Before Hearing Commissioners at Palmerston North

under:	the Resource Management Act 1991
in the matter of:	Submissions on Chapters 6, 13 and 15 of the Proposed One Plan
between:	**Fonterra Co-operative Group Limited** *Submitter*
and:	**Manawatu-Wanganui Regional Council** *Respondent*

Statement of evidence of Dr Michael Robert Scarsbrook for Fonterra Co-operative Group Limited

Dated: 30 October 2009

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STATEMENT OF EVIDENCE OF DR MICHAEL ROBERT SCARSBROOK

QUALIFICATIONS AND EXPERIENCE

1 My full name is Michael Robert Scarsbrook.

2 I have a BSc (1989) and a PhD in Zoology from Otago University, conferred in 1996. I have been a member of the New Zealand Freshwater Sciences Society since 1991.

3 I am employed by DairyNZ Ltd as Development Team Leader – Sustainability, and lead DairyNZ's Environment Programme. I have worked for DairyNZ for 15 months. Prior to this I worked for the National Institute of Water and Atmospheric Research (*NIWA*) for 13 years and 4 months. I was employed as a Freshwater Biologist and filled roles as Leader of the National Centre for Water Resources and Group Manager - Stream Ecology. I was heavily involved in State of the Environment monitoring and reporting, providing input to national and regional water quality assessments. One of my areas of expertise was the analysis of water quality trends. I have contributed to a number of regional (e.g. Southland, West Coast, Hawkes Bay and Auckland) and national State of the Environment reports. I was a major contributor to the recent ENZ07 report (Freshwater Chapter), as well as assisting the Ministry for the Environment (*MfE)* with OECD reporting on two occasions. I have also been involved in the development of a Water Quality database (WQIS), which provides a web-accessible storehouse for data from the National Rivers Water Quality Network and Regional Council datasets. I was the principal author of MfE's Best Practice Guidelines for the statistical analysis of freshwater quality data. I have authored more than 40 scientific papers and book chapters and produced more than 50 technical reports for commercial clients.

4 I have read the Environment Court's Code of Conduct for Expert Witnesses, and I agree to comply with it. My qualifications as an expert are set out above. I confirm that the issues addressed in this brief of evidence are within my area of expertise, except where I state I am relying on what I have been told by another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

5 I am familiar with the Proposed One Plan (*POP)* to which these proceedings relate. In 2004 I was involved in POP design through membership of a Water Quality Technical Advisory Group. As a designated Project Manager in NIWA I helped the Manawatu-

Wanganui Regional Council (*Horizons)* to set up Envirolink-funded projects using NIWA expertise and provided sign-off review for one of the NIWA reports[1] that formed the basis of standards setting within the POP.

SCOPE OF EVIDENCE

6 My evidence will deal with the following:

6.1 The definition of Water Management Zones (*WMZs*);

6.2 The setting of values and objectives for individual WMZs;

6.3 The process of setting of water quality standards in Schedule D to the POP and issues with "effects-based" standards versus reference-based standards;

6.4 A description of existing water quality state and trends in the Region, highlighting the disconnect between nutrient standards and actual nutrient levels in the Region's rivers;

6.5 The process of determining relative nutrient loads from point sources and non-point sources;

6.6 Comments on the uptake of Best Management Practices (*BMPs*) on-farm to drive reductions in nutrient losses; and

6.7 Design of the State of the Environment monitoring network for the region and opportunities for adaptive management.

SUMMARY OF EVIDENCE

7 I support the general approach taken by Horizons to setting up a water management framework in the POP. The process can be summarised in seven steps, which I have used to structure this evidence. In summary, those steps and my comments in relation to them are:

7.1 Step 1 – Define WMZs. Separation of a large and geographically diverse region into manageable sub-catchment units provides opportunities for focussed community-scale action. I support this approach, but the way it has been used to convey water quality information leads to exaggeration of regional water quality issues;

7.2 Step 2 – Identify community values. The POP process has identified a range of values that have been assigned to different WMZs. This step is fundamental to effective

[1] Wilcock et al. (2007)

resource management, but the trade-offs that need to be made when attempting to achieve differing, and at times conflicting environmental, social, economic and cultural objectives need to be recognised and explicitly dealt with. In my opinion, these trade-offs have not been properly addressed in the POP;

7.3 Step 3 – A sub-set of values have been assigned water quality standards. The standards have been set using a combination of existing scientific knowledge, expert panel assessments and modelling. The process has lead to a suite of nutrient standards that appear to me to be overly conservative and largely unachievable in the Region's rivers;

7.4 Step 4 – Assessment of the State of the Environment. Horizons' advisors have estimated the gap between the current state and desired state through comparisons between measured water quality indicators and the defined standards, rather than through comparison with reference (natural) conditions. Only 2 out of 77 monitored water management subzones currently comply with all recommended water quality standards. A number of the sites that fail to comply drain predominantly native forest catchments (i.e., reference sites), suggesting that the standards are more strict than the natural water quality of the Region and therefore, are unachievable as targets for managing human impacts on waterways. Regardless of how the current state of water quality is assessed, there are significant water quality issues in a number of WMZs and these issues need to be dealt with through focussed management action. An assessment of current state is also just a snapshot in time. Analysis of changes, or trends over time, are often more informative for resource managers. Analysis of recent trends in the Region's rivers indicates that despite land use intensification over the last ten years, water quality trends have stabilised or improved. Public perception of water quality in the Region is generally positive;

7.5 Step 5 – Identifying the causes of degraded values. Identifying what causes the gap between current and desired state (Step 4) is difficult, because waterway values are often influenced by multiple stressors that interact in complex ways. Horizons has taken a narrow view of the effects of land use on waterway values by focussing on Point Source and Non-Point Source nutrient loads, and largely ignoring the interacting effects of temperature, sediments and other physical habitat conditions on life supporting capacity;

7.6 Step 6 - Define controls on land use. Setting of limits on farm nutrient outputs is outside my area of expertise, so I have made only limited comments on this in my evidence. However, I understand this matter is discussed in the evidence of Sean Newland, Duncan Smeaton, Terry Parminter and Gerard Willis for Fonterra Co-operative Group Limited (*Fonterra*);

7.7 Step 7 – Monitoring and reporting. This involves design and implementation of a State of the Environment (*SoE*) monitoring programme that will allow Horizons to assess progress towards desired outcomes. Since 2008 Horizons has made significant changes in the design of its SoE network[2]. These changes were made to address identified gaps in the knowledge base as highlighted during investigations for the POP[3]. For example, Horizons lacked a rigorous periphyton monitoring programme prior to notification of POP. Consequently, there is limited data to determine background levels of periphyton in the Region's rivers, or allow validation of the model used to aid definition of nutrient standards that seek to control periphyton. Control of periphyton growth is at the heart of proposed controls on nitrogen outputs from intensive land use.

THE PROCESS OF DEVELOPING A WATER MANAGEMENT FRAMEWORK

8 The POP uses a sequence of steps to link desired outcomes in waterways to land use practices in the Region. I have summarised these as seven steps and use this as a framework for my evidence:

8.1 Define priority management zones;

8.2 Define the values that the community wants protected/enhanced in each zone;

8.3 Define water quality standards that protect/enhance the value (or set of values) within different waterbodies;

8.4 Estimate the gap between current water quality and the standards defined above;

8.5 Estimate the potential causes and relative contributions that different activities make to the gaps in water quality;

8.6 Define policies and objectives that will drive changes to reduce the gap; and

[2] The evidence of Mrs Kathryn Jane McArthur; Section 4.1, pg 37.

[3] Ausseil & Clark (2007) see Section 9.1.

8.7 Carry out State of the Environment monitoring to enable progress reporting against standards.

9 My evidence covers 6 of the 7 steps. Defining policy and objectives (Step 6) is outside my area of expertise as a Freshwater Scientist, but I do comment on the benefits that implementation of BMPs on-farm has for water quality.

STEP 1: WATER MANAGEMENT ZONES

10 Horizons has defined 43 WMZs and 124 sub-zones[4] to provide for integrated management of the Region's water resources at a manageable spatial scale[5]. The zones are catchment or part-catchment based and encompass the waterways within the zones, and the surrounding land area.

11 A range of criteria were applied to derive the WMZs[6]. These included National Water Conservation Orders, Local Water Conservation Notices, ecosystem types, geology, hydrology, resource pressures, location of monitoring sites and the length and availability of monitoring data (both flow and water quality).

12 I support this subdivision of the Region into smaller management units and also support the approach taken by Horizons in defining WMZs. The catchment is the basic unit for managing water resources, but large river catchments (e.g. Manawatu River) are characterised by high levels of spatial diversity in climatic, geological, and hydrological patterns. The River Environment Classification[7], which underpins the definition of the WMZs, is recognised as the best-available tool for managing water resources within this spatial diversity. In my opinion, the WMZs are appropriate and provide opportunities to focus action (e.g. mitigation or remediation) in priority areas, rather than having to attack a poorly-defined regional-scale issue.

13 However, I do not support the use of WMZs to describe regional water quality patterns as shown in Fig. 6.1 of Chapter 6 of the POP (version dated 31 August 2009). I have reproduced this figure in **Appendix 1** of my evidence. This approach is entirely inappropriate, because it requires extrapolation from a single monitoring station (which itself is only a limited sample of the actual conditions) to characterise the water quality for an entire sub-catchment. This will inevitably lead to exaggeration of water quality issues because water quality tends to decrease down a river.

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[4] Schedule Ba of the POP

[5] POP Section 6.4.1

[6] McArthur et al. (2007)

[7] Snelder et al. (2002)

Monitoring data from a single site on a river does provide information on what is happening upstream, but it cannot be used to describe water quality at all points upstream. When reported to the public (e.g. Horizon's 2005 SoE report) it may drive perception of widespread water quality problems, when the actual issue may be caused by a single point source discharge. I would recommend a more scientifically robust approach, involving interpolation between sampling sites to provide a picture of longitudinal variation in water quality (e.g., see Environment Waikato approach to reporting longitudinal patterns along Waikato River; www.ew.govt.nz/EnvironmentalInformation). This would highlight issues with particular river systems and remove the bias produced when characterising water quality in upstream parts of the catchment for which there is no data.

STEP 2: VALUES

14 I support the intent of the water values framework, which is to define, where possible, at the policy level, the values of each water body. I also support the aim of this approach, which is to avoid debates about these on a consent-by-consent basis. Defined values provide a valuable mechanism to co-ordinate management of water bodies.

15 I also support the underlying philosophy of the values framework[8] that:

15.1 The pool of values that have been identified to be associated with a given waterbody should constitute the management objective for this waterbody (ie. one value by itself should not become the overruling management objective for a waterbody);

15.2 Activities should be managed in a way that avoids, remedies or mitigates adverse effects on any of the waterbody's values; and

15.3 There may be cases where all waterbody values may not be able to be protected or reinstated fully, because of the social or economic cost incurred. In this case, the values framework can provide the basis for debate and decision making.

16 Assigning specific values is an appropriate way to manage waterways. Once community expectations for waterways are defined, then the appropriate water quality standards can be put in place to protect or enhance those values. It is important that in setting values the full costs/benefits of individual or suites of values

[8] Ausseil & Clark (2007a)

are recognised by communities. The inevitable trade-offs also need to be considered by the community. For example, by choosing a trout fishery as a key value, the community is accepting the impacts on indigenous biodiversity that may result[9].

17 The POP (Table 6.2) identifies a total of 21 different values, applying to all or parts of the Region's rivers and lakes and their margins. The values are classed into four groups:

17.1 Ecosystem Values - includes five individual values recognising the intrinsic value of freshwater and coastal ecosystems for the living communities and natural processes they sustain. The Life-supporting Capacity value is a key value used for setting water quality standards;

17.2 Recreational and Cultural Values - includes eight individual values, associated with the spiritual and cultural values and the recreational (i.e., non-consumptive or non-commercial) use of the waterbodies;

17.3 Water Use Values - refers to the value of abstracted surface water in supporting the regional communities (eg. community water supply) and economy (ie. irrigation). It includes four individual values; and

17.4 Social and Economic Values - includes four individual values identifying that rivers and their margins provide services and uses that support and protect the regional communities and assets. For example, rivers have a natural capacity to assimilate nutrients, sediments and organic matter. For this reason, rivers are often used as receiving environments for treated wastes from municipal, industrial and agricultural activities. Within the POP this value is termed the Capacity to Assimilate Pollution (*CAP*).

18 For each value a management objective has been defined (POP Table 6.2) and recommendations made on where in the Region the values should apply (POP Schedule Ba; Part Ba2.1).

19 It has been recognised[10],[11] that the potential for some of these values to conflict is reasonably high. For example, the "Water Use" values and "Social and Economic Values" are directly associated with activities that can threaten other values (e.g. Ecosystem Values). Indeed, many values are mutually exclusive (e.g. Natural State and Trout Fishery). For example, the "Capacity to Assimilate Pollution" value will often impact on various social and ecosystem values (e.g.,

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[9] McDowall (2006)

[10] Evidence of Dr Jonathon Roygard, section 3.4.1.

[11] Ausseil & Clark (2007a)

discharges of treated wastewater may render a waterway unsuitable for recreation until the point downstream where in-stream assimilation has reduced contaminant levels below recreation standards). The ability to manage trade-offs between conflicting values is at the heart of the Resource Management Act and its associated instruments.

20 I have been unable to identify how the process of balancing conflicting values is being managed within the POP. In one of the technical reports supporting the POP the following statement is made "*It is envisaged that with the notification of the One Plan in May 2007, refinement of the values set and where they apply will occur in partnership with stakeholders and community groups, and the final waterbody values that will be defined in the One Plan may differ sensibly from those presented in this report*"[12].

21 There have been a number of changes recommended in Officer Reports to the values and associated objectives (Table 6.2 of POP). One of these changes alters the management objective defined for the CAP value to "*The capacity of a water body to assimilate pollution without compromising the ecosystem, recreational, cultural and water use values*". This implies that a trade-off decision has already been made across the entire Region (i.e. the CAP value will not compromise other values). To set this as a management objective essentially removes the CAP value from the list of community-identified values. This decision will have major implications for any consent applications to discharge to water. I have not been able to identify the process of consultation that has led to this.

22 Within the current POP values framework it is not clear how, or when, stakeholders have the opportunity to discuss the inevitable trade-offs between conflicting values. Contrary to the underlying philosophy (see Section 15 above), the POP has taken a sub-set of defined values, assigned numeric water quality standards to protect those values, and identified methods to control land use with the aim of meeting water quality standards. There has been no discussion of whether the numeric water quality standards (set for a sub-set of community values) are appropriate for application to waterways managed for the full set of defined values.

STEP 3: WATER QUALITY STANDARDS

23 Numeric water quality standards provide a useful baseline for measuring progress towards defined management objectives, and an objective basis for identifying sites that comply or do not comply with water quality requirements. As such, they provide greater certainty than qualitative or narrative standards. Numeric standards

[12] Ausseil & Clark (2007a) pg. 13.

can be defined based on effects-based criteria (i.e., standards are set at a level known to reduce risks of significant adverse effects on values) or reference conditions (i.e., levels are set to reflect the natural conditions). Effects-based standards should generally be more permissive than those based on natural state conditions, since effects-based standards would allow for change in natural conditions so long as the magnitude of change does not exceed thresholds for significant adverse effects. I have significant concerns with the numeric water quality standards proposed in the POP because some defined standards appear to be more stringent than even a reference condition approach might allow. I also consider that the development of nutrient standards has been severely impaired by the use of a model that may be inappropriate for many of the Region's rivers.

24 Horizons has developed water quality standards to provide for values assigned to individual WMZs. Numerical standards were developed for seven of the 21 proposed water body values. These were: Life-Supporting Capacity, Contact Recreation, Aesthetic, Trout Fishery, Trout Spawning, Shellfish Gathering and Livestock Drinking Water. The Life Supporting Capacity Value is seen as requiring the most stringent standards, and has been used in the POP as a de facto value on which to base water quality standards for the protection of aquatic ecosystems[13].

25 The POP water quality standards (Schedule D) cover an appropriate range of water quality parameters and can be summarised into four groups:

25.1 Physicochemical parameters to ensure conditions are adequate for aquatic life and water users. These include: pH, dissolved oxygen, temperature, water clarity, biochemical oxygen demand (*BOD*), particulate organic matter (*POM*), and toxicants (ammoniacal nitrogen);

25.2 Recreational use parameters relating to the recreational use of the water bodies and the protection of public health. These include indicators of faecal contamination, water clarity, and periphyton biomass and cover;

25.3 Biological parameters directly linked with the integrity of aquatic ecosystems. These include biomonitoring indicators such as the Macroinvertebrate Community Index (*MCI*) and periphyton biomass and cover;

25.4 Nutrient parameters (soluble inorganic nitrogen and dissolved reactive phosphorus) to control periphyton growth.

[13] Evidence of Mrs Kathryn McArthur, section 5.2.

26 Controlling periphyton growth through improved nutrient management is the aim of the nutrient standards in the POP. Horizons has invested heavily in development of these water quality standards.

27 The standards that most directly affect dairying in the Region are those in relation to controlling periphyton growth. Horizons asked a panel of expert scientists the question "what are the appropriate mechanisms to control periphyton growth?" The following general comments[14] were made:

27.1 Both nitrogen (*N*) and phosphorus (*P*) need to be managed, because of the interconnectivity of water bodies (where different nutrients might be limiting in the same stream network);

27.2 A high background concentration of a 'non-limiting' nutrient can contribute to periphyton blooms if control of the 'limiting' nutrient fails;

27.3 Year-round control of N and P is needed because periphyton growth and vigour are determined by the preceding nutrient conditions and the upstream presence of residual colony-forming periphyton material;

27.4 Not all rivers and streams will require nutrient management to reduce periphyton proliferation (eg. rivers with soft substrates). However, contaminant management is still required in most soft-bottomed river systems, to reduce nutrient pools within sediments and provide for downstream reaches with hard substrates or estuarine/coastal waters; and

27.5 Controls on nutrient levels in water bodies should apply at all flows, with the exception of flood flows where these are defined as flows greater than the flow that is three times the median flow.

28 These comments are based on sound science, but reflect broad generalisations around the control of periphyton growth and are designed to provide conservative statements that might apply throughout NZ. The comments contradict more pragmatic advice within the MfE Periphyton Guidelines (2000). For example, Wilcock et al (2007) recommend that both N and P need to be managed, which is true and appropriate when information on the limiting nutrient is unavailable. However, on page 12 of the Guidelines it states "*In using the soluble inorganic nutrient guidelines for developing consent conditions* [As is the case with Rule 13.1 of the POP]*, it is important to recognise that the specific nutrient limiting*

[14] Wilcock et al (2007)

periphyton growth needs to be identified and consent conditions set in terms of that single nutrient. It is usually unnecessary to specify conditions in terms of both nitrogen and phosphorus."

29 The Periphyton Guidelines highlight[15] the need to manage public expectations around the control of periphyton. It is important that public expectations of what is achievable are realistic. The example given in the Guidelines is where people might want to have a stream managed for recreational fishing, and for this to happen, it might be necessary to eliminate blooms of filamentous algae during summer. However, if the catchment includes a significant proportion of Tertiary marine siltstones which are rich in nutrients, then filamentous periphyton growths are a natural product of the catchment conditions and effective control is not likely to be achievable. Within the Manawatu-Wanganui Region a large proportion (52%) of stream reaches drain areas of soft sedimentary rock types, including Tertiary siltstones[16]. Therefore, because of these natural sources of nutrients (particularly phosphorus) there are likely to be stream reaches within the Region where controlling periphyton growth through on-farm nutrient management will be ineffective. Unfortunately, there is little reliable, quantitative periphyton data to determine the background state of the Region's rivers. However, Horizons has implemented an extensive periphyton monitoring programme as part of its revised SoE monitoring network[17]. This network will, over the next few years, provide the information necessary to identify realistic expectations with respect to periphyton growth in rivers and options for managing those areas where the biomass is unacceptably high owing to human influences. In the meantime Horizons has relied on expert opinion and a regression model to identify nutrient standards for the control of periphyton.

30 I consider that the nutrient standards in the POP that apply to some rivers in the Region are overly-conservative. The primary driver for the nutrient standards was life supporting capacity[18]: "*integration of several Ecosystem values under one set of water quality standards means that the Life-Supporting Capacity standards were key to the protection of native aquatic ecosystems for each individual sub-zone*". However, the Periphyton Guidelines[19] caution against this: "*The nutrient guidelines for the maintenance of benthic biodiversity are very restrictive. …. The nutrient guidelines are there to assist in achieving an instream management objective. It is important not to get bound up in minor breaches of the*

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[15] Biggs (2000), pg. 19.

[16] Ausseil & Clark (2007b)

[17] Kilroy et al (2008)

[18] McArthur (pg. 78. 218)

[19] Biggs (2000) pg. 104

recommended nutrient levels, but to focus on whether the instream management objective is being achieved (ie, focus on outcomes rather than inputs as measures of success)." The outcome being sought by Horizons is the protection of native aquatic ecosystems in different sub-zones. At, present there is limited information to link periphyton biomass to ecosystem health in the Region. Therefore, breaches of nutrient standards may, or may not relate to the outcome being sought.

31 The report by Wilcock et al (2007) concludes that *"Year-round control of N and P is needed because periphyton growth and vigour are determined by the preceding nutrient conditions and the upstream presence of residual colony-forming periphyton material"*. This is contrary to the Periphyton Guidelines[20] which suggest periphyton control for aesthetics/recreation should only be applied over the summer months (1 Nov – 30 April). Horizons does not currently have information on seasonal patterns in periphyton biomass across the Region's rivers. In the absence of this information the conservative approach would be to require N and P control year-round. When seasonal periphyton patterns have been established it may be possible to target nutrient control to specific times of the year. The importance of understanding the seasonality of periphyton growth is highlighted by Dr Biggs in his evidence[21]: "*The timing of proliferations is less likely to be influenced by nutrient regimes than by the seasonal characteristics of the flow regimes.*"

32 Horizons carried out an assessment of nutrient data in the Upper Manawatu River to assess the potential limiting nutrient in rivers[22]. The approach used to determine potential N vs. P limitation is flawed, because it makes the assumption that "*the proposed One Plan nutrient standards will adequately limit the growth of periphyton in rivers…*" The approach also ignores conventional approaches to assessing nutrient limitation using available monitoring data[23]. Using the same NIWA data as Roygard & McArthur (2008) from seven river sites in the region for the period covering 1989-2008, I calculated mean monthly SIN:DRP ratios (i.e., soluble inorganic nitrogen: dissolved reactive phosphorus). Across the seven sites, the average annual SIN:DRP ratio varied from 20 to 80. There was also significant variation between months (average of the seven sites), with the ratio varying from 19 (February) to 71 (September). Based on the criteria used by McDowell et al. (2009) to assess potential nutrient limitation in New Zealand rivers (i.e. SIN:DRP > 15 implies P-limitation), all seven

[20] Biggs (2000)

[21] pg 18; point 47

[22] Roygard & McArthur (2008) – Section 3.4.1

[23] McDowell et al. (2009)

river sites could be considered, on average, to be primarily P-limited in all months of the year. The approach taken by Roygard & McArthur (2008) tends to over-estimate the importance of nitrogen versus phosphorus in limiting periphyton growth.

33 Horizons has provided no direct evidence of the relationship between nutrient concentrations and periphyton biomass. In order to link observed and predicted nutrient concentrations to periphyton biomass, Horizons has relied on a regression model[24].

34 Table 11 in the section 42A Report of Mrs McArthur for Horizons proposes a number of changes to the POP Schedule D Water Quality Standards for river and streams. Key changes relate to the observed exceedence of nutrient standards in some streams draining native forest. The change recommended is that the following be added to the existing numeric standards for both soluble inorganic nitrogen (*SIN*) and dissolved reactive phosphorus (*DRP*) "*or naturally occurring concentration in streams flowing from forested headwaters, whichever is the greater*". I agree with these changes because they remove inappropriate "effects-based" standards and replace them with more appropriate "reference-based" standards. The changes were based on expert opinion. The expert evidence of Dr Biggs states:[25] "*A small number of streams flowing from forested headwater catchments exceed the nutrient concentrations standards in the POP.*[26] *To allow for these circumstances, I recommend a proviso be added to the nutrient standards that sets the standard as either: 1) the numerical value for the water management sub-zone as set out in table D.17, or 2) the naturally occurring nutrient concentration in streams flowing from forested headwaters, whichever is the greater of the two. This will ensure that streams with naturally elevated nutrient concentrations, with no potential for land use related enrichment, are not considered to be 'noncomplying' with the standards in the POP.*" Insertion of this proviso immediately varies the standards from being effects-based to reference-based. The presence of naturally elevated nutrient levels in a number of catchments suggests that the effects-based approach is indicative rather than actual. It further suggests that the effect-based standards are not transferable within the Region. Further, where headwater streams breach the nutrient standards due to underlying geology, then all downstream sites should also be given the same considerations. That is, if a forested headwater stream had DRP levels of 17 mg/m^3 it is inappropriate to make all downstream sites meet the DRP standards of 10 or 15 mg/m^3.

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[24] Biggs (2000)

[25] Page 17, point 45

[26] *Ausseil and Clark, (2007b) Table 27*

35 As highlighted by Dr Biggs in his evidence[27] the modelling approach used to define nutrient standards for each water management sub-zone has a number of limitations: *"First, some areas of the Region have hydrological conditions that do not fit the calibration dataset for the model (in particular, the Central Plateau). Second, the current model does not account for effects of invertebrate herbivores or abrasion by suspended sediment on periphyton biomass. Third,* ***the periphyton biomass data currently held by Horizons is insufficient for testing the calibration of the model for the Region****. My professional opinion was used to fill some gaps associated with these limitations."*

36 The Ausseil & Clark (2007b) report states: "*Whilst a useful tool, the New Zealand Periphyton Guidelines' model was found to generally be very environmentally conservative. The model also does not work on all river types. It is suggested a risk-based model linking the likely occurrence and duration of high periphyton biomass event to nutrient concentration in the water would be a very useful tool.*" This will require detailed information on nutrient and periphyton conditions across the Region's rivers. This information is not currently available, but will be provided over time via the enhanced monitoring network that Horizons now has in place. This information will provide far greater certainty in determining linkages between nutrient loads, periphyton growth patterns, and the desired outcome (i.e.Life-supporting Capacity). Without this information, it is my opinion that the imperative for strict, regulatory controls on nitrogen leaching losses from intensive land use is weak.

37 Dr Biggs states in his Section 42A Report[28] : "*The cumulative effects of uncertainty in the POP water quality approach raise the risk that compliance with nutrient loading limits and numerical standards will not achieve the management objectives. … we need to use the best science to inform decisions, but allow for subsequent 'finetuning' if all issues and responses haven't been adequately allowed for in the predictions or assessments. Indeed, it is important that there is opportunity for adaptive management (ie. use results from and feedback about water quality management under the POP to adjust one or more components of the Plan).*" I share the concern of Dr Biggs with regards to compounding uncertainties and agree that an adaptive management approach based on focussed action in priority WMZs is entirely appropriate. However, I understand that fine-tuning the POP will not be a simple process, but will instead require a plan change if Rule 13.1 becomes operative in its current state. I also understand that the cumulative effects of uncertainty in the POP water quality approach have not been recognised in the POP itself. Rather, the POP contains absolute nitrogen output limits, which could have economic

[27] Biggs pg 21, point 52

[28] pg. 5, point 14

consequences for those land managers who need to meet them, and criminal consequences for those who fail to meet them. It appears to me that the POP rules are not supported by Horizons' scientific advisors.

STEP 4A: WATER QUALITY STATE

38 Based on my knowledge of the Region's rivers and knowledge gained from Council reports[29] I suggest the there are four main issues that constrain values across the Region's waterways:

38.1 Levels of sediment, both suspended (affecting recreation, aesthetic and ecosystem values) and deposited (affecting ecosystem values);

38.2 Physicochemical characteristics that can compromise the life supporting capacity of waterways (e.g. high temperatures, low dissolved oxygen, low/high pH, ammonia);

38.3 Bacterial and/or faecal contamination, which can compromise the water's recreational quality, or suitability for human and/or stock drinking water; and

38.4 Nutrient enrichment, which can cause excessive growth of periphyton and aquatic plants and can compromise recreational, water use and ecosystem values.

39 Table 27 in Ausseil & Clark (2007) provides a valuable summary of water quality state in the Region. The table provides information on 11 key water quality indicators at sites representing up to 77 water management subzones. Where data is available, comparisons are made between recommended water quality standards and measured values at a site. A site fails when measured values do not meet the standard. Of the seventy-seven subzones represented in Table 27 only 2 meet all measured standards. The Upper Mangatainoka complies with all 9 indicators measured at the site. The Upper Whakapapa complies with both clarity and annual periphyton biomass indicators (although only on 2/3 sampling occasions). Three other sites (Upper Mangahao, Upper Mangawhero and Upper Ohau) are close to complying with all indicators. For example, Upper Mangahao almost meets the pH standard and just meets the Temperature and Clarity standards. The Upper Mangawhero has monthly mean DRP concentrations more than double the appropriate standard (15 vs 6 mg/m^3), but it is given a pass because it is a Natural State waterway. Nine of the 26 sites considered to comply with the DRP standard (6 mg/m^3) actually have monthly mean concentrations greater than the recommended

[29] Ausseil & Clark (2007b)

standard. They are given a pass because the elevated DRP levels reflect natural conditions (ie, they are reference sites).

40 Changes to the proposed DRP standard (see paragraph 34 above) to account for the exceedance of the standards at reference sites effectively shift the DRP from a numeric standard to a reference-based standard, but it only applies to reference sites. This creates some inequities. For example, mean monthly DRP concentrations at the Upper Mangawhero site are 15 mg/m^3, while the average concentration at the Lower Mangawhero site is 17 mg/m^3. Both sites exceed the recommended standard, but the Upper Mangawhero is deemed to pass due to it being a natural site, whereas the Lower Mangawhero is deemed to fail because it does not meet the numeric standard. Appropriate reference condition standards should be applied to all WMZ sub-zones.

41 Across the eleven indicators for which there is sufficient data there are variable levels of compliance with standards (**see Fig. 1 below**). Levels of compliance (based on measured concentrations) are greatest for the Ammonia standard (compliance at 68 of 70 sites) and lowest for SIN (15 of 70 sites compliant), clarity (18 of 70), and DRP (25 of 68).

42 I consider that the low levels of compliance across the monitored sub-zones, particularly for water clarity and nutrient concentrations indicates that the proposed "effects-based" standards in the POP are too stringent and do not reflect the natural reference conditions found throughout the Region. How can a Region with 30% of the land area in native forest have only 3% of management subzones complying with "effects-based" standards? How can predominantly natural reference sites[30], such as the Upper Tamaki and Middle Rangitikei, fail to comply with "effects-based" standards designed to protect specific values?

[30] Defined in Table 1, Appendix 1 of Ausseil & Clark (2007)

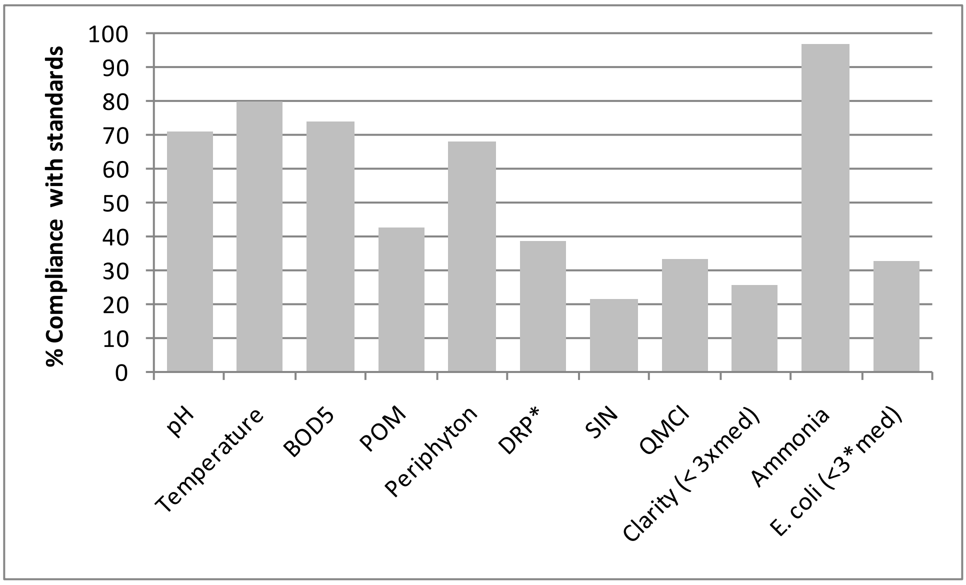

Figure 1. Percentage of monitored management subzones complying with recommended water quality standards for eleven indicators. Data taken from Table 27 in Ausseil & Clark (2007b).

43 I consider that the picture of water quality state provided by Ausseil & Clark (2007b) significantly overestimates water quality problems at the regional scale. Nonetheless, there are significant water quality issues within the Region and these issues will have direct impacts on waterway values. In **Appendix 2**, I have presented data for DRP and SIN across 69 sites. Overlain on the figures are the most permissive standards allowed under the Proposed One Plan (i.e. DRP = 15 mg/m^3; SIN = 444 mg/m^3). 32 sites (46%) exceed the most permissive DRP standard and 21 sites (30%) exceed the most permissive SIN standard. It is also clear from this analysis that there are some key sites within the Region where nutrient enrichment should be of particular concern. For example, five sites have mean monthly DRP concentrations greater than 100 mg/m^3 (i.e. 10x the mid-range nutrient standard of 10 mg/m^3). Five sites also have mean monthly SIN concentrations of greater than 1000 mg/m^3. These sites should be the immediate focus of Regional Council and wider community action.

44 The Ministry for the Environment has recently released water quality league tables for the country[31]. The data for these tables comes from NIWA's National River Water Quality Network (*NRWQN*). Seven of the 77 sites in the NRWQN are located in the Manawatu-Wanganui Region. League tables have been developed for three suites of indicators (Nutrients, Water Quality for Recreational use, and Biological Indicators). Comparison of Manawatu-Wanganui

[31] http://www.mfe.govt.nz/environmental-reporting/freshwater/river/league-table/river-water-quality-league-tables.html

rivers with other New Zealand rivers provides a means of determining where the key issues for the region might lie:

44.1 In relation to levels of nutrients, one site (Manawatu River @ Opiki Bridge) ranks in the worst 10 sites in the country (rank = 72). Overall, the seven sites have an average rank of 48 out of 77;

44.2 In contrast, five of the seven sites rank in the worst 10 sites for recreational water quality (based on clarity and levels of faecal microbes). The average rank across the seven sites is 62 out of 76.

This information suggests that sediment and faecal contaminants in the Region's rivers should be of principal concern to both the Regional Council and Ministry for the Environment.

45 Many of the Region's rivers have issues with elevated levels of nutrients, sediments, faecal contaminants and a range of other stressors. However, the link between community values and water quality state has not been quantified by Horizons. Indeed, in the last public survey it carried out in June 2009 there was a clear signal that the majority of people in the Region considered water quality to be OK or good. 63% of respondents (excluding "don't knows") scored water quality as 6 or higher (**Fig. 2**).

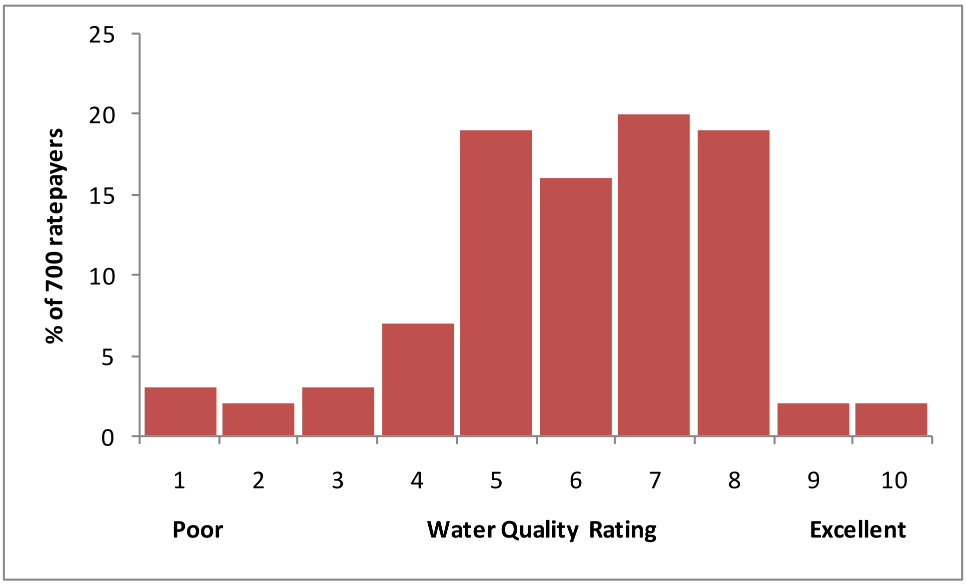

Figure 2. Water quality rating provided by respondents to a phone survey of over 700 Manawatu-Wanganui region residents (survey conducted between Nov 2008 and June 2009). Respondents were asked to rate water quality in the region on a 1-10 scale (i.e., from 1 = poor, to 10 = excellent).

STEP 4B: WATER QUALITY TRENDS

46 Helen Marr's Section 42A Report provides summary answers to a series of questions posed by the Water Hearing Chair in Minute #6 regarding the rule regime for non point source pollution. One of the questions is relevant to information on trends in water quality over time - **Question 5.2. Has that situation changed since the POP was notified?** The "situation" referred to is elevated nutrient levels in rivers. In my opinion, supported by analyses carried out by myself and NIWA water quality scientists, there has been a change in the situation since the POP was notified. The lack of deteriorating trends in key water quality parameters, and the presence of a number of improving trends (see below) suggests that the environmental imperative to control non-point source pollution in the Region has lessened since the POP was first notified. Therefore, the assertion made by Helen Marr that "*most recent monitoring continues to show a trend in elevated nutrient levels from non-point sources*"[32]is not supported by the available scientific evidence..

47 Across the Region, and throughout New Zealand, some significant gains have been made over the last 20 years in addressing a number of issues in relation to water quality. For example, large amounts of organic pollution have been removed from water bodies through addressing point source discharges from industry and municipal wastes. The state of water quality in relation to a range of indicators of point source pollution has improved in many locations, due to this work.

48 For the purposes of this evidence I carried out trend analyses for the period 1999-2008 (i.e. a 10-year dataset) on data from 7 river sites in the Region. These sites are part of NIWA's National River Water Quality Network and are the same sites described in the expert evidence of Dr Robert Davies Colley. Results of my analyses are given in **Table 1**. There were no significant deteriorating trends for the period 1999-2008. There were significant improving trends for Turbidity, DRP, TP, NO_x-N (nitrate/nitrite nitrogen), NH_4-N (ammoniacal nitrogen) and TN (total nitrogen).

[32] Section 2.1.3, pg. 7.

Table 1. Trends at seven National Rivers Water Quality Network sites in the Manawatu-Wanganui Region over the last 10 years (1999-2008). The arrows show the direction of change in each parameter (median sen slope for flow-adjusted data), with statistically significant trends (P<0.05; Seasonal Kendall Trend test on flow-adjusted data) shown as arrows. Green arrows indicate improving trends. 'NS' = not statistically significant. Trend analysis carried out in TimeTrends 2.0 (www.niwa.co.nz).

Site	Turbidity (NTU)	Clarity (m)*	DRP (mg/m^3 P)	TP (mg/m^3 P)	NO_x-N (mg/m^3 N)	NH_4-N (mg/m^3 N)	TN (mg/m^3 N)
Whanganui @ Te Maire	↓	NS	↓	NS	NS	NS	NS
Whanganui @ Paetawa	↓	NS	NS	NS	NS	NS	NS
Rangitikei @ Mangaweka	NS	NS	↓	NS	NS	↓	NS
Rangitikei @ Kakariki	NS	NS	↓	NS	NS	↓	NS
Manawatu @ Weber Rd	NS	NS	↓	↓	NS	NS	NS
Manawatu @ Teachers College	NS	NS	↓	NS	↓	↓	↓
Manawatu @ Opiki	NS	NS	↓	NS	↓	NS	↓

49 The choice of time period over which to analyse water quality trends can be somewhat arbitrary, but it can have a large effect on the outcome of analyses. For example, trend analysis may cover the full period of sampling records[33]. An alternative approach, and that recommended in MfE's Best Practice Guidelines for Analysis of Water Quality Data[34], is to visualise the data to determine what long-term patterns might be present. **Figure 3** shows data from 1989-2008

[33] e.g. Scarsbrook 2006

[34] Scarsbrook & McBride 2007

for DRP in the Manawatu River at Teacher's College. A LOWESS line (smoother) has been added to highlight longer-term changes that underlie the natural seasonal variability. The pattern appears to be of a steady increasing trend through the nineties followed by a steady decreasing trend in the new century. I have chosen the period 1999-2008 to provide a 10-year window that incorporates the peak and decreasing trend in DRP over time.

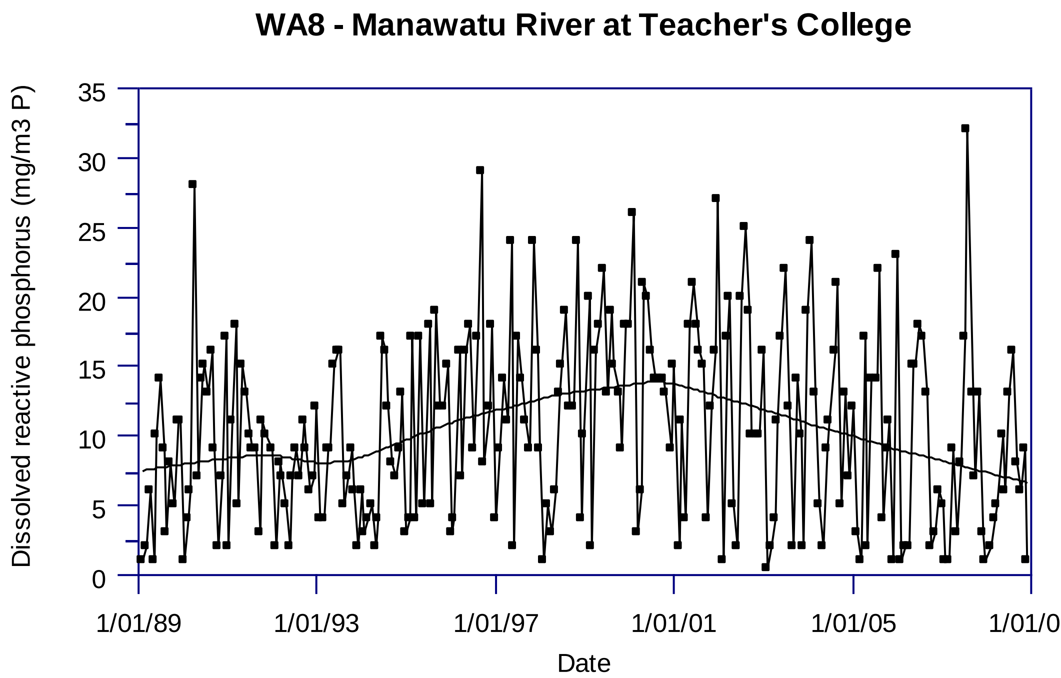

Figure 3. Time series (1989-2008) of DRP concentrations in the Manawatu River at Teachers College (Palmerston North). Data are monthly samples. A LOWESS smoother (30% span) is overlain on the data to highlight long-term patterns. "WA8" is the site identifier used in NIWA's National River Water Quality Network (NRWQN).

50 Horizons has commissioned several studies on water quality trends in the Region. The latest study by Ballantine & Davies-Colley (2009) identified that "*the longer term (19-yr) trend of worsening water quality in the Manawatu has been slowing or even reversing … (i.e., water quality has been improving).*"[35]

51 The Section 42A Report/evidence of Mrs McArthur[36] states that "*Long-term trend analysis of the seven national network sites in the*

[35] Quoted in Dr Roygard's evidence (Box 30; pg. 105)

[36] Pg. 60; point 151

Horizons' Region (1989–2007) showed increasing trends in total oxidised nitrogen (N0x-N) at a number of sites, particularly in the Manawatu catchment, and increasing dissolved reactive phosphorus for the Manawatu at Weber Road (NIWA site WA7). However the shorter term analysis of 2001–2008 data showed decreasing trends at some sites for N0x-N, E.coli and turbidity parameters, suggesting some water quality improvement in recent years. "

52 My own analyses over a 10-year period supports this statement, suggesting that there are indications of improving water quality in some of the Region's major rivers. The cause of these changes is difficult to determine, but river water quality trends can often be associated with changing land use practices or climatic variability.

53 There has been a dramatic reduction in the number of point source discharges of animal waste to the Region's rivers. Between 1997 and 2009 the number of discharges to water decreased from 439 to 16[37]. During the same period, discharges to land increased by 193 consents. The observed water quality improvements would be consistent with expected water quality improvements following such changes. Over a similar time period (1998-2007) dairy cow numbers in the Region increased by around 16%[38], suggesting some land use intensification, but without declining water quality trends.

54 From the above analysis I conclude that water quality is either stable or has been improving over the past decade. This suggests that the imperative for region-wide controls on diffuse nutrient inputs to streams has reduced, and management should focus initially on those areas where values are most compromised, or focus on other issues of concern (e.g. sediment and faecal contamination of waterways)

STEP 5: RELATIVE CONTRIBUTIONS OF CONTAMINANTS FROM POINT SOURCES AND NON-POINT SOURCES

55 Where water quality is not meeting a specified standard, it is important to identify the relative sources that contribute to the problem.

56 Within the Region, 1,377 discharges to land consents and 340 discharge to water consents were identified by Horizons in analysis from information collated in January 2009[39]. Dairy farming made up the majority of the 1,377 discharges to land (ie. 68% of consents). Of the 340 consented discharges to water, the majority of them are stormwater (30%) and temporary discharges, mostly in relation to construction (18%)[38]. The other major categories in terms of

[37] Box 25, pg. 93; Dr Jon Roygard evidence

[38] Expert evidence of Mr Matthew Newman

[39] Section 42a evidence of Dr Jonathon Roygard (section 6.4)

number of consents are other industry (14%), community effluent discharges (11%) and hydroelectricity (10%)[38].

57 There has been a significant reduction in the number of farm dairy effluent (*FDE*) discharges to water[38]. Numbers from January 2009[40] show 15 consents for discharges of FDE were to water and 942 were to land.

58 Region-scale analysis by Horizons[40] has shown land use is predominately sheep and/or beef farming (51%) followed by native cover (31%) and exotic cover eg. forestry (7.5%). Dairy farming is the fourth biggest land use type by area at 6.7% (Note that this value differs from that presented by Mr Matthew Newman in his expert evidence for Fonterra. He estimates that dairying covers 4.8% of the region[41]). 78% of the Region's dairy farming is on Class I to IV land and 22% is on areas greater than Class IV (**Fig. 4**).

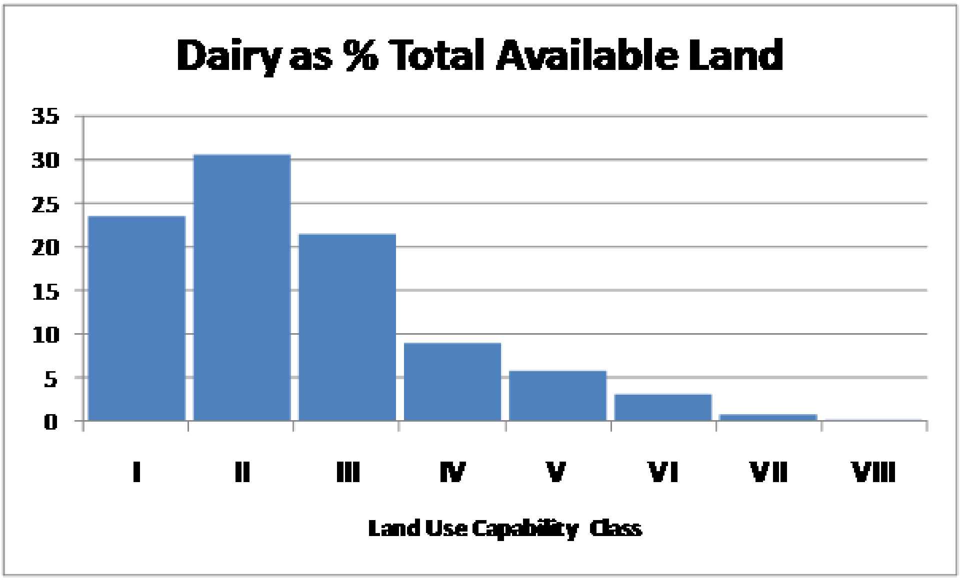

Figure 4. Distribution of dairying by Land use Capability Class. Data reproduced from Table 8 in the Section 42a report of Dr Jonathon Roygard.

59 Horizons is concerned that dairying could more than double in the region[42]. I understand that the evidence of Matthew Newman for Fonterra that dairy cow numbers in the Region are more likely to increase by 20% in the period 2007-08 to 2030-31, with land used for dairying increasing at a lower rate. .

[40] Table 8 in Section 42a evidence of Dr Jonathon Roygard (pg. 98)

[41] Paragraph 27

[42] Section 42A report of Mr Greg Carlyon (Case Study – the dairy sector; pg. 20)

60 Estimation of the relative contribution of point sources and non-point sources to nutrient loads in waterways can be extremely difficult. Calculations by Horizons of point source inputs rely on available information for point sources in the catchment. It assumes that Horizons knows of all significant (individual or cumulative) point sources inputs and has reliable information on discharge characteristics for these sources across a range of flow conditions. One major potential source of uncertainty is around the number of on-site wastewater systems spread throughout the Region. As highlighted by Dr Jonathon Roygard in his Section 42A evidence "*The numbers of consents for this activity represent the fraction of these systems that have applied for consent*". It is unknown what contribution these systems make to nutrient loads. This is a significant gap in understanding of sources contributing to nutrient loads in the Region's rivers.

61 Having calculated the relative contributions from the point sources, Horizons has estimated contribution of non-point sources by removing the point source estimates from the total measured loads. In my opinion, this is likely to overestimate the contribution of non-point source loads and underestimate point source contributions. What is also missing from the analysis is consideration of the natural background loads within the river systems. For example, what would the natural, background nitrogen losses be from the lands now being used for intensive agriculture?

62 I have significant concerns over the method used by Horizons to calculate nutrient loads in the Manawatu River. The methodology used to calculate the river nutrient loads is not a method recognised by experts. The method (flow-stratified approach[43]) was developed specifically for the POP and produces significantly different estimates to those produced using standard techniques (i.e. averaging approach)[44]. The method has not been subjected to independent peer-review through publication in scientific literature.

63 In his evidence[45], Dr Barry Biggs summarises work to model the maximum monthly periphyton biomass under several nutrient loading scenarios (including POP Table 13.2 related loads) in the Manawatu and Mangatainoka catchments. The model uses measured SIN and DRP concentrations to predict periphyton biomass. It also uses the model to predict periphyton biomass based on reduced nutrient levels, which in turn are based on estimated nutrient loads based on nutrient standards. All of these steps introduce uncertainty into the model predictions. In my opinion, this uncertainty requires caution to be exercised when interpreting the numbers. In his summary of evidence, Dr Biggs

[43] Roygard & McArthur (2008)

[44] Section 42A report of Dr Jonathon Roygard Appendix 2, Table 14.

[45] Expert witness evidence of Dr Barry Biggs, pgs 26-27.

concludes "*The model predictions indicate that a shift in SIN and DRP from current state to the Standard load limits* ***would*** *be accompanied by 30 to 75% reductions in maximum monthly periphyton biomass*". In my opinion this statement fails to acknowledge the uncertainty inherent in these model predictions and may lead to unrealistic expectations about the benefits that might accrue from improved nutrient management.

STEP 6: ASSIGNING N-LOSS VALUES TO LAND

64 The POP proposes that intensive land uses (eg. dairying, cropping, and irrigated sheep/beef units) in particular WMZs, will require resource consents to continue to operate and discharge contaminants into the environment. The POP intensive land use resource consent seeks to control outputs (i.e. nutrient loss from a farm).

65 Reducing the losses of nutrients and other contaminants (e.g. sediment) from farms is a key element of the Strategy for New Zealand Dairy Farming[46]. I am aware of a range of methods which have been employed by farmers, communities, the dairy industry, and councils, to control N-loss and protect water quality. I am not aware of any empirical evidence that has linked measured farm-scale reductions of soil profile N-leaching loss to measured water quality benefits at the catchment scale, although a range of models are available to address different components of this question (e.g. OVERSEER, CLUES). In contrast, there is direct evidence that fencing and planting of riparian zones has catchment-scale benefits for water quality in New Zealand streams[47].

66 Fencing and planting of riparian zones is a key component of the Dairying & Clean Streams Accord. Most recently, the benefits of improvements in riparian management have been highlighted for a small South Taranaki stream – part of the Best Practice Dairy Catchments programme[48]. The Waiokura Stream improvements in stream water quality (i.e., significant reductions in concentrations of phosphorus, sediment and faecal bacteria) were attributed to adoption of on-farm Best Management Practices, including fewer Farm Dairy Effluent discharges and riparian management involving permanent livestock exclusion from stream banks and riparian planting to mitigate runoff from pasture.

67 I am concerned that the focus placed by the POP on N-leaching (i.e. Table 13.2) from intensive land uses will drive action to reduce only N-leaching losses as modelled through OVERSEER. This may be to the detriment of other actions that have the potential to give far

[46] www.dairynz.co.nz

[47] Parkyn et al. (2003)

[48] Wilcock et al. 2009

greater ecological benefits for waterways, (e.g. riparian fencing and planting). A focus on reducing N-outputs from farms will require significant investment of time and resources by farmers, with the potential to distract farmers from focussing on other critical mitigation measures, such as faecal, sediment and P control. The control of P may actually be more critical to gaining water quality improvements than N-control in many Manawatu-Wanganui rivers (see para. 32 above).

68 A key management outcome being sought through the POP is "The waterbody supports healthy aquatic life/ecosystems" (POP Table 6.2 Life Supporting Capacity Management Objective). While periphyton is a vital component of healthy aquatic ecosystems, excessive growth of periphyton can alter the conditions within a waterway, making it temporarily unsuitable for some other aquatic life. A number of factors interact to produce levels of periphyton biomass that can adversely affect other species. These potential limiting factors include light, temperature, grazing pressure, nutrient concentrations and, most importantly, flow conditions. All else being equal, it should be possible to control periphyton biomass by reducing the availability of nitrogen and phosphorus, but only if the reductions exceed the levels at which nutrient availability limits growth. Often either N or P is the primary limited nutrient. For example, a recent analysis of over 1000 monitored river sites around New Zealand indicated that P was likely to be the primary limiting nutrient at 75% of sites[49]. The study also concluded that focussing mitigation on P losses rather than N losses might result in more rapid reductions in periphyton growth. As highlighted by the Waiokura study[41], riparian management is an effective means of reducing sediment and P losses to waterways.

69 I understand that the evidence of Sean Newland, Terry Parminter, Duncan Smeaton and Gerard Willis discuss other concerns with the POP approach, and suggest alternatives. I support the suggestions in that evidence that:

69.1 Land users be given more time to achieve the Year 20 values in Table 13.2. There is no regional-scale water quality imperative to immediately achieve the values in the POP;

69.2 Intensive land uses which meet the Table 13.2 values should not have to go through expensive or complicated consenting processes. I cannot see how any such processes will improve water quality in the Region;

69.3 The Table 13.2 values should recognise the uncertainty involved in their formulation, and that:

[49] McDowell et al. (2009)

(a) Land owners which cannot meet them will have to undergo more onerous consenting requirements; and

(b) Land owners who fail to meet the values will be vulnerable to prosecution.

I do not consider that formulation of the Table 13.2 values has been sufficiently robust to justify these consequences. In addition, Horizons is likely to gain a far greater understanding of nutrient-periphyton-ecosystem value relationships over the next few years via its improved monitoring of periphyton. Therefore, the POP should recognise the potential for adaptive management within the 10 years of the plan and allow for on-going revision of in-stream and on-farm targets.

STEP 7: STATE OF THE ENVIRONMENT MONITORING

70 Horizons' State of the Environment (*SoE*) monitoring programme is the primary water quality monitoring programme in the Region, although this effort is supported by NIWA monitoring at a further seven sites.

71 In my view, Horizons has inappropriately characterised the water quality of an entire catchment based on sampling from a single site at the catchment outlet (see **Appendix 2** and paragraph 13 above). Horizons is extrapolating upstream based on a single sample point and monthly sampling. I consider it would be more appropriate to say "water quality leaving the catchment is poor; we know what is happening in the catchment; we will address specific activities in specific parts of the catchment to fix the problem". Assumptions that the results from a single monitoring site apply to all sections of the catchment upstream of that point are not valid.

72 I question the representativeness of the SoE network that Horizons has put in place to monitor the WMZs. Across the Region 31% of the land area is in native landcover[50]. Therefore, to provide an unbiased estimate of water quality state, nearly a third of sites should be in catchments dominated by native cover. This is not the case:[51] "*The selection of SoE sites has focused on areas of pressure.*" It would be useful for the Horizons Officers in their Supplementary Officer Reports to describe the spread of SoE sites across the Region and estimate the representativeness of the sites. If there is significant bias in the spread of sites (e.g. greater proportion of sites in agricultural catchments than the regional land cover patterns would suggest), how does this affect the definition of WMZs and descriptions of water quality state and trends at the Regional scale?

[50] Ausseil & Clark (2007b)

[51] Roygard evidence point 253 pg. 137

73 Ausseil & Clark[52] provide some key recommendations on upgrades to the information that the SoE network might provide Horizons. Included in these recommendations are two that are directly relevant to arguments about the validity of Horizons approach to setting nutrient standards for the control of nuisance periphyton growths. Firstly, Ausseil & Clark[53] recommend the addition of reference sites to cover a number of river classes in the region:[54] "*Reference site data is paramount to better understand the natural characteristics of each class of water.*" Secondly, they state that the "current" periphyton monitoring is largely insufficient to capture estimates of maximum annual periphyton biomass: "*An increased periphyton monitoring programme is strongly recommended.*" Finally, a region-specific nutrient-periphyton model is suggested. This would be based on the data from the improved periphyton monitoring network. A review of the proposed nutrient standards might be required once the model is developed and validated.

74 Horizons has had limited ability to report on periphyton issues in the Region, although this appears to have been rectified with recent establishment of a monthly monitoring programme at 48 sites. The issue of controlling periphyton growths is central to the POP, as the nutrient standards, standard loads and on-farm nutrient leaching loss limits (Table 13.2 of POP) are all in place to control periphyton growth. However, based on available monitoring evidence, there appears to be limited current concern over trends in periphyton[55].

CONCLUSIONS

75 I support the subdivision of the Region into smaller management units and also support the approach taken by Horizons in defining WMZs. The catchment is the basic unit for managing water resources, but large river catchments (e.g. Manawatu River) are characterised by high levels of spatial diversity in climatic, geological, and hydrological patterns. In my opinion, the WMZs are appropriate and provide opportunities to focus action (e.g. mitigation or remediation) in priority areas, rather than having to attack a poorly-defined regional-scale issue. I do not support the use of WMZs to describe regional water quality patterns as shown in Fig. 6.1 of Chapter 6 of the POP (version dated 31 August 2009). I have reproduced this figure in **Appendix 1** of my evidence. This approach is entirely inappropriate, because it requires extrapolation from a single monitoring station (which itself is only a limited sample of the actual conditions) to characterise the water quality for

[52] 2007b

[53] 2007b

[54] Section 9.1, Pg. 160

[55] Expert evidence of Dr John Quinn (point 47; pg. 13)

an entire sub-catchment. This will inevitably lead to exaggeration of water quality issues.

76 I support the intent of the water values framework and the underlying philosophy, particularly the recognition that there may be cases where all values may not be able to be fully protected or reinstated. However, I have been unable to identify how the process of balancing conflicting values is being managed within the POP. Within the current POP values framework it is not clear how, or when, stakeholders have the opportunity to discuss the inevitable trade-offs between conflicting values. The POP has taken a sub-set of defined values, assigned numeric water quality standards to protect those values, and identified methods to control land use with the aim of meeting water quality standards. There has been no discussion of whether the numeric water quality standards (set for a sub-set of community values) are appropriate for application to waterways managed for the full set of defined values.

77 The POP water quality standards (Schedule D) cover an appropriate range of water quality parameters. I consider that the nutrient standards in the POP that apply to rivers throughout the Region are overly-conservative and may be largely unachievable in many rivers.

78 Horizons has provided no direct evidence of relationships between nutrient concentrations, periphyton biomass and life supporting capacity. In order to link observed and predicted nutrient concentrations to periphyton biomass, Horizons has relied on a regression model. This model has not been validated for Horizon's rivers, and is recognised as being inappropriate for river types that make up around 50% of Manawatu-Wanganui rivers.

79 I consider that the low levels of compliance across the monitored sub-zones, particularly for water clarity and nutrient concentrations indicates that the proposed "effects-based" standards in the POP are too stringent and do not reflect the natural reference conditions found throughout the Region.

80 I consider that the picture of water quality state provided by Horizons' reports significantly overestimates water quality problems at the regional scale. Nonetheless, there are significant water quality issues within the Region and these issues will have direct impacts on waterway values. Many of the Region's rivers have issues with elevated levels of nutrients, sediments, faecal contaminants and a range of other stressors. However, public perception of water quality is generally positive.

81 There has been a change in the situation since the POP was notified. The lack of deteriorating trends in key water quality parameters, and the presence of a number of improving trends in nitrogen and

phosphorus levels suggest that the environmental imperative to control non-point source pollution in the region has lessened since the POP was first notified.

82 Horizons calculates the nutrient load attributable to non-point sources as the difference between measured load in the river and the load attributed to point sources. The method used to calculate loads has been devised by Horizons. It produces significantly different results to load calculations using widely-accepted methods. The information used to calculate point source contributions is incomplete and this will lead to over-estimation of the contribution from non-point sources.

83 The focus placed by the POP on N-leaching from intensive land uses is likely to drive action to reduce only N-leaching losses as modelled through OVERSEER. This may be to the detriment of other actions that have the potential to give far greater ecological benefits for waterways, (e.g. riparian fencing and planting). A focus on reducing N-outputs from farms will require significant investment of time and resources by farmers, with the potential to distract farmers from focussing on other critical mitigation measures, such as faecal, sediment and P control. The control of P may actually be more critical to gaining water quality improvements than N-control in many Manawatu rivers. A focus on faecal and sediment (and associated P) contaminants is warranted given the position of Manawatu-Wanganui rivers in national league tables.

84 Horizons has embarked on significant upgrades to its SoE monitoring programme. Recent establishment of a monthly monitoring programme at 48 sites will fill a critical gap in current environmental knowledge. The issue of controlling periphyton growths is central to the POP, as the nutrient standards, standard loads and on-farm nutrient leaching loss limits are all in place to control periphyton growth. These elements have all been put in place without reliable information on periphyton biomass patterns in the Region. There is no information on the real size of the issue in the Region and until the monitoring programme provides this information any policies made to control periphyton growth are in real danger of being ineffective and inefficient.

85 Uncertainties in links between instream outcomes and non-point source nutrient controls support an argument for an adaptive management process, whereby increases in scientific understanding (e.g. improved knowledge of causative factors for periphyton growth in the region) can be used to refine nutrient standards and revise on-farm nutrient output targets over time. However, the uncertainties always present in science should not be used to justify maintaining the status quo. Significant water quality issues in the Manawatu-Wanganui region underline the need to reduce point source and non-point source contaminant loads. This should be

achieved through targeted action to ensure that all resource users are applying mitigation practices that will have demonstrable benefits for community values.

Dr Michael Scarsbrook
30 October 2009.

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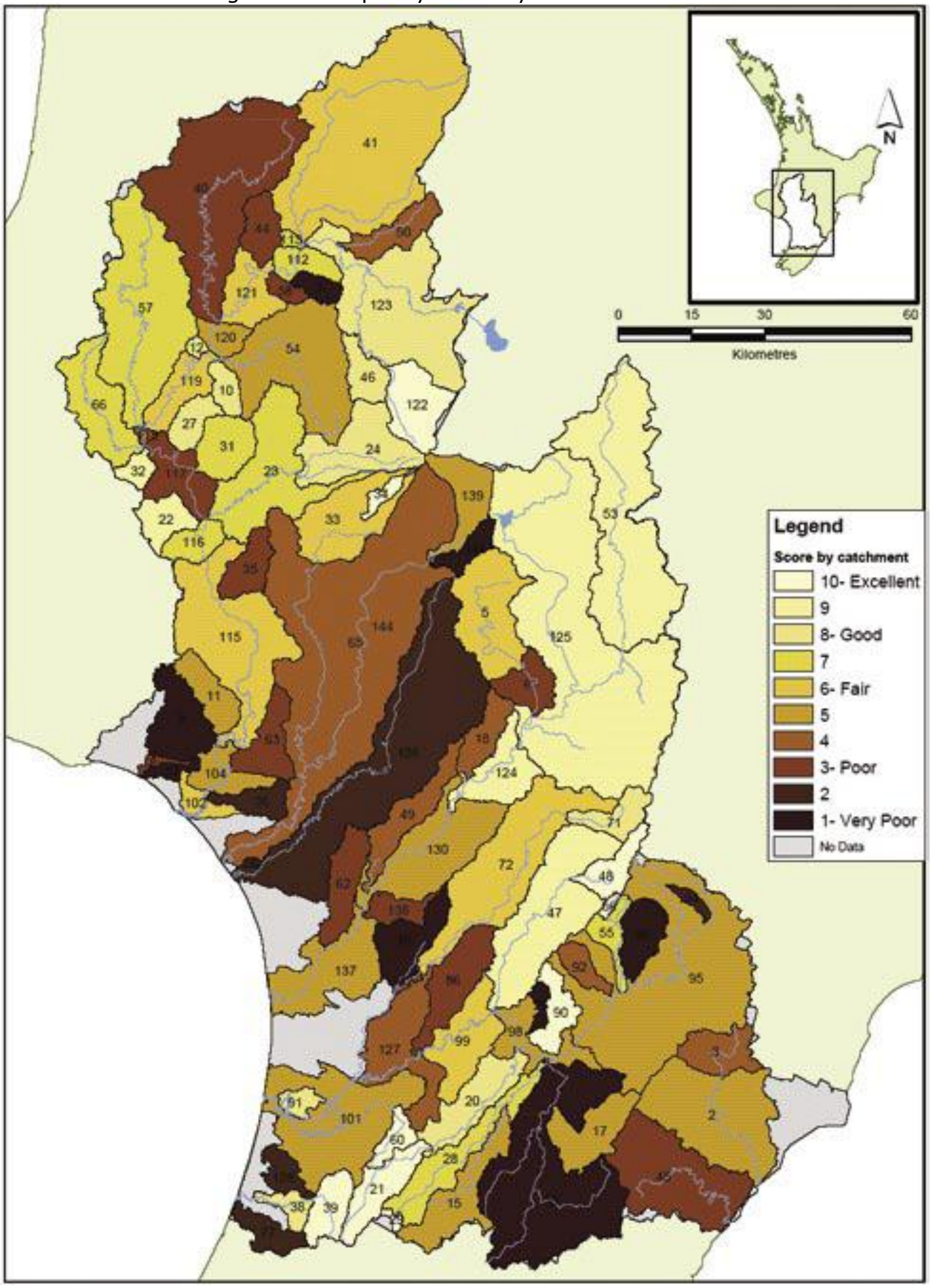
APPENDICES

Reproduced from SoE Report Technical Report Four/Freshwater Quality (2005; pg. 56). A slightly modified Figure also appears on page 6-6 of the POP.

MAP 4- 1: Bacteriological water quality score by catchment.



Appendix 2: Mean Monthly concentrations (mg/m^3) of DRP and SIN at 69 river sites in Manawatu-Wanganui Region.