants that provide an oxygen demand.

31 The ability of fish to survive in hypoxic environments depends on the magnitude of DO decline, how long they are exposed to low dissolved oxygen, the type of fish, their age and their health. They are also affected by other environmental conditions such as temperature, with less tolerance at higher temperature. Water bodies with low DO typically have a low diversity and low abundance of

fish species.

32 Franklin (2013) developed DO criteria for protecting New Zealand fish communities. Imperative targets protect adults and the majority of fish species. The guideline criterion protects salmonids and early life stages of all species, this requires the instantaneous minimum DO of >5 mg/L and the 7-day mean minimum DO of >6 mg/L (Table 1).

33 Davies Colley et al. (2013) used these guidelines to develop river grades for dissolved oxygen as part of the National Objective Framework (NOF) in the proposed amendments to the National Policy Statement for Freshwater (NPS-FW). They proposed the following bottom-lines (class D) for DO;

- 7-day mean of 6.5 mg/L,
- 7-day mean minimum of 5 mg/L, and
- 1-day minimum of 4 mg/L.

34 Due to the uncertainty around interactive effects of high temperature and DO, they proposed that stricter DO thresholds are used if water temperature is also high (e.g. if the 95th percentile temperature was >24^{o}C). The NPS-FM largely adopted the values proposed by Davies Colley et al. (2013) (Table 2), but restricted the application to rivers "below point sources".

35 The values used for DO in Policy 71A equate to maintaining DO in NPS-FM bands A or B. It is considerably stricter than the NPS-FM bottom-line values of 5 mg/L as a 7-day mean minimum and 4 mg/L as a 1-day minimum. The narrative attribute for DO provides a useful description of the likely effects of DO regime within the different bands (Table 2).

36 It is common for rivers to have DO regimes below the B band (i.e. new numbers proposed in Policy 71A) independent of any point source discharge. Particularly in streams with abundant macrophytes or periphyton, but also streams with inflows dominated by groundwater or wetlands. Depree et al. (2016) compared continuous DO logging from sites nationwide with NOF thresholds. When they compared 111 sites with the 7-day average minimum values, the proportion of sites in bands A, B, C and D was 30%, 21%, 20% and 30%. When they compared 367 sites with the 1-day minimum values, the proportion of sites in bands A, B, C and D was 61%, 21%, 4% and 14%. In the Greater Wellington

Region, 20 DO logging sites were compared with the 1-day minimum values, the proportion of sites in bands A, B, C and D was 20%, 40%, 5% and 35%. A greater percentage is bands C and D when using the 7-day average minimum values.

37 Setting Policy 71A DO values to equate to NPS-FM Band B instead of the original values that equated to NPS-FM band C may result in an incremental improvement in the DO regime downstream of some discharges (e.g. from a 'moderate stress' to an 'occasional minor stress' (Table 2)). However, in many situations the upstream DO regime will not meet the standard set in the policy regardless of the quality of a wastewater discharge. In this situation the policy may have the perverse effect of encouraging discharges to waterbodies with naturally better water quality and higher values. Regardless of this, the current approach is a blunt tool and if the DO standard is made stricter it becomes less effects based and more unrealistic to achieve for progressively more rivers. Furthermore, it does nothing to address the much more prevalent effects on the DO regime from other point-source discharges, non-point discharges or management of the riparian zone.

38 As with the QMCI standard, I understand the evidence of Ms Whitney seeks that P71A not be accepted and that if P71 is applied to discharges from wastewater treatment plants, it be amended to provide for guidance and flexibility rather than inflexible standards. I would support these outcomes, specifically in terms of removal of the absolute nature of the DO standard within the policies. In my experience DO can be (and is more appropriately) addressed at the resource consent stage and through conditions of consent.

39 Notwithstanding the question as to whether the oxygen standards should be included within notified P71 or P71A (as addressed in the evidence of Ms Whitney) should the panel be minded to include standards within the policy framework, I recommend changing the DO values in Policy 71A (and notified P71) back to 5 mg/L as a 7-day mean minimum and 4 mg/L as a daily minimum. This would minimise perverse effects of the policy. Additionally, the DO standards could be put into Objective 25 Table 3.4. This would provide a framework to have stricter values for 'significant' rivers compared to other rivers. It would also recognise that there are many pressures that result in rivers having a poor DO regime.

40 I note that Dr McArthur has provided expert evidence on behalf of Department of Conservation (DoC) and recommended using DO standards in Policy 71 equivalent to the threshold between Band B and Band C (paragraph 118 -119). This recommendation appears based on applying more precautionary standards for outstanding waterbodies. However, the stricter standard proposed for DO in Right-of-Reply P71A sets a standard that is not naturally achieved by many waterways in the region and is unnecessary to avoid more than minor adverse effects for many waterways. In practice it will exclude wastewater discharges from some rivers even if the discharge is having only minor effects.

Table 1: Recommended DO criteria for freshwater fish. The imperative protection level is the minimum recommended protection level, and the guideline protection level the target protection level or minimum for early life stages of all species (from Franklin 2014).

Dissolved Oxygen		**Dissolved oxygen (mg/L)**
7-day mean	Guideline	8.0
	Imperative	7.0
7-day mean minimum	Guideline	6.0
	Imperative	5.0
Instantaneous minimum	Guideline	5.0
	Imperative	3.5

Table 2: Bands for DO concentrations (mg/L) in the NPS-FM for the daily minimum and 7-day average minimum. The threshold between bands C and D represents the national bottom-line.

Band	**7-day average minimum**	**1-day minimum**	**Narrative attribute state**
A	≥8	≥7.5	No stress caused by low dissolved oxygen on any aquatic organisms that are present at matched reference (near-pristine) sites.
B	7 - 8	5 – 7.5	Occasional minor stress on sensitive organisms caused by short periods (a few hours each day) of lower dissolved oxygen. Risk of reduced abundance of sensitive fish and macroinvertebrate species.
C	5 - 7	4 - 5	Moderate stress on a number of aquatic organisms caused by dissolved oxygen levels exceeding

Band	7-day average minimum	1-day minimum	Narrative attribute state
			preference levels for periods of several hours each day. Risk of sensitive fish and macroinvertebrate species being lost.
D	<5	<4	Significant, persistent stress on a range of aquatic organisms caused by dissolved oxygen exceeding tolerance levels. Likelihood of local extinctions of keystone species and loss of ecological integrity.

pH

41 I note that the notified version of P71 included a standard relating to pH requiring a change in pH downstream of discharges of no more than ±0.5 units. This has subsequently been removed in the Right-of-Reply Policy P71A. I support the removal of the pH standard as worded in the notified version of P71 because, as worded, it is a poor indicator of effects on aquatic life for most river systems.

42 The pH of a rivers differs depending on the source of the water. It is an important aspect of water chemistry and can cause direct effects on aquatic life, change the toxicity of some pollutants (e.g. ammonia) and affect nutrient geo-chemistry. River pH varies naturally on a diurnal cycle corresponding to the uptake and release of oxygen and carbon dioxide from plants. Maximum pH occurs in the late afternoon and minimum pH in the early morning. These fluctuations can be large (often two pH units) in rivers with high biomass of plants/periphyton and low buffering capacity. Discharges can influence river pH both directly and indirectly by stimulating more plant or periphyton biomass.

43 Past ANZECC guidelines (2000) recommended that changes in pH of more than 0.5 units from the natural seasonal maximum or minimum should be investigated. Default trigger values for lowland river were set as 7.2 – 7.8. Davies Colley et al. (2013) develop river grades for pH as part of the NOF in the NPS-FW. They proposed band boundary thresholds[1] for pH of:

- Band A/B: 6.5 < pH <8.0 (No stress on any aquatic organisms)
- Band B/C: 6.5 < pH <8.5 (Occasional minor stress)
- Band C/D: 6.0 < pH < 9.0 (Stress caused on occasion)

44 Davies Colley et al. (2013) recognised that many some systems such as

[1] Summer monitoring 95th percentile

geothermal water, peat lakes and humic stained streams have natural pH outside of these ranges. Maintaining pH within the B/C boundary would cause only occasional minor stress on sensitive freshwater organisms, so a pH changes of 0.5 units that was within this range would likely be of minor consequence to aquatic life unless the objective is to maintain a river in its natural state.

Conclusion

45 In my evidence I highlight the practical issues with the water quality standards within the officer recommended Right-of-Reply Policy P71A as they apply to discharges from wastewater treatment plants. Specifically, I address the issues with the standards within P71 / P71A relating to QMCI, DO and pH.

46 I would support the removal of the standards from the PNRP policy framework and in my view the issues can be addressed at the resource consent stage and through conditions of consent. As an alternative, I have outlined changes to how the standards could be applied within the policy framework should that be the panels preference, noting that there may be planning implications for such changes and specific wording would require careful consideration.

Keith Hamill

19 September 2018

References

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