BEFORE THE HEARINGS PANEL

IN THE MATTER of hearings on submissions concerning the Proposed One Plan notified by the Manawatu-Wanganui Regional Council

SUPPLEMENTARY EVIDENCE OF KEITH DAVID HAMILL ON BEHALF OF PALMERSTON NORTH CITY COUNCIL

1. INTRODUCTION

1.1 I have prepared this report as supplementary evidence on behalf of Palmerston North City Council. It has been compiled in response to supplementary evidence submitted by experts on behalf of Horizons Regional Council and to clarify aspects of my original evidence.

1.2 I have read, and comment on here, the supplementary evidence of Dr Wilcock, Dr Biggs and Kathryn McArthur. I have also read evidence presented by other submitters including Dr Russell George Death on behalf of NZ Fish and Game Council.

1.3 I have met with submitter experts (Paul Kennedy on behalf of Territorial Authorities), and Council experts (Dr John Quinn, Dr Bob Wilcock, Kate McArthur and Dr John Roygard) to discuss recommendations on water quality standards in Schedule D. The results of this caucus meeting are discussed in the report by Richard Thompson and in supplementary evidence by Dr Bob Wilcock and Kathryn McArthur. The changes to my evidence as a result of agreements in this meeting are summarised here and in the annotated version of Schedule D appended to the evidence of Mr Andrew Bashford.

1.4 I have focused on issues raised in supplementary evidence that were not covered by my original evidence and that requires further explanation. I have attempted to minimise any repetition and am happy to respond to any questions that the panel may wish to ask.

2. SUMMARY OF MY SUPPLEMENTARY EVIDENCE

2.1 After considering the supplementary expert evidence I would like to clarify some matters raised by experts regarding:

(a) Aquatic macroinvertebrates and particular the QMCI standard/target;

(b) Total ammoniacal nitrogen;

(c) Toxicants;

(d) Periphyton;

(e) DRP and SIN.

3. RESPONSE TO SUPPLEMENTARY EVIDENCE

Aquatic macroinvertebrate community

3.1 I support the proposal to shift of footnote 4 referring to MCI into the standards key. This clarifies the use of this standard.

3.2 The QMCI standard is targeted at point source discharges to water, however QMCI scores integrate multiple pressures on the environment and can change for multiple reasons in addition to a discharge. These include change in instream habitat (substrate, stream morphology, bank habitat etc), changes in riparian cover, shading, amount of woody debris, the contribution of other tributaries, stock access to the stream bed, gravel extraction etc. When collecting macroinvertebrate samples considerable attention is given to the surrounding habitat and reducing the influence of habitat by ensuring that samples collected from upstream and downstream sites are from similar habitat. However it is not always possible to eliminate habitat variability, particularly when collecting downstream samples distant from the discharge. These issues are discussed in Stark and Maxted (2007).

3.3 I support the inclusion of the words "*between appropriately matched habitat upstream and downstream of the discharge*." However, I am surprised and concerned that the standard/target is intended to apply regardless of what is causing a change in QMCI score. To assume that a discharge is always the primary cause of a decline in QMCI scores could shift attention to the wrong issue and result in missed opportunities for stream improvement (e.g. riparian planting, shading, erosion protection, off-stream gravel extraction). It may also unfairly target point source discharges which are not causing or not the primary cause of the decline. I am happy to discuss some case examples if the panel wishes. In my view the standards should apply to significant changes to the QMCI which are caused by the discharge in question.

3.4 Supplementary evidence of Mrs Kathryn McArthur suggested a change to the QMCI standard/target to read "*No statistically significant reduction in Quantitative Macroinvertebrate Community Index (QMCI) score*.....". This change confuses the concept of a 'statistical difference' with that of 'meaningful difference' or 'acceptable difference'. In my opinion the QMCI standard/targets should set what is an 'acceptable difference', and this difference should be large enough to detect with statistical confidence using pragmatic sampling methods.

3.5 The sampling method ultimately determines what statistical difference can be detected, and almost any difference can be statistically significant if enough replicates are collected. Consequently, the revised wording could result in allowing no change in QMCI score downstream of a discharge regardless of the cause of the change. In my opinion a standard that requires proving that there is no change is not realistic because there is a certain amount of natural variability in QMCI scores. We typically collect two or more upstream samples as controls when assessing the effects of a discharge. I have calculated the differences in QMCI scores between paired upstream control sites from nine recent surveys of different discharges and found the median difference was 17% (a range of 0% to 27%).

3.6 Table 1 below (based on Stark 1998) shows how increasing the number of sample replicates reduces the statistically significant differences that can be detected between two locations. Hand net samples require fewer replicates to detect the same detectable difference compared to Surber samples because they sample a larger area (e.g. to detect < ±10% difference when the QMCI value is 5, requires 3 hand net samples compared to 8 Surber samples).

3.7 In my opinion, setting a standard/target between 12% and 20% change in SQMCI or QMCI score would be both pragmatic and reasonable. A statistical difference of 20% can be detected using a single replicate collected by a hand net or two replicates collected by a Surber sampler. A statistical difference of 12% can be detected using two replicates collected by a hand net or five replicates collected by a Surber sampler.

3.8 I also propose that a footnote is added specifying that "*where samples are collected using a hand net this standard shall also apply to the Semi-*

Quantitative MCI (SQMCI); or "*samples for calculation of QMCI can be collected by use of either a hand net or Surber sampler*". The term QMCI is used strictly to refer to samples collected only by Surber sample and processed using quantitative methods; but it is also used more loosely used to describe only the method used to process the samples. Restricting the sampling method to Surber sampler would result in considerable more replicates (and expense) to achieve an equivalent level of statistical confidence compared to using the hand net technique. The SQMCI index produces values very similar to the QMCI, but at less than 40% of the cost due to the reduced numbers of replicate samples required to achieve the desired precision, and savings in macroinvertebrate sample processing time (Stark and Maxted 2007).

Table 1: Macroinvertebrate Community Index (MCI), Semi-Quantitative MCI (SQMCI) and Quantitative MCI (QMCI) detectable differences for between 1 and 12 replicate hand-net and Surber samples from stony riffles. The difference in mean index values between two locations must be equal to or greater than the tabulated value below for the difference to be statistically significant. The highlighted cell presents the detectable difference as a percentage of an average SQMCI index value of 5 (from Stark 1998, Table 5).

No. of replicates	***Hand-net MCI***	***Hand net SQMCI***	***Hand net SQMCI (% of 5)***	***Surber MCI***	***Surber QMCI***
1	10.83	0.83	±16.6%	21.67	1.37
2	7.66	0.59	±11.8%	15.32	0.97
3	6.25	0.48	±9.6%	12.51	0.79
4	5.41	0.42	±8.4%	10.84	0.68
5	4.84	0.37	±7.4%	9.69	0.61
6	4.42	0.34	±6.8%	8.85	0.56
7	4.09	0.31	±6.2%	8.19	0.52
8	3.83	0.29	±5.8%	7.66	0.48
9	3.61	0.28	±5.6%	4.22	0.46
10	3.42	0.26	±5.2%	6.85	0.43
11	3.26	0.25	±5.0%	6.53	0.41
12	3.13	0.24	±4.8%	6.26	0.39

3.9 I propose the following wording is used in Schedule D standards key: *"Discharges to water to cause no more than a 20 % reduction in Quantitative Macroinvertebrate Community Index (QMCI) score between appropriately matched habitats upstream and downstream of the discharge.*

Note: Where samples are collected using a hand net this standard shall also apply to the Semi-Quantitative Macroinvertebrate Community Index (SQMCI)."

Total Ammoniacal Nitrogen

3.10 I support the inclusion of standards/targets for both average and maximum total ammoniacal nitrogen. I support the use of the total ammoniacal nitrogen values as described in supplementary evidence by Dr Bob Wilcock. As described in my original evidence, for most situations the average values will be exceeded before the maximum values, however, including maximum values does provide an additional level of protection and comfort.

3.11 I have modified my original recommendation to simply read: The <u>average</u> concentration of ammoniacal nitrogen shall not exceed […] grams per cubic metre.

Toxicants

3.12 I support the inclusion of the wording: "*For metals the trigger value shall be adjusted for hardness and apply to the dissolved fraction*." However the wording "*as directed in the table*" should be removed. This wording reflects recommendations in the ANZECC guidelines, but it is not part of table 3.4.1. This reference to a table is confusing.

Periphyton

3.13 The New Zealand Periphyton Guidelines (Biggs 2000) gives guidance on appropriate periphyton cover for a range of instream values (i.e. 'aesthetics/recreation', benthic biodiversity', 'trout habitat'). A different extent of cover was considered appropriate for 'diatoms/cyanobacteria' compared to 'filamentous algae' because of their different growth forms and impacts on instream biota.

3.14 I support the changes made to Table D-1a 'Region wide water quality standards that apply to natural streams and rivers' and the recommendation in paragraph 42 of Dr Biggs evidence stating that "*the additional periphyton cover standard of no more than 60% cover by diatoms/cyanobacteria more than 0.3 cm thick, as stated in the New Zealand Periphyton Guideline (Biggs, 2000a), is added to the periphyton cover standard in the POP*." This provides clarity to what is being measured by the periphyton cover standards.

3.15 I have removed my original recommendation to include the word 'filamentous' algae for the periphyton Chlorophyll a standard. Not including the word 'filamentous' potentially results in a standard that is less strict than the NZ periphyton guidelines, however this needs to be balanced against maintaining a simple term. In the Periphyton Guidelines the term 'filamentous' algae describes the taxonomy of the periphyton (i.e. what is observed under the microscope), but it is sometimes wrongly interpreted to refer to the growth form or length of the periphyton. Simply using the term 'algae' in this standard would help avoid this confusion.

Dissolved Reactive Phosphorus (DRP) and Soluble Inorganic Phosphorus (SIN)

3.16 Seasonality of periphyton abundance is driven to a large extent by the timing of flood events but it is also controlled by a complex set of other factors including water temperature, grazing pressure, shading, substrate stability, nutrient concentrations etc.

3.17 Figure 1 below shows the monthly average days of accrual based on the days of accrual following a FRE3 flood for each sample date of the NZ National Water Quality Monitoring Network (NWQMN) sampling of the Manawatu River at Palmerston North between March 1989 to June 2009. This clearly shows the seasonality of flooding in the river, with most floods occurring in winter and spring[1].

3.18 Although flood events play a major role in structuring periphyton communities it is interesting to note that for the 20 year dataset of the NWQMN dataset for sites on the Manawatu River there was no statistical correlation between periphyton cover and days of accrual. This can be seen in Figure 2, autumn samples (March to May) often had very low periphyton cover despite some very long periods of accrual.

3.19 As discussed in my evidence a complex set of factors influence periphyton growth in rivers. Many of these factors converge in winter (e.g. increase flow frequency, lower temperatures, fewer hours of daylight) to reduce the risk of excessive periphyton proliferation. It does not eliminate the risk (as seen in my evidence and in 2008/09 monitoring data presented in supplementary evidence by Kathryn McArthur), but the risk is significantly less and provides opportunity for tailoring consent conditions to balance benefits against costs and to allow a monitoring based approach. This is particularly relevant to the PNCC WWTP discharge because alum dosing would allow the phosphorus

[1] Note that these are actual days of accrual and the annual mean differs from the value calculated by Henderson and Diettrich (2007) because it does not include a 5 day inter-flood spacing.

concentration of the effluent to be changed within a day to match the risk of periphyton proliferations.

Figure 1: Monthly average days of accrual in the Manawatu River at Palmerston North for New Zealand National Water Quality Monitoring Network sample dates between March 1989 and June 2009.

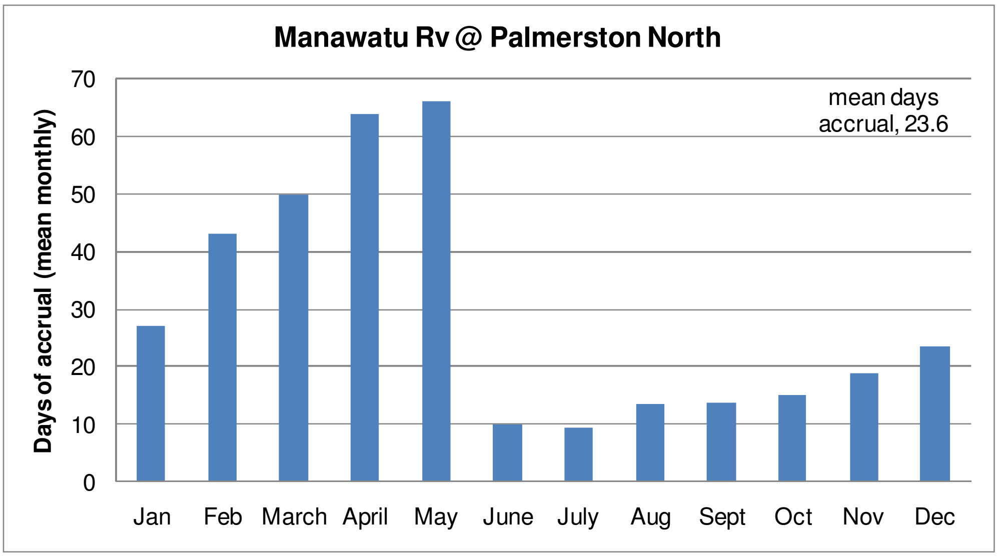
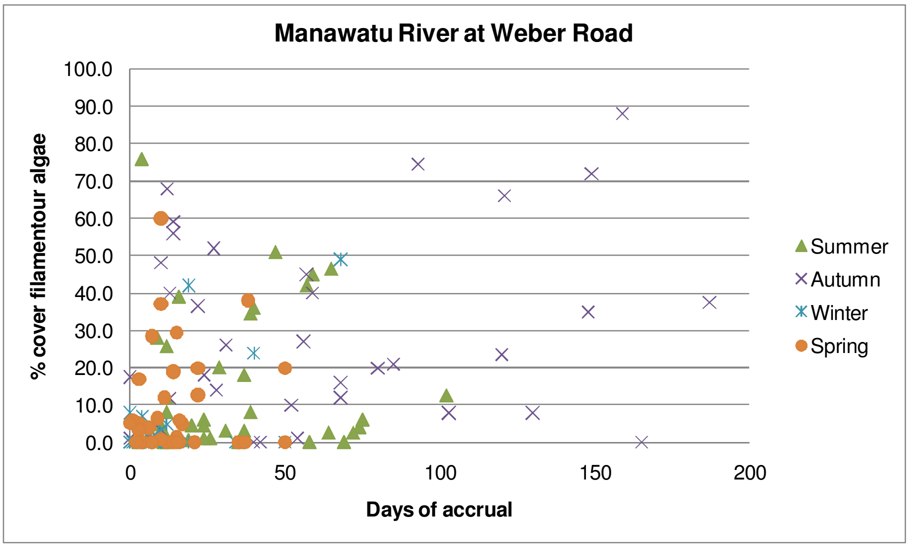
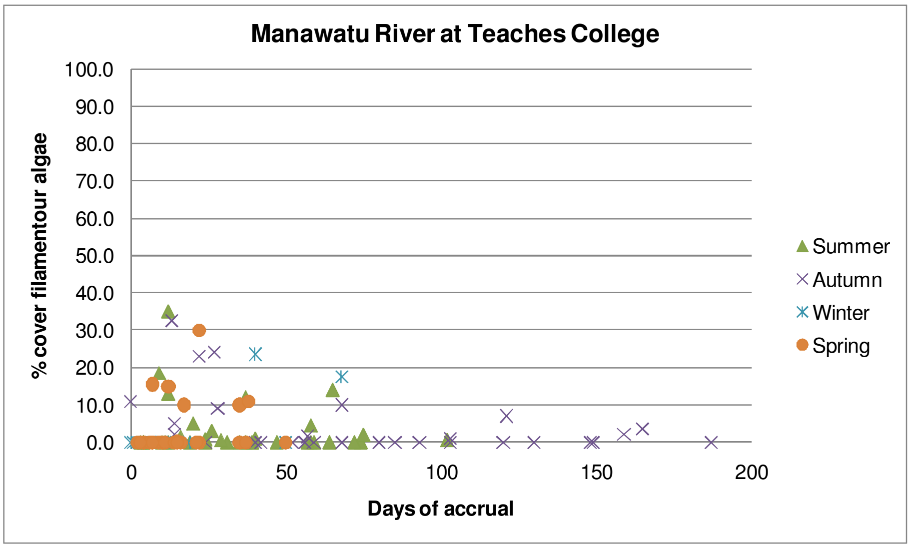
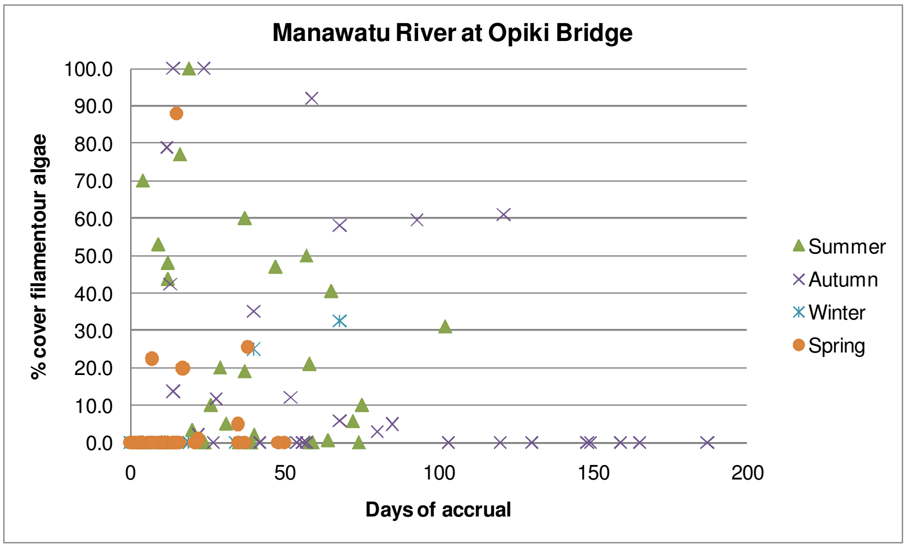


Figure 2: Relationship between periphyton cover and days of accrual at three sites in the Manawatu River (data from NWQMN Mar 1989 to Dec 2008, excluding data between 2003 and 2006 labelled as 'dubious')







Keith David Hamill
February 2010

References

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