Review of monitoring in the Tukituki catchment, Hawke's Bay

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Prepared for

Hawke's Bay Regional Council

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Executive Summary

Hawke's Bay Regional Council, through an Envirolink medium advice grant, commissioned NIWA to: (1) review science programmes for the Tukituki River catchment, (2) establish effectiveness and deficiencies of current programmes, (3) determine technical competency of HBEWG members and HBRC staff, (4) confirm appropriateness of analysis, interpretation and reporting, and (5) recommend any additional programmes. The following is a list of the main recommendations and conclusions – a full list is given in the text.

Conclusions

There is evidence of increasing nutrient concentrations at some sites contrary to the first requirement of Objective 27 to '…maintain or enhance water quality…' There is evidence that nutrients and other contaminants adversely affect water quality and pose a threat to aquatic ecosystems or contact recreation during summer low flows, contrary to the second requirement of Objective 27 to '…sustain or improve aquatic ecosystems…'

In recent years Council has invested a considerable amount of effort in SOE monitoring, and this has identified several problems with water quality and ecosystem health. In some instances Council has failed to act on problems that have been identified. For example, issues of high nutrient concentrations and high summer periphyton biomass were identified in 2004 if not earlier. On the other hand, the issue of high SRP inputs from the oxidation ponds at Waipukurau and Waipawa has been identified and is being addressed, although concerns remain about their effect on contact recreation. I am advised that Council plans to reallocate some resources from SOE monitoring to investigations that address identified problems.

Even drastic reductions in nutrient load may not result in complete compliance with water quality and periphyton guidelines.

The current Recreational Water Quality (RWQ) and State of the Environment (SOE) monitoring programmes are fit for purpose. However, contact recreation and public health risk below the oxidation ponds is a potential issue which merits investigation.

Water clarity seems not to be a pressing management problem in the Tukituki.

Council reports demonstrate the technical competence of the staff who wrote them. Sampling methods are well documented, and results are analysed, written up and archived in a professional manner.

The HBEWG raise several important issues and some of their suggestions have merit. Some of HBEWG's statements and suggestions are not consistent with current science, law or management.

The lack of reliable information about actual water abstraction restricts Council's ability to make policy decisions about water quantity, quality and ecology. Management would be improved if there was metering and timely/accurate reporting of surface and groundwater abstractions.

A groundwater model of the Ruataniwha Plains is being developed and will help quantify the effects of groundwater pumping and surface water extraction on river flows, water quality and ecology.

None of the documents sighted during this review includes a quantitative analysis of current land use intensity or trends over time. Land use data would be a very useful adjunct to the SOE water quality monitoring data.

Recommendations

Ensure that compliance monitoring below the Waipukurau oxidation pond always occurs at the end of the 400 m mixing zone. Effluent may not mix completely across the channel within the mixing zone and samples need to be collected within the effluent plume.

Review contact recreational use in the lower Tukituki and determine if there is a public health risk arising from the Waipukurau and Waipawa oxidation pond discharges.

Consider including an additional site in the Recreational Water Quality Monitoring Programme (e.g., Tapairu Road, Tamumu, Shag Rock or Patangata) and a tighter protocol for identifying rainfall-related events.

Consider including an additional site in the SOE monitoring programme to quantify the effects of the Waipukurau and Waipawa oxidation ponds after complete mixing (e.g., Tapairu Road, Tamumu, Shag Rock or Patangata).

Collate land cover/use data, examine for spatial patterns and time trends, and forecast likely future changes. Examine spatial and temporal correlations between land cover/use and water quality/ecology. Conduct a preliminary modelling study using OVERSEER and/or CLUES to relate land cover/use and water quality, both in space and over time.

Re-examine water quality at the SH50 sites and land use in the headwater catchments to ensure the trends identified are not an artefact of flow differences, and determine whether they are the result of land use intensification.

Compare the spatial patterns in land use with the locations of the groundwater quality monitoring wells. Ensure monitoring wells are located in places where they are most likely to detect the effects of land use intensification on groundwater quality and quantity.

Examine groundwater nutrient data for trends and spatial patterns. Compare trends and spatial patterns in groundwater and surface water nutrient data. Do preliminary mass balance calculations to determine the effect of groundwater return flows on stream nutrient concentrations.

Undertake a desk study on the impacts of surface and groundwater abstractions on river flow, depth and velocity and its effects on nutrient concentration and periphyton biomass.

Continue existing field studies using diffusing nutrient substrates and re-analyse existing water quality and land use datasets to determine the role of P and N, separately or together, in the control of periphyton growth. Use the findings to make decisions on whether to control N, P or both on a catchment-by-catchment basis. Consider including a guideline for SIN in the RRMP in addition to the existing guideline for SRP.

Use available data to predict periphyton biomass and compare with annual observations. Hence decide whether the Biggs (2000) equations give satisfactory predictions or whether they need adjusting for Hawke's Bay conditions.

Conduct a modelling study based on CLUES and the Periphyton Guideline to relate land use, water quality and periphyton biomass.

Predict MCI scores in the Tukituki for undeveloped and developed-managed states using the method of Leathwick (2008) and compare with measured values. Hence determine whether diffuse and point source pollution is adversely affecting MCI scores in the lower Tukituki. Confirm that trends in MCI at the SH50 sites are not an artefact of changes in flow, and examine whether they are the result of land use changes in the headwaters.

Consider a nutrient spiralling investigation in the Tukituki.

Use the results of the Sarazin and Zimmerman (2003) to identify priority areas for retirement and riparian fencing. Collate information about subsidies paid, education undertaken, and the length/area of new riparian buffers created and re-assess the effectiveness of Policy 45.

Review methods used to set minimum flows given the possibility of applications to divert and store water.

Review abstraction consent conditions, metering, reporting (including automatic on-line reporting), compliance monitoring and enforcement of consent conditions in relation to the effects of ground and surface water abstraction on water quality and ecology.

Determine whether contact recreation or stream ecology is adversely affected by sediment or water clarity. Undertake a desk study, identify linkages between hill-country, wind erosion, suspended sediment and water clarity, and decide whether suspended sediment and clarity are adversely affected by controllable activities in the catchment.

Determine whether the resuspension of fine sediment from the bed poses a public health risk or a risk to ecosystem health through contaminants such as faecal microbes, heavy metals or pesticides.

Council and HBEWG maintain their dialogue. HBEWG focus on issues rather than technical details. Council recognise that HBEWG bring valuable information to the debate.

1. Introduction

The Tukituki has been identified as a sensitive catchment and Hawke's Bay Regional Council (hereafter Council) conducts monitoring to determine the state, and trend over time, of its freshwater resources. Council obtained an Envirolink medium advice grant to:

'…review the science programmes for the Tukituki River catchment…including the applicability and appropriateness of methods, analysis and reporting framework…'

State of the Environment (SOE) monitoring and subsequent reporting is undertaken to provide information on the effectiveness of plans and policies in achieving the environmental outcomes decided on by the community through the plan and submission process. Therefore, the ability of rules to achieve environmental and societal targets rely on the delivery of defensible and scientifically robust SOE monitoring information. An independent peer review was requested of the appropriateness and ability of the SOE monitoring programme and associated investigations to detect trends with time and other changes. Council expect the review to ensure the scientific rigour of the programme, and to provide refinements where necessary.

The final terms of reference for this study were:

- To establish the effectiveness of the current science programmes of the HBEWG and HBRC to determine the state of the Tukituki Catchment (frequency, parameters and methods).

- To determine the technical competency of HBEWG members and HBRC staff involved in the science programmes, including any contractors.

- To confirm the appropriateness of the analysis methods.

- To confirm the appropriateness of interpretation methods, reference documents and reporting.

- To identify deficiencies in the current science programmes for the Tukituki River to identify state.

- To recommend any additional programmes or interpretation methods to improve knowledge on the state of the Tukituki River.

The review was conducted by reading relevant Council reports (listed in References) and making follow-up enquiries with individual staff members by email or phone. In addition several key papers and MfE reports were consulted and issues were discussed with NIWA colleagues who have worked in the region.

A draft was discussed with Council staff (19th December 2008) and with the Hawke's Bay Environmental Water Group (22nd December 2008) before being finalised. These discussions, and follow up correspondence, clarified the terms of reference, and identified a few omissions and errors of fact.

Several people have contributed to this process including: Graham Sevicke-Jones, Brett Stansfield, John Phillips, Husam Baalousha, Andrew Curtis (Hawke's Bay Regional Council), John Quinn (NIWA), and David Renouf (Hawke's Bay Environmental Water Group). Their contributions are gratefully acknowledged.

The views expressed in this report are those of the author. Consensus was not reached on some of the matters discussed.

2. Council policy and monitoring strategy

2.1 Regional Resource Management Plan

Objectives and policies relevant to surface and groundwater quantity and quality are detailed in the RRMP and summarised in Tables 1 and 2.

Table 1: Summary of main surface and groundwater quantity and quality objectives.

Objective	
21	No degradation of existing groundwater quality in the Heretaunga and Ruataniwha Plains aquifers systems.
22	The maintenance or enhancement of groundwater quality in unconfined or semi-confined productive aquifers in order that it is suitable for human consumption and irrigation without treatment, or after treatment where this is necessary because of natural water quality.
23	The avoidance of significant adverse effects of water takes on the long-term quantity of groundwater in aquifers and on surface water resources.
24	The avoidance or remedy of any significant adverse effects of water takes on the operation of existing lawful efficient groundwater takes. This review does not discuss Objective 24.
25	The maintenance of the water quantity of the rivers and lakes in order that it is suitable for sustaining aquatic ecosystems in catchments as a whole and ensuring resource availability for a variety of purposes across the region, while recognising the impact caused by climatic fluctuations in Hawke's Bay.
27	The maintenance or enhancement of the water quality of rivers, lakes and wetlands in order that it is suitable for sustaining or improving aquatic ecosystems in catchments as a whole, and for contact recreation purposes where appropriate.

Table 2: Summary of main surface and groundwater quantity and quality policies.

Policy	
37	Establishes minimum flows and allocatable volumes for several rivers, including the Tukituki.
40	Sets out the steps followed if/when river flow approaches the minimum.
45	Covers non-regulatory methods for controlling non-point source discharges and stock access to waterways including: identification of priority areas for retirement of buffers, provision of financial incentives, education and co-ordination.
47	States that water quality in rivers and lakes will be managed through the use of environmental guidelines[1].
71-73	Set out the environmental guidelines for the following water quality parameters: temperature, dissolved oxygen (DO), ammonium, dissolved reactive phosphorus (SRP), water clarity, and suspended solids (SS), together with the procedures for applying these guidelines.
79	Gives guidelines for the beds of rivers and rivers. Policy 79 is largely concerned with physical disturbance to the river bed and/or culverts and other structures. This review does not discuss Policy 79.

[1] Page 68 of the RRMP implies that Policy 47 only applies to point source discharges. However, page 11 of the Strategy states '…the region has many river sites that comply with current guidelines. However, there are some that do not. Most non-complying sites occur in warm, dry, low elevation pastoral areas where land use pressures are high…' which implies that Policy 47 also applies to diffuse sources. This review assumes that Policy 47 applies to both point and diffuse sources, and this assumption was endorsed at the meeting on 19th December 2008.

2.2 Water Management Review

The monitoring strategy has evolved over time to meet the changing needs of Council. The current strategy has been strongly influenced by the Water Management Review (EMS 2005). This Review made a total of 76 recommendations (listed Appendix 1). Those relevant to this review are summarised in Table 3.

Table 3: Summary of major recommendations from the Water Management Review.

Identify waterways managed for contact recreation, and initiate monitoring and public warning systems.
Identify rivers that are degraded as a result of excessive nutrients, high water temperature and algae growth.
Investigate reasons for poor water quality and macroinvertebrate health, and develop management responses.
Protect non degraded rivers.
Identify rivers that would benefit from riparian protection and develop management objectives. Consider regulation where education and financial incentives have not delivered desired outcomes.
Retain the current non-regulatory approach to accelerated hill country erosion.
Review hill country erosion management interventions and determine which are most effective.
Determine whether excessive fertiliser use on hill country contributes to declining surface water quality and consider regulatory provisions rather than rely on the Code of Practice for Fertiliser Use.
Consider reviewing the groundwater quality management framework in the light of recent reports on nitrate and pesticide contamination.
Continue long term baseline monitoring of aquifer and river levels.
Identify where groundwater levels are declining, the likely cause, and any required management interventions.
Continue to use IFIM to establish minimum river flows but consider assessing iwi cultural values.

Identify the adverse effects of land use change and intensification, and any deficiencies in Plan provisions.
Adopt a more up to date model for determining crop water requirements.
Decide when to review existing allocations, including reclaiming water allocated but not used.
Complete the assessment of potentially irrigable land.

2.3 Surface water quality monitoring strategy

The Surface Water Quality Monitoring Strategy (Stansfield 2006) defines Council's surface water quality and ecology monitoring strategy for the Hawke's Bay region covering the period 2006-2011. Council intend to review the strategy in 2011. This report reviews those parts of the strategy relevant to the Tukituki River catchment.

The strategy states: '…Monitoring seeks to determine whether the rules and policies in the Regional Resource Management Plan (RRMP) address priorities identified in a recent Water Management Review (EMS 2005)...' and '…the information that is provided (by monitoring) enables Council to determine if the policy is effective…' The rules, policies and their objectives alluded to are contained in the RRMP and are listed in Tables 1 and 2. The most challenging are objectives 23 and 27 (Table 1).

In the Tukituki catchment water quality has been measured at about 60 sites over the last 30 years (Ausseil 2008). Currently 11 sites are sampled monthly[2] for SOE water quality reporting and data are available for 5 other sites. 9 sites are sampled annually for ecology

The strategy makes it clear that Council does not have unlimited resources for monitoring. In addition to monitoring the Tukituki, staff are also required to monitor a number of other waterways.

2.4 Surface water quantity monitoring strategy

Flow strongly influences water quality and river ecology. Floods scour periphyton and accumulated fine particulates from the bed. They also carry high particulate loads that settle during the recession and may subsequently contribute SRP and/or SIN to the water. Council cannot control flood flows but it can take steps to control erosion. Low flows are usually when problems arise with water quality and ecosystem health.

[2] Quarterly prior to 2005

Prolonged summer low flows lead to the accrual of high periphyton biomass which causes problems of aesthetics and for water users (e.g., anglers). In combination with high water temperature, high periphyton biomass leads to low night-time DO concentration and high day-time pH which adversely affect sensitive organisms (e.g., mayflies and trout).

Of the 16 monitoring sites in the Tukituki, 7 have flow recorders, 8 have high or medium quality correlations with recorders, and only 1 site (Mangatarata) has a poor flow record. Not all the major tributaries are monitored – several in the headwaters, but few in the lower Tukituki, are sampled.

Policy 37 establishes minimum flows for the Tukituki (RRMP pages 63 and 105). Minimum flows are determined using hydraulic habitat modelling (IFIM). The RRMP (2006) notes that minimum flows were being revised at the time of publication. The setting of minimum flows is a separate exercise from SOE monitoring. It involves detailed mapping of selected channel reaches to determine the habitat preference (viz., the preferred depths and velocities) of keystone species. Hydraulic modelling is then used to estimate how depth and velocity change with flow – which in turn indicates how preferred habitat changes with flow.

Policy 40 sets out the steps followed as river flow approaches the minimum. Council provides information to users, encourages users to voluntarily schedule or ration water, and may apportion, restrict or suspend abstractions to ensure they do not cause a breach of the minimum flow. The monitoring of river flow and abstractions is operational rather than SOE monitoring. It is carried out separately using different methods and has different objectives – namely day-to-day scheduling of irrigation takes and compliance monitoring. Compliance monitoring is outside the scope of this review.

2.5 Groundwater quantity and quality monitoring strategy

Groundwater is used extensively in the Ruataniwha Plains (which lies in the middle Tukituki catchment) for domestic water supply, stock watering and irrigation. Metered groundwater abstraction[3] has increased from <1 million m^3 yr^{-1} in 1996 to about 9 million m^3 yr^{-1} in 2006. Currently about 16 million m^3 yr^{-1} of groundwater (3.4% of rainfall recharge) plus about 4 million m^3 yr^{-1} of surface water (1% of rainfall recharge) is abstracted (Baalousha 2008a). Demand for groundwater is forecast to increase in the future as a result of land use intensification and climate change.

[3] about 20% of abstraction is currently metered

There are currently 13 monitoring wells in the Ruataniwha where level and water quality are measured – typically quarterly. Monitoring is carried out to assess the effectiveness of objectives 21, 22 and 23 (Table 1).

2.6 Council water strategy

A draft 'Water Strategy' document is currently going through Council. Council has adopted three goals for the region – a vibrant community, a prosperous region, and a clean and healthy environment. Council state that '…a clean and healthy environment is the most strategic of the goals and underpins the success of the others – without a good environment our community will not enjoy living in the region and prosperity may be hard to achieve...'

The Water Futures section includes an objective '…quantify high flow run-of-river water harvesting regimes and storage capabilities...' Currently there are no major diversions to storage from Hawke's Bay rivers – water is abstracted for irrigation as and when needed. Objective 3 indicates that this may change in the future – a point discussed in more detail later in this report.

The Land use Change section has the goal of '…informing and encouraging optimal land use for economic benefit which maintains/enhances environmental sustainability…' The scope states '…while recognising the importance of good economic return from the land to Hawke's Bay's economy, it needs to be achieved in a way that is environmentally sustainable. Land use changes and land use intensification is generally driven by economic forces but can have externalised (community) costs in the form of environmental impacts...' It is not clear from the objectives, however, how Council intend to deal with these externalised costs.

3. Hawke's Bay Environmental Water Group

Mr David Renouf, on behalf of the Hawke's Bay Environmental Water Group (HBEWG), prepared a folder of material in which are raised several issues relating to water quality, monitoring and management in the Tukituki River. A summary of this material is given in Table 4. Supplementary commentary was tabled by HBEWG at our meeting on 22nd December. HBEWG sent letters dated 14th January and 12th February, plus a copy of a letter from Fish & Game to HBRC dated 16th December 2008. These are included as Appendix 2. The matters raised in these letters have been considered and used to amend some of the recommendations in the final report. A letter responding to HBEWG is included in Appendix 2.

Table 4: Summary of issues raised by the Hawke's Bay Environmental Water Group.

No.	Topic	Issue
Nutrients and algae		
1	Algal biomass, sewage fungus and aquatic plants.	States water column sampling is unreliable. Suggests monitoring (1) algal chemistry, (2) periphyton biomass monthly rather than annually, (3) BOD in relation to sewage fungus.
2	Sediment and the hyporheos.	Suggests monitoring sediment for faecal microbes, heavy metals and SIN.
3	Ecosystem health.	Suggests monitoring birds, native fish, mussels etc. Suggests ecological surveys of river health.
4	Dissolved oxygen.	Suggests monitoring diurnal DO variations.
5	Blue-green algae.	States these are a problem.
6	Nutrient spiralling.	Points out this is not currently measured.
7	Nitrogen and phosphorus.	Suggests a study of nitrogen. Suggests adding SIN to guidelines in the RRMP. Suggests reducing the current SRP guideline of 15 mg m^{-3}.
8	Guidelines in the RRMP.	Suggests adding contaminants (heavy metals, pesticides etc.). Argues the Tukituki was classified under previous legislation and that guidelines should be the standards. Suggests a temperature guideline.
Oxidation ponds		
9	Mixing zones.	Argues that water quality standards & guidelines should be met within the mixing zone.

10	Waipukurau – mixing.	States that sampling below the pond misses the plume. Argues that the pond discharge enters and pollutes the Pah Flat Stream. Suggests re-instating site 25 (Tapairu Rd) as a routine monitoring site – although there may be mixing issues at this site.
11	Health risk below ox ponds.	Suggests microbial monitoring below ox ponds. States guidelines commonly breached.
12	Ox pond consents conditions.	Suggests limits on a range of contaminants including toxicants.
13	Water quality after 2014.	Suggests problems will still occur.
Water quantity		
14	Setting low flows.	States rivers are over-allocated. Suggests revising minimum flows.
15	Monitoring water abstraction & use.	Suggests all water use be measured.
16	Groundwater allocation.	States groundwater is over allocated.
General		
17	RRMP.	Suggests a review of guidelines and more rigorous enforcement.
18	Land use controls.	Suggests placing limits on nutrient yield (e.g., 3 kgN ha^{-1} yr^{-1}, 0.1 kgP ha^{-1} yr^{-1}).
19	Animal health.	Suggests revised stock water guidelines and notification system for breaches.
20	Sampling methods & design.	Suggests a review. States not all parts of the Tukituki are being monitored and that methods are not adequate.

The final terms of reference for this study require an assessment of the '…technical competency of HBEWG members and HBRC staff involved in the science programmes, including any contractors…' I confine my comments to topics I am familiar with – mixing, catchment processes, stream nutrient dynamics and periphyton growth. My dealings with the group have been brief. I met with four members of the HBEWG on the 22nd December and have corresponded with the secretary, David Renouf, on several occasions.

The HBEWG expressed to me their frustration that water quality, water quantity and ecosystem health in the Tukituki are declining but Council seems to be taking little action. There is evidence to support this view. For example, issues of high nutrient concentrations and high summer periphyton biomass were identified in 2004, if not earlier, and yet Council appear to have slow to address the issue of diffuse sources of nutrient.

My assessment is that the technical competency of the HBEWG is only moderate, as would be expected given that members do not have professional expertise in many relevant technical areas. I believe that some of the statements made by the HBEWG are wrong in fact and I disagree with some of their suggestions – details are given below.

Notwithstanding, I admire the resolve of the HBEWG to safeguard and improve ecosystem health in the Tukituki River. I believe they have a valuable role to play in keeping important issues in the public arena.

HBEWG have requested a significant expansion to the existing monitoring programme for the Tukituki. I believe that the HBEWG (and possibly some Council staff) fail to appreciate the important distinction between monitoring and investigation. The former is aimed at identifying problems and the latter to finding causes and solutions. The HBEWG suggests including in routine monitoring some tests that I believe might be considered for investigations, but are not suitable for routine monitoring. At the meeting on 22nd December I emphasised my strong belief that Council needs to be very clear in separating monitoring from investigations. Over the last 4-5 years Council has invested considerable time/effort in SOE monitoring. In my opinion, Council now needs to re-focus its efforts on any investigations needed to refine and address problems. I am informed that this is indeed happening. In an email (dated 9th February 2009) Graham Sevicke-Jones states that '…in the last few years the focus has been to establish the SOE monitoring network rather than to undertake investigations. This has been clearly spelt out to Council. This year's LTCCP includes a commitment to additional expenditure for investigations...' I re-iterate that, in my opinion some monitoring suggested by the HBEWG should be considered for investigations, but may not be suitable for routine monitoring.

Table 4 Issue 1. I disagree with the HBEWG that it is essential to include algal chemistry in monitoring. Algal chemistry helps identify nutrient limitation. Council already uses nutrient diffusing substrates to identify nutrient limitation and little additional information would be provided by algal chemistry.

I disagree with the HBEWG that it is essential to monitor BOD. This may be appropriate where organic wastes containing sugars (e.g., dairy factory effluent) cause problems with 'sewage fungus'. I accept that bacterial slimes may be present in some places (e.g., close to point source discharges). However, I have seen no evidence to indicate that sewage fungus is a major or a widespread problem in the Tukituki. Rather, it is my opinion that periphyton problems arise principally from the growth of algae stimulated by nutrient inputs. If the HBEWG has evidence to the contrary then I recommend they provide it Council.

I disagree with the HBEWG that it is essential to monitor diurnal variations in DO, although this might be appropriate as part of an investigation of the effects of periphyton on stream ecology.

I disagree that it is essential to monitor faecal microbes in sediment, although sediments are a known store and source during spates. A case can be made to investigate public health risk from disturbing fine sediment while bathing – ideally as part of the recommended re-assessment of the public health risk that arises from oxidation pond discharges.

It is clear that the HBEWG is not familiar with the detail of some sampling methods. I disagree with the HBEWG that collecting river water samples from near the surface fails to quantify accurately SRP and SIN concentration. In lakes that stratify in summer, surface concentrations may be lower than bottom water concentrations. However, rivers like the Tukituki are invariably well-mixed vertically. Deep in the river bed gravels SIN concentrations may differ from those in the river water itself but surface-groundwater interactions are complex and, in my opinion, should not be included in routine monitoring. The HBEWG seem unaware that in rivers water clarity is routinely measured horizontally using a black disc thereby enabling measurements to be made even during low flows when water depth is low. It is not standard practice to use a vertical secchi disc in rivers even to determine whether the bed or snags are visible when looking vertically into a swimming hole.

On legal matters, I find it hard to accept the arguments advanced by the HBEWG relating to '…reasonable mixing…' (Table 4 Issue 9). These arguments imply that standards/guidelines must be met within the mixing zone – this is not my understanding of case law on this topic notwithstanding the quoted statement from the

Environment Court that '…mixing zones not be used for the treatment of wastes…' A legal opinion may help clarify this issue.

I agree with HBEWG that in the past compliance monitoring results from below the Waipukurau oxidation pond may not have quantified accurately the impact of the discharge because of complex and incomplete mixing. However, I have recently been advised (email Graham Sevicke-Jones dated 9th February 2009) that following discussions with CHBDC in 2007 the oxidation pond discharge point is now maintained in the same location and re-instated after a fresh. Compliance monitoring now always occurs 400 m downstream from the discharge point (viz., at the edge of the mixing zone). In the past the sampling point was fixed but the discharge point could move and occasionally was only a matter of metres from the sampling point.

Effluent may not mix completely across the channel within the 400 m mixing zone. Consequently samples need to be collected from within the plume – it is not clear whether this happens currently.

The monitoring determinants are now consistent with those used for SOE monitoring. However, since mixing may not be complete at this site care must be taken when using results for SOE reporting.

There seems little merit in undertaking further <u>compliance monitoring</u> at Tapairu Road. However, Tapairu Road should be considered (along with other sites below Waipukurau) as a possible additional site for Recreational Water Quality monitoring. There may also be merit in considering an additional SOE monitoring site below the Waipukurau and Waipawa oxidation ponds at a point where mixing is complete (e.g., Tapairu Road, Tamumu, Shag Rock or Patangata).

The HBEWG has expressed frustration that Council has not taken legal action against CHBDC when water quality <u>guidelines</u> for SRP appear to have been breached below the oxidation ponds. My understanding is that Council can only take legal action if <u>consent conditions</u> are breached. Notwithstanding, a breach of the SRP guidelines should prompt Council to review consent conditions.

On some matters the HBEWG is able to provide anecdotal and semi-quantitative information which, in my opinion, Council should use to guide their monitoring, investigations and policy. One example discussed on the 22nd December relates to odour in the Tukituki. John Scott stated that after fishing in the lower reaches of the Tukituki (below the oxidation ponds) waders and other gear left unwashed quickly develops an objectionable odour. This is not the case after fishing in other Hawke's Bay rivers. The suggestion is that compounds from the oxidation ponds, or from periphyton whose growth is stimulated by nutrients from the ponds (e.g., blue-greens), cause this odour problem. Council should consider investigating issues of this nature raised by the HBEWG and other members of the public.

It might be tempting for Council to ignore the HBEWG because the arguments they advance do not always align with main stream science, law and management. I believe this would be unwise. The issues raised by the HBEWG are important and some of their suggestions have merit.

Conclusion: Some of the statements made by the HBEWG are, in my opinion, wrong in fact and some of their suggestions are not in line with current science, law or management. HBEWG does not have a '…science programme…' that can be compared with that of Council. However, the issues raised by the HBEWG are important and some of their suggestions have merit.

4. Steps to assess the effectiveness of policies in the Tukituki

4.1 Questions addressed

For monitoring to be effective it must enable Council to determine whether or not its objectives and policies are effective in meeting its objectives. An informal ranking was assigned at the meeting with Council staff on 19th December 2008. A recent phone survey by Council emphasised that the public ranks water quantity and quality as the top two issues in the Tukituki. Questions that need to be addressed are listed in Table 5.

Table 5: Questions to assess the effectiveness of monitoring policies.

Objective	Rank	Question
21	2	Is groundwater quality vulnerable?
21	5	Is groundwater quality vulnerable? Is groundwater quality in the Ruataniwha Plains aquifers system changing?
22	5	Is groundwater quality suitable for human consumption and irrigation without treatment?
23	1	Does groundwater abstraction have significant adverse effects on groundwater resources or surface water resources?
25	1	Is water quantity suitable for sustaining aquatic ecosystems?
27	1	Is water quality in the Tukituki being maintained or enhanced? Is water quality in the Tukituki suitable for sustaining or improving ecosystems? Is ecosystem health in the Tukituki satisfactory? Is water quality suitable for contact recreation where appropriate in the Tukituki?
Policy	**Rank**	**Question**
45	1	Is Policy 45 effective in reducing stock access to waterways and providing buffers against the effects of runoff, are priority areas for retirement being identified and are financial incentives, education and co-ordination effective?
47, 71-73	2	Are environmental guidelines currently being met in the Tukituki? Are activities that affect water quality in the Tukituki being managed effectively?

4.2 Monitoring and investigation

If the questions in Table 5 are answered in the negative then managers need to ask the following questions:

Table 6: Follow-up questions.

Investigations	
A	What is causing the problems with water quantity, water quality and/or ecology?
B	What needs to be done to restore/enhance water quantity, water quality and ecology?

It is sensible to separate monitoring from investigations. The former involves routine sampling over a long period of time to collect information about a range of determinands at a limited number of fixed sites. These data are often analysed for trends. The latter involves intensive sampling over a short period of time to address a specific issue, sometimes to support modelling and invariably to support decision making (e.g., a policy change or a consent application). Sometimes monitoring can suggest reasons for trends (e.g., deteriorating water quality or a degraded ecosystem) but trend detection rather than explanation is its prime purpose.

For this separation to work effectively, there need to be clearly defined and robust procedures for deciding when monitoring has detected a problem (i.e., when questions in Table 5 are answered in the affirmative) and when investigations are required (i.e., when questions in Table 6 need to be addressed). Council needs to have sufficient flexibility in its sampling and budgeting procedures to respond when a problem is identified so that it can set about determining its cause(s) and required remediation(s). One way to do this is to have separate monitoring and investigations budgets – the former is committed and the latter discretionary.

It takes time to investigate the causes of a problem, identify and implement solutions, and for them to take effect. Council needs to consider not only well-known issues (e.g., oxidation pond discharges) but also emerging issues (e.g., increasing water demand, land use intensification, and public health risk from zoonoses). Sometimes an exploratory investigation of an emerging issue is required prior to monitoring.

5. Assessment

5.1 Recreational Water Quality Monitoring

A series of annual reports dating back to 2001 summarise results from microbiological monitoring at 30 sites in the Hawke's Bay region during summer (November-March) as part of the Recreational Water Quality Monitoring Programme (Waldron and Madarasz-Smith 2008; Cameron and Madarasz-Smith 2007 and others). Sampling sites have been selected using several criteria: popular recreational sites, sites classified for 'Contact Recreation' in the Regional Coastal Plan, sites used for SOE monitoring, sites used for trend identification, and/or sites selected in co-operation with TLAs and/or Hawke's Bay District Health Board. The Tukituki River is sampled at two sites:

- Tukituki @ Black Bridge. This site is in the tidal part of the river and is regularly used for swimming. The site is downriver from Waipukurau and Waipawa – both townships have oxidation ponds that discharge into the river.

- Tukituki @ SH2 Waipukurau. This is a popular swimming spot in summer located upriver from the oxidation pond outfalls. The site may be affected by runoff from Waipukurau.

Compliance with microbiological guidelines is summarised in tables and colour-coded maps in each of the annual reports, and a trend analysis is presented. These give the reader an excellent summary of the main findings. Full results are tabulated in an appendix for closer inspection.

The indicators sampled (*E. coli* and *Enterococci*) include enteric bacteria of human and animal origin. *E. coli* and *Enterococci* themselves are not disease causing but indicate the presence of recent faecal material which may pose a public health risk if there is disease in the community. It is believed by some that a given level of indicator bacteria of animal origin poses a lower public health risk than the same level of indicator bacteria of human origin. However, some diseases are carried from animals to humans (e.g., Campylobacteriosis) and consequently the presence of *E. coli* and *Enterococci*, even if predominantly of animal origin, does indicate a risk to public health. The New Zealand microbiological water quality guidelines (hereafter Guidelines) treat the risks equally of indicator bacteria of animal and human origin. (www.mfe.govt.nz/publications/water/microbiological-quality-jun03)

The monitoring reports and an earlier study (Stansfield 2002) have found that the microbial indicators are often high following rainfall, especially at freshwater and estuarine sites. This phenomenon is well documented in the literature and arises from the resuspension of settled fine sediment and runoff from the catchment (Nagels et al. 2002). The high concentrations of indicator bacteria observed after rain in the Tukituki may be predominantly of animal origin but the Guidelines treat the risks equally of indicator bacteria of animal and human origin. More importantly, the Guidelines recommend sampling at times when contact recreation is actually occurring – which probably excludes floods. This logic seems to lie behind Council placing less emphasis on high concentrations in fresh and estuarine waters after rain events than on high concentrations during dry weather. If high concentrations are measured during dry weather, sites are re-sampled daily until concentrations return to guideline values, and warnings are posted while concentrations remain high. After rain, however, sites are not resampled in fresh and estuarine waters – the national sampling Guidelines do not recommend re-sampling under these circumstances. Notices are posted (e.g., on the Council web site) advising the public not to swim for ~3 days after rain. Marine sites are re-sampled regardless of whether rain did or did nor fall – as suggested by the national sampling Guidelines.

Referring to Objective 27 (see Table 1), the Recreational Water Quality Monitoring needs to be able to answer the question '…is water quality suitable for contact recreation where appropriate in the Tukituki…' I conclude that:

- The reports sighted give an excellent summary of indicator microbial concentrations at two popular swimming locations in the Tukituki River;
- health risk is being assessed following national sampling guidelines;
- re-sampling of fresh and estuarine waters occurs when guidelines are breached during dry weather;
- re-sampling of fresh and estuarine sites does not occur when guidelines are breached after rain because public health risk is likely to be low during such events either because bathing is unlikely during floods;
- re-sampling of marine waters occurs when guidelines are breached regardless of weather conditions; and
- protocols for liaising between Council, TLAs and the local Medical Officer of Health, and for advising the public against swimming if this becomes necessary, are set out in the reports.

Conclusion: The current Recreational Water Quality Monitoring Programme is fit for purpose.

HBEWG (2008) state that a 2003 Opus report showed microbial contamination frequently exceeding guidelines below the Waipukurau oxidation pond (Table 4 Issue 11). The Opus report has not been sighted but the following points relate to monitoring:

- it is conceivable that microbial contamination occurs downriver from the oxidation pond;
- it is likely that concentrations decrease downriver through natural disinfection processes;
- it is not clear how far downriver microbial indicator concentrations exceed guidelines;
- summer monitoring at Black Bridge (c. 60 km downriver from the oxidation ponds) shows a high level of compliance with guidelines (see above);
- there is recreational use (notably fishing, kayaking and swimming) in the lower Tukituki, and so there is merit in the issue raised by the HBEWG;
- it is not clear the extent to which the lower Tukituki River is used for contact recreation, although at the meeting on 22nd December the HBEWG stated that contact recreation is common at Tapairu Rd, Tamumu Bridge, Shag Rock and Patangata – below the oxidation ponds;
- the guidelines under which the recreational water quality monitoring is carried out suggest monitoring where and when contact recreation actually occurs; and
- Council must be mindful of not monitoring unless there is a good reason to do so.

Recommendation: Review contact recreational use in the lower Tukituki and determine if there is a public health risk arising from the oxidation pond discharges.

Recommendation: If it is established that contact recreation occurs commonly in the lower Tukituki upriver from Black Bridge in locations that may be affected by discharges from the oxidation ponds, Council should consider including an additional site in their Recreational Water Quality Monitoring Programme (e.g., Tapairu Rd, Tamumu, Shag Rock or Patangata).

Recommendation: If it is established that there are points of public access where microbial guidelines are not being met and contact recreation may occur (e.g., Tapairu Rd, Walker Rd, or Tamumu Bridge) then they should ensure the public is informed of any risk to public health (e.g., through signage).

Ausseil (2008) concluded that water clarity only complies with the standard set in the RRMP (1.6 m black disc) in only 55-75% of samples collected below 3 times median flow – albeit at more sites than the two identified bathing sites. Council needs to determine whether water clarity is an issue for recreational use in the Tukituki and whether controllable activities in the catchment are having an adverse effect on water clarity. Water clarity is discussed more fully in Section 4.4.2.

Recommendation: Review contact recreational use in the lower Tukituki and determine whether it is adversely affected by water clarity.

A minor weakness of the reports sighted is the apparent lack of a clearly defined protocol for determining which samples are, and which are not, affected by rainfall. In one of the reports checked in detail (Cameron and Madarasz-Smith 2007) there seem to be discrepancies between the graphs in Appendix 2 and the tables in Appendix 3 in the classification of rainfall related events. For example the Marine table in Appendix 3 classifies the *Enterocci* value at Porongahau Beach of 520 per 100 mL on 28th November 2006 as a rainfall related high value. However, the figures in Appendix 2 show no significant rainfall at Ben Nevis apart from ~2 mm on 22nd November 2006. There also appears to be a discrepancy at Te Awanga Coastal on 27th February 2007. Thus the statement on page 7 '…Seven of these exceedances were related to high rainfall events…' may be incorrect. It is possible that follow up sampling was not undertaken when it would have been advisable.

Recommendation: Consider a tighter protocol for identifying rainfall-related events and deciding whether or not to re-sample.

This could take the form of a control chart. A flow versus indicator correlation is developed from historic sampling. High concentrations associated with known contamination (e.g., sewage overflows) are excluded. A control line is fitted (e.g., the upper 67% confidence interval). Any sample falling below the control line does not trigger any action. On the other hand, any sample falling above the control line triggers follow-up sampling. This approach would formalise what appears to be happening at present. It would make the decision whether or not to undertake re-sampling more transparent and scientifically defensible.

5.2 Classification of sampling sites

Stansfield (2004) reviewed SOE monitoring data for the period 1998-2003. Data had been collected quarterly[4] over the Hawke's Bay region including the Tukituki. Sites were classified – based on climate, source of flow and topography – using the REC classification system. The Tukituki catchment includes several different Classes including:

- warm dry low elevation hard sedimentary pasture;
- warm dry low elevation soft sedimentary pasture;
- cool wet hill alluvium hard and soft sedimentary;
- cool wet hill volcanic acidic pasture;
- cool wet low elevation; and
- cool dry low elevation alluvium pasture.

One objective of the Stansfield report was to ensure that the monitoring programme sampled a representative number of sites in each Class. The report emphasises that river habitat (e.g., depth, velocity, slope, flow variability, shear stress, substrate type and mobility etc.) varies spatially and consequently differs between monitoring sites in the headwaters, the middle and lower parts of the catchment, and the tributaries. The response of river ecosystems to 'stressors' (e.g., sediment, nutrient, shade, flow etc.) needs to be assessed bearing in mind differences in habitat. This is relevant to how Council and the public perceive the spatial gradient in the MCI macroinvertebrate index discussed in Section 5.4.10.

Conclusion: Differences in physical habitat between sites affect MCI scores but this is not always clearly stated in commentaries.

5.3 State of the Tukituki in 2004

Stansfield (2004) included box and whisker plots for each water quality variable sampled from 1998-2003. Plots were grouped by Class enabling a visual comparison between sites in the same Class. However, sites in the Tukituki were not grouped together and it is difficult compare water quality at different sites in the Tukituki. No

[4] SOE sampling is now conducted monthly

attempt was made by Stansfield (2004) to relate pressure to water quality or ecological condition, nor was there a discussion of specific water quality or ecological issues in the Tukituki. Stansfield (2004) noted that '…warm and cool dry low elevation sites show low compliance with periphyton guidelines...' and '…this is expected as low elevation areas generally have higher nutrient concentrations (which) combined with a dry climate ensures good periphyton accrual…'

Stansfield (2006) in the Strategy report makes two comments about monitoring carried up to 2004 '…current results indicate that nutrient concentrations are increasing in some catchments. To date this has not resulted in a significant ecological change of these systems…' and '…the region has many river sites that comply with current guidelines. However, there are some that do not. Most non-complying sites occur in warm, dry, low elevation pastoral areas where land use pressures are high…' The Tukituki is not identified as one of the rivers in which nutrient concentrations were increasing or which did not comply with water quality guidelines – although this is a reasonable inference.

There are four important points in these statements. First, periphyton biomass often exceeds guideline values. Monitoring of periphyton biomass only occurs once per year – normally during summer low flows. One would expect periphyton biomass to be high at such times because during low flows: dilution of point and diffuse source nutrient loads is low, periphyton losses through shear and abrasion are low, high temperature and light favour rapid periphyton growth, and high temperature disadvantages some grazing macroinvertebrates. Second, the Tukituki River experiences long periods of low flow in summer. These allow periphyton biomass to accrue to high levels and to remain high for long periods. High flows (>3 times median flow, Biggs 2000) 'flush' periphyton from rivers and were freshes to occur more frequently, then high periphyton biomass would occur less frequently and for shorter periods. Third, nutrient concentrations are high in low elevation sites. Periphyton growth rate increases with increasing nutrient concentration. One would expect to find higher periphyton biomass more often and in more of the river system where nutrient inputs and concentrations are high, provided other factors (e.g., flow, temperature and shade) are not limiting. Fourth, nutrient concentrations are increasing over time at some sites. One would expect this to increase periphyton growth rate and to result in high periphyton biomass occurring more frequently and in more places along the river.

It is not clear what conclusions Council reached on the following questions raised by the Stansfield (2004, 2006) reports, or what actions (if any) they took:

- Do periphyton biomass and nutrient concentrations that exceed guidelines mean that Council's objectives are not being reached?

- Do increasing nutrient concentrations mean that Council's objectives are not being reached?
- Can land use be better managed to reduce nutrient concentrations?
- Does Council need to investigate these issues further?
- Does Council need to amend its policies and rules on these issues?

No attempt is made here to address these questions because the data discussed in Stansfield (2004, 2006) are included in the dataset analysed by Ausseil (2008) and are discussed in Section 5.4.

Conclusion: Issues of high nutrient concentrations and high summer periphyton biomass were identified in 2004 if not earlier.

5.4 Current state of the Tukituki

A draft report (Ausseil 2008) has recently been prepared by consultant Dr Olivier Ausseil. Its aim is to analyse water quality and monitoring data in the Tukituki catchment collected by Council and NIWA between 1977 and 2008 and to investigate:

1. the state of the Tukituki River and its main tributaries;
2. temporal trends;
3. the annual contaminant loads in the Tukituki River; and
4. the contribution of the different point source discharges and main tributaries to the contaminant loads.

The main conclusions from the report are discussed in this section from the perspective of assessing the adequacy of the available monitoring data.

5.4.1 Microbiological water quality

Ausseil (2008) concludes that microbiological water quality is good across the catchment and is improving over time. This conclusion is consistent with the annual reports of the Recreational Water Quality Monitoring Programme discussed in Section 5.1.

5.4.2 Water clarity

Ausseil (2008) concludes that water clarity is acceptable.

The RRMP sets the clarity standard in areas used for contact recreation as 1.6 m black disc. At flows <3 times median, compliance with this standard ranges from 55-75% at 5 sites on the Tukituki main stem (Ausseil 2008, Table 8). Compliance is lowest at the upriver site (SH50) – possibly because of natural erosion in the headwaters – and shows no consistent pattern in the middle and lower sites.

At flows <median, compliance with more stringent values suggested for trout (based on their ability to see and capture food) are significantly lower – 29-58% for 3.5 m and 5-25% for 5 m. Compliance with these suggested guidelines for trout is highest at the most upriver site (SH50) and decreases downriver. It is not clear what 'standing' these clarity values for trout hold – they do not appear in the RRMP.

The RRMP sets the standard for SS concentration as 10 mg L^{-1} at all flows with the *proviso* that if SS naturally exceeds 10 mg L^{-1} then an activity may not increase it by more than 10%. Compliance is lowest (71% at <3 times medium flow) at the most upriver site (SH50) – possibly because of natural erosion in the headwaters – and gradually improves (85-92%) with distance downriver. Turbidity is routinely measured but appears not to be used to guide management decisions.

Referring to Table 1, the questions relevant to this review are:

1. Is clarity being maintained or enhanced?

2. Is clarity adequate for sustaining or improving aquatic ecosystems?

3. Is clarity adequate for contact recreation?

4. Are activities in the catchment adversely affecting clarity?

5. Is monitoring adequate to detect and manage such activities?

No statistically significant trends have been identified in the main stem of the Tukituki or Waipawa Rivers although in the Makaretu River clarity appears to have decreased at c. 3% per year (Ausseil 2008).

At most water quality monitoring sites the number of samples exceeds 50 – sufficient for characterising clarity, SS and turbidity. Five sites (Tukipo at Ashcroft Rd, Tukituki at SH2, Waipawa at Nth Block Rd, Mangaonuku at Tikokino Rd and Mangatarata Stm) have fewer samples (e.g., BD – 15-46) which limits the ability to detect small changes. However, given that clarity is deemed to be '…acceptable…' the small number of samples at these sites may not be of significance.

Conclusion: The documents sighted give the impression that water clarity is not a pressing management problem in the Tukituki.

It is beyond the scope of this review to make a detailed analysis of clarity or offer an opinion on whether existing clarity is, or is not, acceptable. However, it is noteworthy that Ausseil (2008) has highlighted that:

1. at flows <3 times median, water clarity is in compliance with the 1.6 m standard for bathing waters in only 55-75% of the samples – albeit at some sites that may not be commonly used for bathing;

2. the more stringent clarity values for trout are frequently not attained in the middle and lower reaches; and

3. the lowest clarity and the highest SS occur at the SH50 sites nearest to the foothills.

Referring to Objective 27 (Table 1) the question arises whether clarity is suitable for sustaining aquatic ecosystems (notably the trout fishery) and contact recreation (notably swimming).

Natural erosion in the hill country probably contributes to low clarity and high SS at the SH50 sampling sites. The Land Monitoring Strategy (Phillips 2006) characterises land in the Hawke's Bay as '…erodible hill country with a smaller proportion of productive plains…' and goes on to say '…there is evidence that erosion problems exist…' but '…we lack monitoring to say just how bad hill country erosion is…' Council has begun to monitor hill country erosion using aerial photography analysed using the Point-Grid method of Doug Hicks. Council is also investigating, in partnership with TerraLink, new methodologies using high resolution satellite imagery. No information appears to be forthcoming yet from these studies quantifying hill country erosion or assessing the practicality and likely effectiveness of control measures. No information exists linking hill country erosion with water clarity.

On the plains wind erosion is a significant issue where soils are light. For some years Council monitored wind erosion by mapping and surveying shelter belts and by measuring dust accumulation as part of the air quality monitoring strategy. This monitoring provided information about the location and rates of wind erosion although results have not been sighted. This information might help make a ‘first cut’ estimate of the effects of wind erosion on water clarity.

Other sources of suspensoids that affect water clarity include stock access to waterways, riverbank erosion, surface runoff from forestry, cropping land and pasture, road runoff and point source discharges.

Council may decide that clarity, SS and turbidity are at acceptable levels. In this case management intervention is not required and monthly SOE monitoring is sufficient for tracking future trends. Council may decide that further investigation is needed of the factors affecting water clarity. If so then it is recommended these start with a desk study of the effects of erosion on water clarity. Council will then be in a better position to decide whether water clarity is being affected by natural and uncontrollable processes. If so then further investigations may not be justified and SOE monitoring is sufficient for tracking future trends. Council may decide that clarity, SS and turbidity are not acceptable and that controllable activities in the hill country and/or plains are contributing to these problems. If this is the case then further investigations are required. These could include sediment budget modelling and sediment source tracking using isotopes.

Recommendation: Undertake a desk study, identify linkages between hill-country, wind erosion and water clarity, and decide whether clarity could be adversely affected by controllable activities in the catchment.

5.4.3 Nutrient enrichment and periphyton growth

Ausseil (2008) states that ‘…the largest single issue appears to be nutrient enrichment and associated periphyton growth, with a degradation from upriver to downriver...’ This statement is consistent with the RRMP which includes a phosphorus standard aimed at controlling periphyton growth, and statements about the protection of ecological values. It is also consistent with conclusions in Stansfield (2004, 2006). Periphyton growth during summer low flows has been a well recognised issue in the Tukituki River and elsewhere in Hawke’s Bay for some years.

Conclusion: There is evidence that nutrient enrichment adversely affects water quality, and poses a threat to aquatic ecosystems and contact recreation during summer low flows, contrary to Objective 27.

5.4.4 Nutrient limitation

Ausseil (2008) concludes that '…the system appears to be phosphorus limited although periods of co-limitation by phosphorus and nitrogen occur during low flows…' An elegant analysis of SIN:SRP ratios as a function of flow is advanced to support this conclusion. Ausseil (2008) notes that drawing inferences from nutrient concentrations in the river water is fraught with danger – I concur. One way to determine nutrient limitation directly is to use bioassay techniques. These include the use of 'diffusing substrates' in which periphyton are grown in the field on porous media impregnated with combinations of nutrients selected in such a way as to tease out which is in short supply at the test location. Council staff are using this method during specific investigations. A second way to determine nutrient limitation is to measure the concentrations of nutrients within periphyton tissues – a high N:P ratio within tissue is a better indicator of P limitation than a high N:P ratio in the overlying water. A third way is to measure enzyme activity in periphyton – a high phosphatase activity is an indicator of P limitation. These methods may be appropriate for specific investigations but, arguably, should not be part of routine SOE monitoring.

Ausseil (2008) argues that at high flows, SIN concentrations in the river water are high and the SIN to SRP ratio is high. Under these circumstances, if either nutrient limits periphyton growth, it is more likely to SRP. However, at high flows and/or concentrations neither nutrient may be limiting growth. In the laboratory the 'saturation' concentration for growth by individual cells and thin biofilms is very low – typically of the order 1 mgP m^{-3} and 10 mgN m^{-3} (Biggs 2000). When a thick periphyton biofilm develops, nutrient must diffuse from the water into the biofilm before cells can use it for growth. In these circumstances increasing nutrient concentration in the water increases the diffusion rate. This in turn increases the growth rate of the biofilm, even though water concentrations are above the values that would 'saturate' the growth of a very thin biofilm.

Conclusion: SIN and SRP concentrations and their ratio during high flows provide little useful information about likely nutrient limitation during summer low flows.

At low flows, SIN concentrations in the river water, and the SIN:SRP ratio, are often low. The fact that SIN concentrations in the river are low indicates that N is in short supply and is removed from the river water quickly when resupplied by inflows and/or recycling within the channel. At such times it is highly likely that N supply limits the growth rate of periphyton. The question then arises why SIN should appear to be limiting during summer low flows while SRP appears to be limiting at other times?

If the optimal N:P ratio for periphyton is 7:1 and the inflow concentrations are 200 mgN m^{-3} and 20 mgP m^{-3} (viz., ratio 10:1) then one would expect P limitation – if either nutrient is limiting. If plant uptake removes 10 mgP m^{-3} (50%) and if N is removed in the proportion 7:1 – the optimal for periphyton – concentrations should drop to 130 mgN m^{-3} and 10 mgP m^{-3}. Thus the ratio increases from 10:1 to 13:1. However, apparently the opposite happens in the Tukituki River – at low flows as SIN and SRP concentrations decrease, the N:P ratio decreases.

There are four possible explanations. First, the supply of N to the river may decrease during summer more than the supply of P. Nitrate – the dominant contributor to SIN – concentrations are high in the shallow groundwater that drains intensive agricultural land. Deep groundwater often has low nitrate concentrations – although these may increase over time through drainage from intensive land use. If summer low flows are maintained by the upwelling of deep, low nitrate groundwater then river N:P ratios may be lower in summer than in winter. This assumes that P is equally abundant in shallow and deep groundwater. Second, nitrate is removed by plant uptake and/or microbial denitrification in riparian zones along river banks, wetlands, and in the channels of tributaries especially during summer low flows. A larger proportion of runoff may pass through riparian zones and/or wetlands in summer than at other times of the year. Nitrogen removal in wetlands and riparian areas has been postulated as the reason rivers at Whatawhata had very low SIN concentrations and low N:P ratios during summer low flows (Dr John Quinn, NIWA, pers. comm.). Third, the supply of P to the river may increase relative to N during summer. One possible mechanism is the release of P from sediments accumulated in the river bed. Phosphorus is known to adsorb to fine particulates but to maintain an equilibrium with water concentrations (Stumm and Morgan 1981). As P is removed from the water (e.g., by periphyton growth) then P is released from the sediment to try and maintain this equilibrium. Fourth, it is possible that river denitrification affects the N:P ratio. Under anaerobic conditions in the hyporheos, microbial communities oxidise carbon using nitrate as the electron acceptor and in so doing liberate nitrous oxide and/or di-nitrogen gas to the atmosphere. Under normal flows the rate of river bed denitrification is insufficient to noticeably affect nitrate concentrations (quote from nutrient attenuation workshop). However, during summer low flows it is conceivable that the combination of shallow water depth, permeable gravels of the Tukituki and low SIN inflows could mean that riverbed denitrification has a significant effect on SIN concentrations in the river.

Conclusion: SIN depletion during summer low flows indicates that N limits periphyton growth at such times. At slightly higher flows SRP and SIN are likely to be co-limiting.

In cold, northern hemisphere lakes maximum summer phytoplankton biomass is strongly correlated with lake-average nutrient concentration in early spring (viz., before phytoplankton begin to grow) (Dillon and Rigler 1974). Rivers are more complex than lakes because nutrient uptake induces longitudinal gradients in concentration. Nevertheless, in spring, before periphyton become abundant, SIN and SRP concentrations provide a good indicator of which nutrient is likely to limit growth later in the year and also of the maximum biomass that is likely to accrue. The MfE Periphyton Guideline (Biggs 2000) contains empirical equations that relate maximum periphyton biomass to the annual average SIN or SRP concentration and time since the last flood.

The Hawke's Bay SOE monitoring dataset contains >100 SIN and SRP samples at key monitoring sites. As demonstrated by Dr Ausseil, this is adequate to characterise the nutrient status of the river. It should also provide satisfactory input data for the empirical equations for predicting periphyton biomass given in the Periphyton Guideline (Biggs 2000).

Periphyton biomass (and macroinvertebrate numbers) are only monitored once per year following a period of low flow. This sampling strategy may miss the maximum periphyton biomass. Monthly water quality monitoring does not include periphyton biomass measurements and this makes it difficult to determine the extent to which SIN and SRP concentrations might have been affected by periphyton uptake.

Monthly measurements of SRP and SIN concentration together with continuous measurements of flow would enable periphyton biomass to be predicted using the empirical equations of Biggs (2000). Annual measurements of periphyton biomass would enable limited verification of these equations. If verification shows that these equations need to be adjusted for Hawke's Bay conditions, then annual measurements of periphyton biomass may not be sufficient and a separate investigation might be required.

Recommendation: Use available data to predict periphyton biomass and compare with annual observations. Hence decide whether the Biggs (2000) equations give satisfactory predictions or whether they need adjusting for Hawke's Bay conditions.

5.4.5 Management of nutrient

It is often easier to control P than N. The former tends to move attached to particulate material and controlling sediment supply (e.g., through retiring eroding land, fencing cattle out of rivers, using grass filter strips and/or detention basins to trap particulates) is seen as easier than dealing with drainage and groundwater.

Some volcanic rocks are susceptible to P leaching (e.g., old groundwater in the central volcanic plateau have high natural SRP concentrations – Timperley and Vigor-Brown 1986). This makes it more difficult and costly for the control of just P to be effective. Because P is often found loosely bound to particulate material, historic sediment in the river bed, banks and flood plain are a potential source of P which, if released into the river, may negate the benefits of catchment control. Management of only one nutrient may be a risky strategy.

HBEWG (Table 4 Issue 7) suggest a study of nitrogen and this suggestion has merits.

It is widely argued that managing just N or just P is a risky strategy and that both N and P need to be managed (Wilcock et al. 2007). Recent Council studies indicate that the limiting nutrient changes as you move down the Mohaka River. Ausseil (2008) shows that the limiting nutrient changes as flow decreases in the Tukituki River.

So-called ‘blue-green’ algae (cyanobacteria) can ‘fix’ atmospheric N and as a result the control of just N is a risky strategy. HBEWG (Table 4 Issue 5) raise concerns about blue-green algal blooms in the Tukituki River. Recently blue-green algae seem to have become more abundant in rivers throughout New Zealand and have caused some problems including dog deaths. It is not clear why these blooms have occurred and whether they are an enduring feature resulting from land use intensification and/or climate change. In 2003-2004 blue-green algal blooms caused problems in several North Island lakes. However, in subsequent years there have been few problems with such blooms – emphasising their sporadic nature.

Recommendation: Continue the current field study using diffusing nutrient substrates, and re-analyse existing water quality and land use datasets, to investigate the role of P and N, separately or together, in the control of periphyton growth.

Depending on the outcome of this study, Council may need to consider including a guideline for SIN in the RRMP in addition to the existing guideline for SRP. The study should address the question of whether it is best to control N, P or both. This will depend on the sources on N and P, what can practically achieved to control inputs, and what historic stores there are in the system.

Recommendation: Make decisions on whether to control N, P or both on a catchment-by-catchment basis.

Recommendation: Consider including a guideline for SIN in the RRMP in addition to the existing guideline for SRP.

5.4.6 Spatial patterns in nutrient concentration

Ausseil (2008) states that '…SIN and SRP concentrations indicate good water quality at SH50 (the most upriver sites) but increase rapidly between SH50 and SH2…' and '…high yields (of SIN and SRP expressed in kg ha^{-1} yr^{-1}) in the Tukituki and Waipawa catchments correspond with areas of high land use intensity…' Elsewhere in New Zealand strong relationships have been found between land use intensity, nutrient loads and water quality. However, in the reports sighted little quantitative information is presented about land use intensity. Such information would be useful. It would enable comparisons to be made between spatial patterns of land use intensity and water quality.

Recommendation: Collate land cover/use data. Examine time trends in land cover/use and forecast likely future changes. Examine spatial and temporal correlations between land cover/use and water quality/ecology.

Having collated land cover/use data, it would also be possible to make quantitative comparisons between nutrient generation (using models such as OVERSEER, SPASMO and/or CLUES) and the results of monitoring. From such a comparison, estimates could be made of attenuation[5] and/or discrepancies identified in the available information.

The Land Monitoring Strategy provides GIS information on land cover and use (LCDB2). This data would be valuable for the work suggested. However, this information does not include the details of management (viz., stocking rates, fertiliser usage etc.) which limits Council's ability to accurately quantify 'pressures' arising from land use (Phillips 2006). In some locations, more detailed analysis has been conducted using aerial photographs (e.g., the Heretaunga and Ruataniwha Plains).

Stansfield (2006) comments that '…current results indicate that nutrient concentrations are increasing in some catchments. To date this has not resulted in a significant ecological change of these systems…' Ausseil (2008) states that '…SIN seems to originate from intensive agriculture in the Ruataniwha Plains rather than from point sources…' This statement seems a reasonable inference based on the fact that SIN concentration increases significantly through this part of the catchment. Nitrate is highly mobile and leaching rates from intensive pasture, cropping and horticulture can be very high compared with extensive grazing and forestry (Menneer et al. 2004).

[5] Attenuation is the loss or temporary storage of nutrient between where it is generated (on the land) and where it is measured (at the catchment outlet) and/or where it causes water quality problems (in the river channel or a receiving lake)

No land use data are included in Dr Ausseil's analysis and none of the documents sighted during this review includes a quantitative analysis of current land use intensity or trends over time.

Conclusion: Land use data would be a very useful adjunct to the SOE water quality monitoring data.

Ausseil (2008) comments that during summer low flow SIN and SRP concentrations decline in the lower Tukituki. This has also been observed during recent sampling (Dr John Quinn, NIWA, *pers. comm.*). The likely explanation is the uptake of soluble nutrient by periphyton and/or dilution by low nutrient inflows.

The relationship between nutrient inputs, river flow, periphyton growth and ecological health in the Tukituki are complex – see discussion below. However, this does not mean that the increasing trends along the river as it flows through intensively farmed areas (as identified by Stansfield and Ausseil) can safely be ignored. Ausseil (2008) suggests that the Waipawa and Mangatarata catchments should be the focus of investigation aimed at reducing diffuse source nutrient inputs. Presumably these catchments were selected because they contribute the largest loads. However, it would be useful to collate information on land use intensity throughout the entire catchment and to match patterns in land use with water quality. It is suggested that not only current land use intensity be quantified, but also historic patterns and emerging trends.

Recommendation: Conduct a preliminary modelling study using OVERSEER and/or CLUES and relate land cover/use and water quality both in space and over time.

5.4.7 Temporal patterns in nutrient concentration

Ausseil (2008) concludes that '…SRP concentrations are increasing over time at several (but not all) sites in the mainstem and tributaries..' This is consistent with previous studies (e.g., Stansfield 2004, 2006). Thus, there is evidence that water quality is not being '…maintained or enhanced…' as required by Objective 27 at least in respect of SRP and SIN concentrations at some monitoring sites.

Increasing trends in nutrient concentration is cause for concern. Elsewhere in New Zealand such trends have led to the imposition of land use controls because eutrophication is seen as a threat to water quality (e.g., Taupo Regional Plan Variation 5). However, Objective 27 also states '…in order that it is suitable for sustaining or improving aquatic ecosystems…' Thus an important question is whether high SRP and/or SIN concentrations cause adverse effects on aquatic ecosystems, or whether adverse effects could arise in the future.

Conclusion: There is evidence of increasing nutrient concentrations at some sites which does not meet the first requirement of Objective 27 to '…maintain or enhance water quality…'

The SOE dataset includes a sufficient number of samples over at least 10 years (typically >100) for a scientifically defensible trend analysis to be conducted at key sites. Ausseil (2008) notes that the sampling interval varies (mostly quarterly or monthly). He chose to average and/or extrapolate to get a monthly dataset that he analysed for trends. Other methods of analysis are available but these are unlikely to give a significantly different result.

The Tukipo at SH50 breaches nutrient guidelines for both SRP and SIN and, unlike most other sites, microbiological water quality is not improving. The Mangaonuku shows an increasing trend in SRP and SIN. No information is given about land use in these sub-catchments. It is tempting to conclude that land use intensification has contributed to these increases, although no evidence for this has been sighted. This issue was discussed in Section 5.4.6.

On page 35-36 the rather surprising conclusion is reached that SRP concentrations have been increasingly significantly (6% per year) at all the SH50 sites (viz., in the upper reaches of the catchment). No land use data is presented but the impression is given that the upper parts of the catchment are largely undeveloped hill country, forestry or extensively grazed pasture. There is no discussion about possible reasons for an increasing trend in SRP concentration.

There are at least two possible explanations for the observed trend. First, land use change. Nutrient concentrations are generally low at the SH50 sampling sites – as expected for rivers draining undeveloped land. This means that a small increase in land use intensity could have a significant effect on SRP concentration. By examining land use data in parallel with water quality monitoring data – as suggested in Section 5.4.6 – this possibility could be investigated. Second, hydrology. Table 12 of Ausseil (2008) shows that 2004-2006 were significantly wetter than 2006-2008. If the input of P remains constant then concentrations can be expected to increase with decreasing flow, and *vice versa*. It is possible that the increasing trend in SRP concentration is not symptomatic of a change in phosphorus input but rather the result of a change in flow. Table 11 states that concentrations were '…flow adjusted…' prior to trend analysis. Nevertheless it might be advisable to re-examine this issue – given its importance – and ensure that the trend is not an artefact of flow changes.

Recommendation: Re-examine water quality at the SH50 sites and land use in the headwater catchments to ensure the trends identified are not an artefact of flow differences and determine whether they are the result of land use intensification.

Sample numbers are small at several sites (e.g., Tukipo at Ashcott Rd, Waipawa at Nth Block Rd, Mangaonuku at Tikokino Rd, Mangatarata and Waipawa below oxpond). At these sites it would not be possible to detect small changes in concentration or load. However, any large changes could be detected and, if samples continue to be collected, the power to detect small changes will increase over the next few years. The ability to detect small changes is not in itself a compelling reason to continue sampling – sampling should only continue to answer a clearly defined and important management question (e.g., to monitor the effectiveness of control measures).

5.4.8 Oxidation ponds at Waipawa and Waipukurau

Ausseil (2008) concludes that these are the largest source of P in the catchment. Dividing the average reported P load by the median and MALF respectively, the increases in SRP expected at the Waipukurau outfall are 12 and 40 mgP m^{-3} and at the Waipawa outfall are 9 and 26 mgP m^{-3}. The guideline for SRP concentration – after adding the upriver 'background' concentration – is 15 mgP m^{-3}. It is clear that the two oxidation pond discharges are likely to result in the SRP guidelines being exceeded at river flows below median. This probably contributes to periphyton growth and problems with ecological health in the lower Tukituki.

Monitoring in the Waipawa shows that SRP concentration increases significantly from above to below the oxidation pond outfall and exceeds the guideline – as expected. However, at Waipukurau there is a discrepancy between the expected increase in SRP concentration and measured increases. Ausseil (2008) suggests that mixing below the Waipukurau oxidation pond is complex and HBEWG (Table 4 Issue 10) argue that the sampling site may not be suitable for detecting the effects of the discharge.

As discussed in Section 3, compliance monitoring in the past may not have quantified the impact of the oxidation pond discharge because of complex and incomplete mixing. It is my understanding that compliance monitoring now always occurs 400 m downstream from the discharge point. Effluent may not mix completely across the channel within 400 m of the discharge point. Consequently, samples need to be collected within the plume to check for compliance. It should be possible to identify where the plume lies (e.g., using a hand held conductivity meter or visually). It is recommended that 3 samples be collected at 25%, 50% and 75% distance across the plume, and bulked.

Recommendation: Ensure that compliance monitoring below the Waipukurau oxidation pond always occurs at the end of the 400 m mixing zone. Effluent may not mix completely across the channel within the mixing zone and samples need to be collected from within the effluent plume.

If mixing is incomplete then these plume samples will over-estimate the fully-mixed concentration of determinands such as P and N. However, the principal purpose of this sampling is to check compliance with consent conditions.

One objective of SOE monitoring may be to quantify the effect of the oxidation ponds on P and N concentrations in the river. If so then an additional SOE monitoring site could be considered at a point below Waipukurau, where mixing is complete (e.g., Tapairu Road, Tamumu, Shag Rock or Patangata).

Recommendation: Consider including an additional site in the SOE monitoring programme to quantify the effects of the Waipukurau oxidation ponds after complete mixing (e.g., Tapairu Road, Tamumu, Shag Rock or Patangata).

Council has granted consents that require SRP loads from the oxidation ponds to be significantly reduced by 2014. Some members of the public believe Council should act more quickly on this matter. HBEWG (Table 4 Issue 13) suggest that the 2014 consents may not solve all the water quality, ecological and microbial contamination problems associated with the oxidation ponds. Ausseil (2008) comments that even drastic reductions in nutrient load may not result in complete compliance with water quality and periphyton guidelines. I concur.

Conclusion: Even drastic reductions in nutrient load may not result in complete compliance with water quality and periphyton guidelines.

It is not within the scope of this study to review the consent process for the oxidation ponds. Rather it is to review the ability of the monitoring programme to detect problems. However, there are merits in the suggestion that an integrated approach needs to be taken to determining the cumulative effects of the myriad of land use activities and discharges in the catchment. One way to approach this problem is through modelling as is discussed in Section 5.5.

Conclusion: The issue of high SRP inputs from the oxidation pond has been identified and is being addressed.

5.4.9 Attenuated and unattenuated nutrient loads

Dr Ausseil makes a comparison between the SRP load discharged from the oxidation ponds (Central Hawke's Bay District Council compliance records) and river loads (that he calculated from measured concentrations and flows). He notes that the catchment load has experienced some 'attenuation' (e.g., nutrient removal in riparian zones, wetlands, groundwaters or tributaries) by the time it reaches the outfalls. Nutrients from the oxidation ponds undergo attenuation downriver from the outfall –

evidence for this comes from the fact that nutrient concentrations are lower at Red Bridge and Black Bridge than at Shag Rock – but are unattenuated at the outlet pipe. Nevertheless, Figures 16 and 17 of Ausseil (2008) enable a comparison to be made of the load in the river at the outfall with river load at the point of discharge.

It would be useful to collate information about unattenuated loads. Typically the load seen in the river is of the order 50% of the load generated – the other 50% being 'attenuated' somewhere in the system. Nutrient loads generated in the catchment, prior to attenuation, cannot easily be measured. They can, however, be estimated (e.g., using models such OVERSEER, SPASMO, SPARROW[6] and CLUES[2]). If this were done, the oxidation pond load for P would be a smaller proportion of the total P load generated (diffuse plus point source). This would not alter the fact that at the point of discharge the oxidation ponds significantly increase SRP concentrations.

5.4.10 Spatial patterns in macroinvertebrate communities

Ausseil (2008) points out that '…macroinvertebrate communities show a pattern of degradation down the catchment…' This is consistent with previous findings (e.g., Stansfield 2004, 2006). It is also consistent with progressive nutrient enrichment and the stimulating effect on periphyton growth (Stansfield 2004).

Conclusion: Patterns of degradation down the catchment suggest that Objective 27 '…sustaining or improving aquatic ecosystems…' is not being attained.

The macroinvertebrate community index (MCI) is used to assess macroinvertebrate communities. The MCI gives higher scores to species that prefer cold water, high dissolved oxygen concentrations and low-moderate periphyton biomass (e.g., stoneflies and mayflies) than to species that can tolerate warm water, lower dissolved oxygen concentrations and more abundant periphyton (e.g., snails). Physical habitat influences the macroinvertebrates that inhabit a river reach both directly (flow variability, substrate type, depth, velocity) and indirectly (rates of heating/cooling, reaeration, scouring periphyton biomass, and removing fine sediment). As a result one would expect to see changes in the MCI index with distance along the Tukituki main stem as a result of natural changes in slope, flow variability, temperature, width, depth, velocity and substrate. More important is the difference between the measured MCI and the values expected in the undeveloped state (viz., pre-Maori) or a developed-managed state (viz., farming and urban with best management practice).

[6] which also includes attenuation

Conclusion: No information was sighted to enable the difference in MCI to be determined between current conditions and either the undeveloped state or a developed-managed state.

It is difficult to tease apart natural differences from those caused by land use and point source discharges. There are no unmodified rivers similar to the Tukituki to serve as a control. However, Dr John Leathwick has recently developed statistical methods for making this separation. At a recent conference (Leathwick 2008) a method was described which correlates MCI scores with annual nitrogen load (predicted by the CLUES model) and %age of catchment area in native forest for each river reach in the River Environment Classification (REC) dataset. Nitrogen load and %native forest explain about 50% of the variation in MCI scores.

Recommendation: Predict MCI scores in the Tukituki for undeveloped and developed-managed states using the method of Leathwick (2008) and compare with measured values.

HBEWG suggest measuring periphyton and macroinvertebrate biomass monthly at the same time as water quality. Frequent measurements of periphyton biomass together with SRP and SIN concentrations and flow would be useful for testing the equations in Biggs (2000). However, such sampling would be a special investigation rather than routine SOE monitoring. It is not clear whether more regular MCI measurement would significantly advance current understanding of river ecology issues. It would significantly increase the costs of SOE monitoring.

5.4.11 Temporal patterns in macroinvertebrates

Ausseil (2008) concludes that '…MCI indices are deteriorating over time in the upper catchment…' This, like the increasing trend in SRP concentration at the SH50 sites, is surprising given the undeveloped nature of the headwater catchments. It suggests that water quality is not being '…maintained or enhanced…' at these sites as required by Objective 27. Potentially this has significant management implications given that Policy 72(d) in the RRMP requires that '…where existing water quality is better than the guidelines, no more than minor degradation of water quality will be allowed…'

Macroinvertebrate sampling is only conducted once per year following a period of low flow – thus sample numbers are small. Despite this a statistically significant trend has been identified at the SH50 sites. It is conceivable that such a small number of samples could inadvertently contain 'bias' especially given the large differences in flow over the sampling period (Ausseil 2008).

Recommendation: Confirm that trends in MCI at the SH50 sites are not an artefact of changes in flow, and examine land use changes in the headwaters.

5.4.12 River flow

Flow strongly influences river water quality and ecology by determining the dilution of point sources, depth, velocity, scour of periphyton and fine sediment, reaeration rate, heating/cooling rate, and exchange rate with the hyporheos. Water and contaminants from the catchment flow to streams along different pathways (viz., surface runoff, interflow, shallow groundwater, deep groundwater). As the catchment wets and dries the proportion of water travelling along each pathway changes. Consequently contaminant inputs from diffuse sources, and the resulting stream concentrations, vary with flow.

Flow data is available in the Tukituki to help interpret water quality and ecology monitoring. Of the 16 monitoring sites, 7 have flow recorders, 8 have high or medium quality correlations with recorders, and only 1 site (Mangatarata) has a poor flow record (Ausseil 2008). Given its high SRP concentration, monitoring is likely to continue in the Mangatarata and it is desirable for either: further gaugings so that a correlation can be established with a nearby recorder, or a flow recorder.

Relevant questions for this study are whether:

1. water abstraction has adverse effects on water quality, aquatic ecosystems and/or contact recreation; and

2. current monitoring is able to detect such effects, so as to inform policy.

Minimum flows are set using the IFIM approach. This approach is used extensively throughout New Zealand and is endorsed by EMS (2005). The setting of minimum flows is a separate exercise from SOE monitoring. It involves determining the habitat preferences (e.g., depths and velocities) of keystone species, detailed surveying of selected channel reaches, hydraulic modelling (to estimate how depth and velocity change with flow) and hence determining how habitat changes with flow. Habitat preference curves have been developed for keystone species including native fish. Work is currently underway to refine the habitat preferences for trout in Hawke's Bay rivers.

Total surface water allocations exceed the established allocatable water (Brooks 2007). Total allocation is a poor indicator of the actual water use – as little as 30-40% of allocated surface water may actually be used (HBRC 2006). Council has poor knowledge of actual water use. In the Ruataniwha Plains 14 out of 76 surface water abstraction sites are metered (Brooks 2007). Consent holders are required to provide Council with pumping data but compliance monitoring and enforcement of consent conditions is rare (Brooks 2007). Compulsory metering and 'real time' reporting have been recommended but are not currently in place. The Surface Water Quantity Strategy (HBRC 2006) states that '…based on the current information it is difficult to identify the success or otherwise of Council policy concerning surface water quantity…'

Conclusion: The lack of reliable information about actual surface water abstraction restricts Council's ability to make policy decisions not only about water availability and allocation, but also about water quality and ecology.

The effects of surface water abstractions on nutrient concentration from diffuse sources are probably of second-order importance because removing water also removes the nutrient it contains. The effects of abstraction on periphyton biomass are also probably of second-order importance because flows typically need to exceed 3 times median to dislodge periphyton, allocatable flow is only 7-10% of median flow (Table 6), and surface water abstractions have only a minor effect on freshes of this magnitude.

Table 6: Summary of median, minimum and allocatable flows.

Site	median flow[1] $L\ s^{-1}$	minimum flow [2] $L\ s^{-1}$	allocatable flow [2] $L\ s^{-1}$	minimum /median %	allocatable/ median %
Waipawa at RDS	8,574	2,300	566	27	6.6
Tukituki at Tapairu Rd	9,194	1,900	814	21	8.9

[1] Ausseil (2008) Table 1   [2] Brooks (2007) page 12

Land use intensification has occurred recently and is forecast to continue, notably in the Ruataniwha Plains. This will increase the demand for irrigation water. Surface water is currently over allocated which means that Council cannot grant new consents to abstract surface water unless it either recovers and reallocates allocated but unused takes, or reduces minimum flows[7]. Both options increase risks to Council and abstractors, and would not be popular with recreational water users.

[7] It is noted that consents were recently granted to abstract water for irrigation from the Tukituki and Waipawa rivers. It is understood that the hearings committee was advised the

In theory, irrigation takes should decrease so that the minimum flow is always maintained until the point is reached where natural flows, in the absence of any abstraction, drops below the defined minimum. By monitoring river flows at key locations continuously (via telemetry) Council is well placed to determine the allocatable flows, and advise abstractors of any restrictions. Reports sighted indicate, however, that Council has very little information about actual water consumption. If so then Council would appear to be unable to determine compliance or to enforce consent conditions.

It is not clear, however, from the sighted reports whether over-allocation and the lack of compliance monitoring of water consumption cause adverse effects on river flow, water quality and ecology. It is argued by some that during summer the ecosystem is stressed naturally, flows drop below the minimum naturally during droughts, the river ecosystem has evolved to cope with droughts, and the river ecosystem recovers after droughts. It is argued by others that limits need to be placed on abstractions to prevent adverse effects on other water users and the river ecosystem. The appropriate time to resolve the way in which surface water abstractions are resolved is when Council reviews minimum flows.

Recommendation: Undertake a desk study on the impacts of surface and groundwater abstractions on river flow, depth and velocity and its effects on nutrient concentration, periphyton biomass and MCI.

Council currently focuses on a managing to single, minimum flow. Council may need to move to managing the flow regime including freshes rather than just a single minimum flow. Currently allocatable flows are small compared to freshes but this could change if irrigators look to divert and store flood flows – as has been suggested. There is currently debate about the way to manage such diversions so as to least disrupt natural flow variability. This topic is beyond the scope of this review but two points are relevant to monitoring, First, in some rivers complex abstraction rules are set aimed at preserving natural flow variability. Second, for complex rules to be implemented and monitored effectively it is necessary to have continuous metering and on-line reporting of river flows and major abstractions. Such a system may not be currently feasible, but could be an aspiration of Council.

Recommendation: Review methods used to set minimum flows given the possibility applications will be received to divert and store flood flows. At the same time review consent conditions, metering, reporting including automatic on-line reporting, compliance monitoring and enforcement of consent conditions in relation to the effects of water quality and ecology.

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rivers concerned were already over-allocated. The legality and justification for granting these consents are unclear.

5.4.13 Surface-ground water exchanges

Several reports sighted during this review highlight the fact that surface water and groundwater are connected. The Tukituki and Waipawa Rivers lose flow to groundwater in the upper part of the Ruataniwha Plains and gain flow in the lower part (Baalousha 2008a). Gains from groundwater maintain river flow in the lower Tukituki during summer. Losses to groundwater help maintain important aquifers (e.g., Ruataniwha). The Ruataniwha aquifer is a large storage system replenished by recharge (rainfall minus evapotranspiration) and gains from rivers in the west, and depleted by groundwater abstraction, surface water abstraction and losses to rivers in the east. Because surface and groundwaters are strongly linked in the Ruataniwha, the management of one affects the other.

Council determined that surface waters were over-allocated in 2000 and since then has issued no further consents to abstract surface water[8]. However, consents to abstract groundwater have increased allocated amounts by about 300% since 2000. The Ruataniwha groundwater system may now be close to the point where groundwater pumping is affecting river flow (Brooks 2007). A strong case can be made to combine the management of surface and groundwater abstraction (Zermansky, in Brooks 2007).

Conclusion: Management of river flows, water quality and ecology would be easier if there was integrated, accurate and rapid reporting of surface water and groundwater abstractions.

HBRC (2006) and Baalousha (2008a) make it clear that surface-groundwater interactions are not fully understood or quantified. Several of the reports sighted state that further investigations are required to understand and quantify surface-groundwater flow interactions, or that such investigations were underway. HBRC (2006) mentions a research study that seeks to identify patterns of gain and loss along river reaches (Study 411-24) – but no results were sighted.

Whereas methods exist to determine the effects of surface water abstraction on river ecosystems (e.g., IFIM) no such methods exist to determine the effects of groundwater abstraction. Brooks (2007) recommends developing a groundwater model to address this problem and this work has commenced.

Groundwater quality and vulnerability

Council has held concerns for some time about the vulnerability of groundwaters to contamination from land-based activities. To date assessments and investigations have

[8] Although see footnote 7

focused on identifying which aquifers are confined (less vulnerable) and which are unconfined (more vulnerable) and on identifying point-sources of potential contamination (e.g., septic tanks, tips, industrial and food-processing wastes).

Concerns are increasing about the effects of land use intensification on nitrate contamination of groundwaters.

Deep groundwater usually contains lower nutrient concentrations than drainage from intensively farmed soils. If this is the case, inflows from deep groundwater to rivers are likely to contain lower nutrient concentrations than inflows from drains, ditches and shallow groundwater. However, over time groundwater nutrient concentrations are likely to increase in response to land use intensification – notably nitrate concentrations. Increasing groundwater nitrate concentrations associated with land use intensification is well documented in the Rotorua and Taupo catchments (Morgenstern and Gordon 2004, Vant and Smith 2004). Consequently, groundwater nutrient inputs to rivers may increase over time, causing river concentrations to increase.

No documents were sighted during this review that address the vulnerability of groundwaters in the Tukituki to nitrate contamination from land use intensification. No information was sighted about groundwater age – important because it determines the lag times between land use intensification and changes in groundwater nutrient concentration (Morgenstern and Gordon 2004).

Groundwater is known to flow into the Tukituki River in the lower parts of the Ruataniwha Plains – an area where intensive agriculture is already occurring and further intensification is forecast. Ausseil (2008) points out that SIN concentrations increase significantly in this part of the Tukituki River. It seems a reasonable inference that this SIN comes from agricultural runoff and that a significant proportion is delivered via groundwater.

Baalousha (2007a) plots the mean concentrations of 5 ions (Ca, Cl, Na, Mg, HCO_3) in wells throughout the Hawke's Bay including the Ruataniwha. The report states that '…parameters such as nitrate are not presented because their concentrations are negligible…'. Baalousha (2007b) re-plots this data and adds NO_3 although concentrations are too low to see on the graphs. Trend analysis is presented for Ca, Cl, Na, Mg, HCO_3 but not for NO_3. The text comments that no trends were detected in any water quality parameter.

It is stated that '…all the analysed chemical parameters are within the limit of the New Zealand drinking water standards…' (Baalousha 2007b page 12). However, the RRMP states '…nitrate exceeded drinking water standard in samples collected at

Bridge Pa…' (RRMP 2006 page 49) which seems to be at variance with Baalousha (2007b).

Baalousha (2008b) collates data from a survey of 144 shallow wells (<25 m) conducted in 2003-2004. There are over 1700 shallow wells (<25 m) in the Hawke's Bay region and the 144 sampled are a carefully chosen subset. Nitrate concentrations above the Ministry of Health drinking water guideline (>11.3 mgN L^{-1}) were found in 8 wells (6%) and concentrations >50% of the guideline in another 6 wells (4%). All contaminated wells were shallow. Mapped results indicate some contaminated wells in small coastal communities – possibly associated with septic tank drainage – and some where land use was farming or horticulture – probably associated with soil drainage.

The average nitrate concentration in the Hawke's Bay region is 1.2 mg L^{-1} (Baalousha 2007a page 10) – well below the drinking water standard (11.3 mg L^{-1}). An average groundwater nitrate concentration of 1.2 mg L^{-1} may not pose a health risk but is of environmental significance where groundwater flows back into rivers. The RRMP does not set guidelines for SIN concentrations in Hawke's Bay rivers but ANZECC (2000) suggests values of 0.120 and 0.440 mg L^{-1}. Clearly the average groundwater nitrate concentration exceeds these guidelines.

The SOE groundwater wells monitored for water quality were selected because they are somewhat remote from the localised effects of abstraction, and by inference from land use intensification. If so then the SOE wells may yield lower nitrate concentrations than is typical of the rest of the aquifer.

The Council groundwater database contains information on groundwater nitrate concentrations although this review has not analysed these data. It would be useful to analyse groundwater nitrate, surface water SIN concentration and land cover/use data for trends and spatial patterns. By combining this data with river flows and abstraction rates, it would be possible to do preliminary mass balances. These would help decide on the impact of groundwater N inputs on river N concentrations, now and in the future.

Recommendation: Compare the spatial patterns in land use with the locations of the groundwater quality monitoring wells. Ensure monitoring wells are located in places where they are most likely to detect the effects of land use intensification on groundwater quality and quantity.

Recommendation: Examine existing groundwater nutrient data for trends and spatial patterns. Compare spatial patterns in groundwater nutrients, land use and surface water nutrients.

Recommendation: Do preliminary mass balance calculations and hence determine the likely effect of land use intensification on groundwater nutrients, and the effects of groundwater return flows on stream nutrient concentrations now and in the future.

Groundwater quantity

Abstraction lowers groundwater levels which in turn may reduce groundwater inflows to rivers. As with surface water abstractions, groundwater abstractions probably have a second-order impact on river flows compared with rainfall/runoff. Nevertheless during summer low flows when abstractions are highest it could have a significant adverse effect – certainly this issue merits investigation.

Baalousha (2008a page i) estimates that currently consented and actual groundwater abstractions in the Ruataniwha Plains are 10% and 3.3% of net recharge. HBEWG assert (Table 4 Issue 16) that groundwater is fully allocated but no data have been sighted which support this figure and it differs markedly from the findings of Baalousha (2008a).

No information was sighted examining trends in aquifer water levels and relating these to rainfall recharge and pumping rates. Brooks (2007) examined monthly mean flows in March (at the end of the irrigation season) and July (after recharge) in the Waipawa and Tukituki rivers where they leave the Ruataniwha Plains. He concluded that recent increases in groundwater pumping have not significantly reduced March flows in the Waipawa. However, in the Tukituki there is evidence of reduced March flows which may be the result of groundwater pumping. Brooks (2007) points out that this analysis ignores rainfall recharge and that it is hampered by the lack of reliable pumping data. Examining year-to-year patterns in March river flows is not the ideal way to quantify the effects of groundwater pumping.

Brooks (2007) and reviewer Dr Gill Zermansky, GNS-Science, both recommend developing a groundwater model for the Ruataniwha Plains to better quantify the effects of pumping groundwater on river return flows and aquifer water levels. At the time of writing a groundwater model for the Ruataniwha Plains has been developed using MODFLOW. A steady-state calibration has been completed and is currently under review. Work will start on non-steady calibration and testing early in 2009. Calibration, testing and use of the groundwater model may be constrained by the poor quality of information on pumping rates.

Conclusion: A groundwater model of the Ruataniwha Plains is being developed and will help quantify the effects of groundwater pumping and surface water extraction on river flows, and hence on water quality and ecology.

5.5 Catchment modelling

None of the reports sighted during this review quantify the effects of land use on nutrients, periphyton and ecosystem health.

Council recently commissioned a series of Envirolink small advice grants on catchment sensitivity and nutrient limits to prevent excessive periphyton growth. Findings are detailed elsewhere (Rutherford 2008) but relevant conclusions are:

- The New Zealand Periphyton Guideline (Biggs 2000) sets out a methodology for assessing the sensitivity of periphyton biomass to nutrients and flow.

- This methodology has drawbacks and HBRC may need to adapt the methodology based on local knowledge.

- It is recommended that the methodology be tested in a major catchment like the Tukituki where flow, nutrient concentration and periphyton biomass are measured.

- In unmonitored catchments, models would be required to predict the effects of land use on nutrient concentration. Models would also be required to predict the effects of future land use change. Currently CLUES is the most suitable model for predicting the effects of land use on nutrient concentration.

- CLUES would need to be adapted before it could be combined with the New Zealand Periphyton Guideline (Biggs 2000) to predict periphyton biomass. This is feasible.

- Underpinning this approach is the assumption that periphyton biomass is a good indicator of ecosystem health. This is a reasonable assumption provided the guideline values for periphyton are appropriate.

- An essential step is to review the available monitoring data and determine the desired maximum summer low flow periphyton biomass to ensure ecosystem health, and use this periphyton guideline value.

Recommendation: Consider a modelling study based on CLUES and the Periphyton Guideline to relate land use, water quality and periphyton biomass.

5.6 Nutrient spiralling

The Envirolink small advice grant mentioned in Section 5.5 also discussed nutrient spiralling. Findings are detailed elsewhere (Rutherford 2008) but relevant conclusions are:

- Periphyton remove SRP from the water but release it again when they decay. In order to predict SRP concentrations below point or diffuse sources it is necessary to quantify nutrient spiralling.
- An understanding of nutrient spiralling is needed in order to apply the nutrient guideline in the RRMP of 0.015 gP m^{-3}.
- Nutrient spiralling determines the distance below a point source of nutrient where periphyton growth rate and biomass accrual are high (e.g., the distance below the Waipukurau oxidation pond where periphyton biomass is high because of the nutrients they discharge).
- Nutrient spiralling also determines the effects of diffuse sources of nutrient, for which the mathematics are more complex but tractable.
- Nutrient spiralling is likely to be important in several Hawke's Bay rivers, including the Tukituki.
- A mathematical model has been formulated that can assist, but the model needs to be applied and tested.
- It is desirable to undertake a longitudinal survey in the Tukituki during summer low flows. Such a survey was originally planned for 2007-2008 but a flood intervened.
- It is desirable to undertake nutrient addition experiments in conjunction with the longitudinal survey.

Nutrient spiralling studies would be a special investigation of short duration but intensive. There would be little merit in including spiralling studies as part of SOE monitoring.

Recommendation: Consider a nutrient spiralling investigation in the Tukituki.

5.7 Riparian habitat

Policy 45 outlines non-regulatory methods for controlling non-point source discharges (Table 1). From the information sighted, the principal mechanism covered by Policy 45 is the fencing of streams to create riparian buffers – the main benefits being to

- reduce stock damage to stream beds and banks;
- reduce direct inputs of urine and faecal material into streams; and
- encourage riparian vegetation that shades streams.

The question for this review (Table 5) is whether Policy 45 is effective in identifying priority areas for retirement, reducing stock access to waterways and providing buffers against runoff.

Sarazin and Zimmerman (2003) surveyed 320 km of riparian habitat along 5 rivers and 18 streams on the Ruataniwha Plains. Measurements included:

- streamside vegetation;
- adjacent land use;
- stream bank stability;
- disturbance by stock;
- potential for sediment and contaminant input;
- stream habitat diversity;
- substrate size; and
- channel complexity.

From this was created a ‘score’ and sites were designated Class 1 (excellent, score = 406-540), Class 2 (good, score = 271-405), Class 3 (poor, score = 136-270) or Class 4 (very poor, score <135). Maps were produced on which riparian zones are colour coded by Class.

The main stems of the Waipawa and Tukituki Rivers were assessed as having ‘good’ (Class 2) overall riparian buffer scores.

Many of the tributaries, however, had ‘poor’ or ‘very poor’ buffer scores. The reasons for the low scores were:

- inadequate vegetation to shade the channel;
- low streambed habitat diversity; and
- disturbance by stock.

The authors concluded that ‘…the best way to improve scores is to fence off stream margins from stock...and…introduce plants that will provide adequate shade…’

Separate maps were produced showing just stock disturbance scores. Again the main stems of the Waipawa and Tukituki Rivers were predominantly Class 1 or Class 2 but many of the tributaries were Class 3 or Class 4 – indicating that stock had access and were causing disturbances.

The impression gained from this 2003 study is that many small streams on the Ruataniwha Plains were not fenced to exclude stock. The survey did not quantify fencing – rather they assessed stock damage. They noted that stock were sometimes deliberately being grazed <u>inside</u> well fenced buffers and that fences were difficult to maintain in some areas because of frequent flooding.

This survey is the first step towards identifying priority areas for retirement and fencing. The second step would be to assess the practicality and cost/effectiveness of fencing (e.g., how flood-prone the stream is, how willing is the landowner to manage the fenced riparian zone etc.).

Recommendation: Use the results of the Sarazin and Zimmerman (2003) to identify priority areas for retirement and riparian fencing.

There is evidence that cattle in the riparian zone result in degraded habitat. An ecological survey was conducted of streams on the Ruataniwha Plains (HBRC 2003). It was found that sites with good riparian habitat (viz., high scores) generally had good macroinvertebrate communities. There was a significant positive correlation between habitat score and MCI index (HBRC 2003, Figure 21). Certain taxa (mayflies, caddisflies and beetles) were present where riparian habitat was good but were absent from sites where it was poor – being replaced by other species (two-winged flies). A confounding factor in this analysis is that some of the reaches surveyed dry out in summer. It is not clear what role riparian habitat has in such ephemeral stream systems.

In 2006-2007 a student surveyed fencing around spring-fed streams in the Ruataniwha – about 40-50% were fenced on both sides (Andrew Curtis, *pers. comm.*). Spring-fed streams are easy to fence but in other streams flood damage is a problem. In one flood-prone stream, riparian fences have been rebuilt 3 times in 5 years.

Discussions on 19th December concluded that Council does not have good information about the proportion of stream margins that are fenced and successfully exclude stock. It is estimated by Council staff that:

- about 75% of all streams in the Ruataniwha are unfenced;
- the majority of ephemeral channels (dry in summer) are unfenced;
- about 40% of main channels that flow all year in the eastern part are unfenced;
- the majority of steeper gulleys in the western part are fenced; and
- even where fenced, stock are often present in the riparian zone.

It must be stressed that this is an assessment and is not based on detailed site surveys.

Many riparian buffers are periodically grazed to ‘clean them up’. While there are merits in short, controlled grazing of grass filter strips (to remove the nutrient they have trapped), there is anecdotal evidence of prolonged and uncontrolled grazing by cattle within riparian buffers which negates the benefits of fencing.

Conclusion: Many farmers seem unaware of, or are ignoring, best management practices for riparian buffers. Council may need to reassess their education procedures and consider regulations.

Council makes money available for fencing and re-planting. However, no reports were sighted that summarise this expenditure. Staff offered to ‘dig out’ the expenditure and also pointed out that some farmers do their own riparian fencing without Council subsidies.

Overall it is very difficult to assess the effectiveness of Policy 45. Much of the information about riparian fencing gathered during this survey was anecdotal. Information about expenditure on fencing and planting is available but not in easily digestible summary form. Similarly a summary of the length/area of existing and new buffers did not seem to exist.

Recommendation: Collate information about subsidies paid, education undertaken, and the length/area of new riparian buffers created and re-assess the effectiveness of Policy 45.

6. Conclusions

There is evidence the local community feels Council is slow to recognize and act on problems in the Tukituki – notably water abstraction, nutrients/periphyton, ecology and the oxidation pond discharges. This view was expressed by several speakers at the public meeting in Hastings on 12th March 2008 and by the Hawke's Bay Environmental Water Group. The HBEWG expressed the view that:

- monitoring has identified problems;
- existing policy is not being implemented to address these problems;
- few investigations have been conducted on emerging issues; and
- policy is not been reviewed.

Examples they give include:

- the recent granting of consents to abstract water for irrigation despite surface waters already being fully allocated and groundwater heavily allocated;
- persistent problems with periphyton growth, fishability and odour in the Tukituki;
- phosphorus discharges from the oxidation ponds that cause guidelines for SRP to be breached at low flows; and
- a monitoring programme that focuses on water column chemistry, only measures periphyton biomass and invertebrates annually, and does not monitor algal mat chemistry, faecal microbes and heavy accumulation in the sediments, or indicators of ecological health such as mussels, fish and bird-life.

The HBEWG supplied me with a folder in which are collated a number of articles, together with a commentary written largely by David Renouf. I admire the resolve of the HBEWG to safeguard water quality in the Tukituki. I believe that some of their statements are incorrect and I disagree with some of their suggestions. In my opinion the HBEWG does not have a '…science programme…' which can be compared with that of Council. There were a few glaring mistakes in the commentary supplied which indicates that the technical competency of the HBEWG is low in some areas. This is hardly surprising given that their members are not professionals in these areas.

However, the <u>issues</u> raised by the HBEWG are important and some of their suggestions have considerable merit. It might be tempting for Council to ignore the HBEWG because their arguments do not always align with main stream science, law and management. I believe this would be unwise. In my opinion the HBEWG has a valuable role to play in keeping important issues in the public arena. I urge Council and the HBEWG to maintain their dialogue. I urge HBEWG to refrain from commentary on technical topics outside their level of competency and rather to focus on problems and issues – the 'what' rather than the 'how'. I also urge Council to recognise the aims and objectives of the HBEWG, the fact that they bring valuable anecdotal information to the debate, and that they are not technical experts who sometimes feel 'outside' the decision making process.

I recommend: that Council and HBEWG maintain their dialogue, that HBEWG focus on issues rather than technical details, and that Council recognise that HBEWG bring valuable information to the debate.

An alternative view to that expressed by the HBEWG is that Council:

- is aware of the major issues;
- has undertaken investigations where necessary;
- has made informed decisions; and
- is acting where activities have been shown to cause significant adverse effects.

An example would be the 2014 consent conditions imposed on the Waipukurau and Waipawa oxidation pond. The HBEWG and the public may be unaware of three constraints on Council.

First, the problems facing Council in the Tukituki are complex. Hawke's Bay is not alone in struggling to come to grips with the management of diffuse source contaminants, land use effects on flow and water quality, and river ecosystem response. These problems require a careful mix of SOE monitoring – to identify problems – and investigations – to address problems and make decisions.

Second, Council must carefully allocate resources to monitoring, investigations and interventions. Ratepayers are unlikely to be happy with unnecessary expenditure on monitoring and investigations but expect targeted monitoring and investigations that lead to effective policy and management.

Third, under the RMA Council is obliged to protect water quality and river ecology while providing for the reasonable demands of water for uses including irrigation and the disposal of wastes. This is a balancing act and not surprisingly Council decisions often elicit criticism from the public. Council needs to document its reasons for making decisions and to back these up with robust science where appropriate. It also requires effectively communicating to the public its reasons for making the decisions that it does. Arguably this last step has not been successful in the Tukituki in recent times.

The reports sighted during this review show that Council puts considerable effort into SOE monitoring and that this SOE monitoring is effective at providing background information about a range of issues. Council has well documented procedures for collecting samples, laboratory analysis, and reporting the results. The technical staff involved in these steps demonstrate a high level of technical competence.

The collection of data is the first, and arguably the easier, part of monitoring. The second, more difficult part, is to extract information useful to management from the data. It is not uncommon to encounter the '…data rich, information poor…' syndrome. This occurs where there is data available but either it has not been used to draw conclusions that managers feel confident to act on, or it is not relevant to the particular management issue being addressed. Fewer reports were sighted about follow-up investigations than about SOE monitoring – exceptions include Baalousha (2008a).

The impression gained from the reports sighted is that in over the last 4-5 years Council has put more effort into monitoring (aimed at identifying problems) than into investigations (aimed at solving problems) in respect to water quantity and quality in the Tukituki. However, I am informed by Council staff that of a total budget of $1,300K[9] about $300K was spent on SOE monitoring with the balance on investigations.

There is also the matter of timing – the reports sighted identify trends and issues, and several mention investigations to address them that are currently underway. On the other hand, monitoring reports dating back to 2004 raised the issue of land use intensification, nutrients and periphyton proliferation and yet rather little follow-up work seems to have been undertaken in the Tukituki.

The role of SOE monitoring is to identify whether or not Council policy is effective in meeting the goals and objectives set in the RRMP. In my opinion the SOE monitoring has shown itself to be adequate for obtaining a general picture of water quality issues

[9] Presumably for the Hawke's Bay region as a whole

in the Tukituki catchment. In addition it has furnished some valuable quantitative information that can help make management decisions and/or guide further investigations.

Objective 27 poses the following questions:

- Is water quality in the Tukituki being maintained or enhanced?
- Is water quality in the Tukituki suitable for sustaining or improving ecosystems?
- Is ecosystem health in the Tukituki satisfactory?

It is clear that high SRP loads from the Waipawa and Waipukurau oxidation ponds cause nutrient guidelines to be exceeded below median flows. This probably contributes to periphyton growth, and problems with ecological health in the lower Tukituki. Council has granted consents that require SRP loads from the oxidation ponds to be significantly reduced by 2014. Some members of the public believe Council should act more quickly on this matter. Notwithstanding, the issue of high SRP inputs from the oxidation ponds has been identified and is being addressed.

When SRP inputs from the oxidation ponds are reduced, it has been suggested by the HBEWG and Ausseil (2008) that nutrient concentrations and periphyton biomass may still not comply with guidelines set in the RRMP. No quantitative assessment was sighted during this review to support this suggestion. Council should address this question. If they do, then it would be possible to use the approach in the New Zealand Periphyton Guideline (Biggs 2000).

The annual Recreational Water Quality Surveys show a high level of compliance at 2 popular bathing spots in the Tukituki. Concern has been raised about possible public health risks to recreational users arising from the oxidation pond discharges at Waipukurau and Waipawa. A deficiency in the science programme is the lack of information on recreational use of the Tukituki between the oxidation ponds and Black Bridge, and any public health risk associated with the oxidation pond discharges. Council may need to review recreational use in the lower Tukituki River and if necessary add monitoring sites at Tapairu Rd, Walker Rd, Tamumu Bridge, Shag Rock or Patangata.

There is only moderate compliance with the water clarity guideline for bathing water and clarity rarely reaches recommended values for trout feeding. Council may need to review the sources turbidity and suspended solids, and determine whether there are controllable activities in the catchment (e.g., hill country or wind erosion) that have an adverse effect on clarity.

In my opinion one serious deficiency in the current science programmes is that land use, water quantity and water quality studies are not more closely linked. For example spatial and temporal trends have been identified in river nutrient concentrations, periphyton biomass and invertebrates, and the suggestion has been made that these are associated with spatial and temporal patterns of land use. However, no quantitative analysis of these relationships has been attempted.

Land use intensification seems inevitable in the Ruataniwha. It is likely to increase nitrogen, and probably phosphorus, inputs to the Tukituki which will affect periphyton and ecology during summer low flows. Council has signalled the need to better quantify the possible effects of land use intensification. A recent Envirolink project explores possible ways to address issues of catchment sensitivity, nutrient limits and nutrient spiralling and outlines how the catchment model CLUES could be used in conjunction with the New Zealand Periphyton Guideline (Biggs 2000) to address the first two issues. Some work would be required to adapt both CLUES and the Periphyton Guideline to Hawke's Bay conditions. An improved understanding of nutrient spiralling is desirable and could be addressed by a one-off field survey during summer low flows.

There is evidence that water quality in the Tukituki is not '…suitable for sustaining or improving ecosystems…' and/or that '…ecosystem health…' is unsatisfactory. Ausseil (2008) has identified an increasing trend in SRP concentration and a decreasing trend in MCI index at the SH50 (upriver) sites. This is evidence that water quality is not being maintained or enhanced at these sites. The trends may be an artefact of significant changes in flow during the monitoring period, but they may be the result of land use change in the headwaters. Stansfield (2006) and Ausseil (2008) identify trends of increasing SRP and SIN concentration, increasing periphyton biomass and decreasing MCI index moving from upriver to downriver. A longitudinal gradient in MCI is to be expected because slope, substrate, temperature and flow variability change. Council need to estimate what MCI would be in the absence of pressures from land use and discharges – Dr John Leathwick has recently developed a new method. Council then needs to explain to the public the extent to which MCI scores have been adversely affected by increased nutrients and/or periphyton. Ausseil (2008) points out that few sites comply with clarity values suggested for trout feeding.

The issues identified reinforce the link between nutrient load, periphyton abundance and ecological health. This is arguably the most important, and also the most complex, problem in the Tukituki. The fact the nutrients and periphyton do not comply with guidelines indicates that conditions are unsatisfactory – at least during summer low flows. However, the MCI index in the middle and lower river appears not to exhibit any trends which suggests that conditions are not deteriorating. This raises the possibility that the middle and lower river routinely become stressed (e.g., because of prolonged low flows most summers) and that recent land use intensification has made little difference. Hawke's Bay rivers have a long history of periphyton 'blooms' during summer low flow conditions.

Ausseil (2008) comments that even drastic reductions in nutrient concentration are unlikely to prevent algal proliferations particularly during prolonged low flows. This is not an easy question to address. However, it would be possible to use a combination of catchment modelling using CLUES together with the Periphyton Guideline (Biggs 2000) to make a preliminary assessment of the sensitivity of the catchment to land use change and flow abstraction. The benefits of nutrient reduction are likely to be reduced growth rates which determine how often nuisance growths occur.

Flow affects water quality and ecology and so abstraction has the potential to aggravate problems of water quality and ecology. However, the Tukituki has a history of long summer droughts when flows are very low for 1-2 months. Abstractions may have a second-order effect on water quality and ecology compared with floods. This situation could change dramatically if irrigators move to diversion and storage of flood flows. From the reports sighted, it is not clear whether abstraction currently affects water quality and ecology in the Tukituki. In the Ruataniwha Plains surface and groundwaters are closely linked. However, no information was sighted which accurately quantify the effects of surface and/or ground water abstraction on river flows. Analysis is hampered by an incomplete knowledge of actual water use (as opposed to what is allocated in consents). Improved monitoring and reporting of water abstractions would help quantify their effects on river flow.

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8. Appendix 1: Priorities identified by EMS (2005).

No.	Priority	Recommended Action	Responsibility
Surface Water Quality			
1	Medium	Clearly identify which lakes, rivers or reaches of rivers are being managed for contact recreation purposes and include those details in the PHBRRMP.	Monitoring
2	High	Initiate a comprehensive water quality monitoring programme and associated public warning system for all inland lakes and rivers which are identified as being managed for contact recreation purposes in the PHBRRMP.	Monitoring
3	Medium	Investigate the reasons for water quality degradation in the 6 - 7% of rivers region wide where water quality is either declining for non-flow related reasons or where macroinvertebrate health is poor.	Research
4	Medium	Develop management responses for the 6 – 7% of degraded rivers region wide once the reason for the degradation is understood.	Policy
5	High	Ensure that management systems are in place for non degraded rivers which ensures that they are protected from any identified causes of declining water quality in degraded rivers.	Policy
6	Low	Better communicate the fact that surface water quality within Hawke's Bay is generally good and ranks well on a national scale.	Education
7	Low	Investigate options adopted elsewhere in NZ to cater for iwi concerns regarding sewage discharges to inland waterways and determine in consultation with iwi if such measures would be appropriate for Hawke's Bay.	Policy
8	Medium	Use water quality and benthic ecology information to identify rivers that are degraded as a result of excessive nutrients, high water temperature and algae growth.	Research
11	Medium	Identify which degraded rivers would benefit from enhanced riparian vegetation (and associated restrictions on stock access).	Research
12	High	Develop specific, measurable and time bound objectives for rivers targeted for riparian management for inclusion in the LTCCP and PHBRRMP.	Policy
13	Medium	Evaluate the effectiveness of the new regulatory regime (rule 7 of the PHBRRMP) in achieving riparian management objectives.	Monitoring
14	Medium	Consider the introduction of targeted regulation in existing priority areas where education and financial incentives have not delivered the desired riparian management outcomes to date.	Policy
15	Low	Produce a guideline document that summarises the benefits of riparian vegetation as outlined in literature and combines this with Hawke's Bay monitoring information to show the benefits of riparian vegetation in the Hawke's Bay context and provide guidance on riparian planting design.	Education
16	Medium	Ensure that stock access to rivers is factored into any further educational or regulatory initiatives undertaken to promote riparian management.	Policy

No.	Priority	Recommended Action	Responsibility
17	Low	Retain the current non-regulatory approach to accelerated hill country erosion involving the provision of advice and grant assistance to farmers.	Policy
18	High	Review Council's past hill country erosion management interventions and determine which have most effectively contributed to achieving Council's desired outcomes. Ensure that future efforts utilise the most effective methods of management intervention.	Research
19	Medium	Investigate whether the declining surface water quality that is evident in the 7% of rivers monitored under the regional SOE programme is due in part to excessive fertiliser use on hill country properties.	Research
20	Medium	Determine the extent to which the increase in phosphorous levels in some rivers is due to excessive fertiliser use and associated diffuse runoff from hill country properties.	Research
21	Medium	Identify priority areas (these may the same as those used under the Regional Landcare Scheme) where the further management of fertiliser use on hill country properties would be beneficial.	Research
22	Medium	Consider further regulatory provisions specifically targeted at fertiliser use over and above a reliance on the Code of Practice for Fertiliser Use.	Policy
23	High	Obtain existing research, monitoring and investigation reports from other councils in NZ who have or are addressing earthworks management.	Policy
24	High	Using existing earthwork research, monitoring and investigation reports from other councils, develop and implement a targeted research and consultative programme to quantify the scope of the earthworks management problem in Hawke's Bay. This should involve further discussions with territorial authority and HBRC staff and the targeted monitoring of a range of earthworks activities (from large scale subdivisions to individual building sites).	Policy
25	Medium	Examine a range of subdivision consents granted by the region's territorial authorities on erosion prone sites to determine the extent to which controls for sediment run-off are included.	Policy
26	Medium	Collate any existing earthworks regulatory provisions in the region's district plans and assess their adequacy and consistency in comparison to regional level provisions in other areas (such as those used by the ARC).	Policy
27	Medium	Identify any regulatory gaps or regional inconsistencies in the approaches taken at a territorial authority level and initiate a regional plan development or regional plan variation accordingly utilising existing provisions from other regions as far as possible.	Policy
28	Medium	Discuss any lack of enforcement of existing territorial authority regulatory provisions with the appropriate territorial authorities with the aim being to develop a joint strategy for ensuring that any problem areas are resolved. This could include joint monitoring, coordination and integration of compliance staff actions, even or transfers of powers from the territorial authorities to the HBRC.	Policy
29	High	Continue with the existing LTCCP and annual plan stormwater projects.	Policy

No.	Priority	Recommended Action	Responsibility
30	High	Become fully conversant with the latest stormwater management research and policy development initiatives in other regions, particularly in Auckland, before proceeding further with the development of provisions for the PHBRRMP.	Policy Research
31	High	Address potentially overlapping roles and responsibilities with the region's territorial authorities prior to proceeding further with the development of stormwater management provisions for the PHBRRMP.	Policy Consents
Groundwater Quality			
32	Low	Continue with the existing LTCCP and annual plan onsite sewage treatment projects.	Policy Research
33	Low	Become fully conversant with the onsite wastewater research and policy development initiatives in other regions, particularly in Auckland, Bay of Plenty and Waikato, before revising the existing framework in the PHBRRMP.	Policy Research
34	Low	Address potentially overlapping roles and responsibilities with regard to onsite wastewater management with the region's territorial authorities.	Policy
35	Low	Develop for a simple onsite wastewater regulatory framework that delineates (maps) areas where certain systems are or are not allowed and uses rules that are based on simple performance standards rather than subjective and difficult to measure environmental outcomes.	Policy
36	Medium	Consider whether the findings of the 2002-2003 investigation of shallow groundwater nitrate levels and the 2002 national pesticide project indicate a need to review the current groundwater quality management framework in the PHBRRMP.	Research
Groundwater Quantity			
37	High	Define and map the location of the "productive aquifers" referred to in Policy 75 of the PHBRRMP.	Research
38	High	Develop objectives and policies for the aquifers outside the coverage of Policy 75 of the PHBRRMP.	Policy
39	Medium	Consider proactively advocating groundwater takes in preference to surface water takes in areas of the Ruataniwha Plains where the surface water flows are subject to natural or induced low levels and consider if similar management intervention is required in other parts of the region.	Policy Consents
40	Medium	Continue long term baseline monitoring of aquifer levels.	Monitoring
41	High	Urgently complete the proposed computer model of the Heretaunga Plains aquifer.	Research
42	High	If required for the operation of the proposed model of the Heretaunga Plains aquifer require real time telemetering of abstraction information to Council for large takes or takes located within critical aquifer areas - on an appropriate cost sharing basis with consent holders.	Policy Consents
43	Medium	Articulate policies 30 and 42 of the PHBRMP to resource users and ensure those policies are implemented at the time consents are granted.	Consents
44	Medium	Consider stepping back to a monthly or annual water take meter reading frequency in non-critical areas.	Research Consents

No.	Priority	Recommended Action	Responsibility
45	High	Urgently produce an updated State of the Environment document that clearly states where groundwater levels are declining, the likely cause of any decline, and whether or not that decline is considered to be of concern.	Research
46	High	Decide what if any management interventions are required to arrest declining aquifer levels.	Research Policy
47	High	Fully review the groundwater management approaches adopted by other regional councils and determine whether or not allocatable volumes of abstraction and aquifer abstraction cessation levels should be established for Hawke's Bay aquifers.	Policy
48	High	Establish the necessary research, investigation and policy development projects and budgets to deliver a robust groundwater allocation framework for Hawke's Bay.	Policy Research
Surface Water Quantity			
49	Medium	Continue long term baseline monitoring of river levels.	Monitoring
50	Low	Continue to use IFIM to establish minimum flow for rivers, but consider undertaking an assessment of iwi cultural values in relation to low flows and determine whether or not the IFIM derived values cater for those values.	Research
51	Low	Reemphasise to iwi and conservation interests that NZ derived habitat preference curves for native fish have been used in the setting of Hawke's Bay minimum flows.	Research
52	High	Assess the implications of using a Q_{90} flow as the management level for setting allocatable volumes of abstraction and undertake consultation regarding that potential change with user groups and conservation interests.	Research
53	Medium	Assess and report on the comparative advantages and disadvantages of other methodologies developed by NIWA, other CRI's, or other regional councils for determining the allocatable volume of abstraction – particularly methodologies which allow abstractors to input to the level of risk associated with the allocatable volume.	Policy
Land use Intensification			
54	High	Identify the adverse effects associated with land use change and intensification that are occurring now that are not being appropriately controlled by the region's territorial authorities.	Policy Research
55	High	Identify if any adverse effects associated with land use change and intensification are due to deficiencies in existing District Plan provisions or due to deficiencies in the way existing District Plan provisions are administered.	Policy
56	High	Discuss with the region's territorial authorities their willingness to either change or vary their District Plans, or their actual implementation; to alleviate any identified deficiencies in District Plan content or implementation.	Policy
57	Medium	If necessary, develop appropriate regional plan provisions to avoid or mitigate identified adverse effects associated with land use change and intensification with an emphasis in the first instance on permitted activity rules as the initial tier of regulatory intervention.	Policy
Water Allocation			
58	High	Adopt a more up to date model for determining the crop water requirements in Hawke's Bay.	Research

No.	Priority	Recommended Action	Responsibility
			Consents Policy
59	Medium	Decide whether the more up to date model for determining the crop water requirements in Hawke's Bay should be used to proactively and immediately review all existing irrigation allocations or whether that would be dealt with upon the expiry and renewal of existing consents.	Policy
60	Medium	Investigate the feasibility of a regulatory process for 'reclaiming' presently allocated water that is not being used without needing to wait for consents to expire or be surrendered.	Policy
61	High	Consider prioritising the distribution of allocable water, particularly in terms of providing for community health and wellbeing.	Policy
62	High	Consider prioritising the cessation of abstractions at times of low flow, particularly in terms of community health and well being and social and economic disruption.	Policy
63	Medium	Determine whether existing minimum flows and allocable volumes adequately cater for surface water bodies traditionally important to iwi in the region.	Research
64	Medium	Jointly scope with consent applicants the necessary water availability research in areas where Council knowledge of the resource is sparse.	Research Consents
65	Medium	Develop a policy through the LTCCP process to subsidise or compensate resource users who investigate water resource availability in areas outside of the main aquifers and rivers, particularly where that information subsequently enters the public domain and is of benefit to Council and future resource users.	Policy Research
Administration			
66	Low	Review current and historical Council practice to determine any common themes or trends with regard to consent durations.	Consents
67	Low	Develop a consent durations policy for inclusion in the PHBRRMP that better reflects current Council practice (including catchment and aquifer expiry dates) and any significant national trends and leading case law principles.	Policy
68	High	Consider appointing an iwi liaison officer with skills and qualifications in technical and policy matters to act as a conduit between Council and hapu.	Policy
69	High	Establish an agreed charge out rate to recompense iwi representatives for their input to resource consent application consultative processes – with the payment to be made directly from applicant to iwi.	Consents
70	Medium	Consider actively supporting the development of an iwi resource management plan(s) for Hawke's Bay consistent with MfE guidelines on such documents.	Policy
Operations			
71	Low	Continue Council's current passive facilitation role with regard to promoting water storage and irrigation of supplying hydrological information to private sector interests upon request.	Monitoring

No.	Priority	Recommended Action	Responsibility
72	Low	Complete the assessment of potentially irrigable land in Hawke's Bay so that the ultimate potential irrigation demand can be compared to existing and known allocatable volumes of abstraction from rivers and aquifers – thereby enabling any ultimate shortfall to be identified.	Research
73	Low	Review approaches taken elsewhere with regard to promoting water storage and irrigation, particularly the Marlborough District Council's facilitation work in their Southern Valleys area.	Policy
74	Low	Identify priority areas where aquatic weeds will be removed from watercourses after they are cut.	Operations
75	Low	Investigate and trial alternatives to mechanical cutting such as the use of low impact aquatic herbicides.	Operations
76	Low	Scope and execute the proposed river beach raking research programme on "specific species requirements for pool and riffle requirements and tributary access" in consultation with conservation groups.	Operations

9. Appendix 2: Correspondence with the HBEWG.

2A. Letter of 6th January

6th January 2009
Dr Kit Rutherford
NIWA PO Box 11115
Hamilton

Dear Dr Kit Rutherford

23rd of December 2008 Meeting with you in Napier to discuss your DRAFT 'Review of monitoring in the Tukituki catchment, Hawke's Bay' before it is finalised. We thank you for this opportunity
John Phillips from HBRC and Colin Crombie, John Scott, Bill Dodds & David Renouf of the Hawke's Bay Environmental Water Group were present.
Given the lack of time there were some issues not discussed and others, which did not fully reach a conclusion this is the reason for this letter

Briefly discussed when, what, where to sample was not fully discussed a point raised was about nitrate increased with depth as the quote below shows there are other contaminants found higher with depth

"in the stream bank of a Whangamata stream at two depths, surface and 2 cm, showing a mosaic of denitrification potential, and an increase in nitrate with depth." Ref:#

"Olsen and Townsend (2003) found higher concentrations of hyportheic (25 cm depth) dissolved oxygen, ammonium and phosphorous in the Kye Burn" Ref: # - HBEWG Ref: page 10 *58

"the hyportheic zone has the potential to play a significant role in influencing surface water quality" Ref:#

"the fact that the extent of the hyportheic zone was likely to have greatly exceeded the maximum sampling depth" Ref: # 32.4 – 32.5 Freshwaters of NZ – HBEWG Ref: 3. page 1.(A)

Figure 32.4 shows clearly the substantial differences of concentrations of contaminates of samples taken from the edge and the centre of DRP, Nitrate & Ammonium
This shows clearly the importance of robust sampling design and procedures, which needs to be established and stated & written clearly, <u>because this is the fundamental factor used to identify the health & condition of the Tuki Tuki River</u>

Sampling
- Where across the width of the water way
- At what depth in the water column – if no surface sampling no oil will be detected, often the Tukituki River has an oily surface – if not deep enough heavy suspended solids will not be measured
- At what time of day – there is no 24 hour sampling for D/O
- What to sample for – present list is not complete or satisfactory
- Contact recreational sampling. The present depth may not be providing an accurate measurement

Because at the present depth given that the light intensity at that depth most of the faecal coliform may have died off. So when there is turbulence in the waterway again other faecal coliform, which were lower in the water column will rise higher in the water column
We have concerns about sampling because it must be robust to give accurate & complete measurements of all components

As suggested because of cost savings can be made that some sampling may be a waste of time especially after and during rainfall events except to measure the levels of suspended solids.
No one should be swimming during and after rainfall events while the river is still in flood and in a dirty condition so that no sampling for bacteria would be warranted also other sampling is a waste of time
Less sampling at high flows but increase sampling at below & low flows
Trp -72

I asked HBRC what changes have been made after 2005 to sampling and what are the current design & methods of sampling?

Because the fundamental crucial part of this issue is having the most adequate robust method & design of sampling to establish the accurate measurement of the health & condition of the Tuki Tuki River which is not being done at the moment.

There are many months when the Tuki Tuki River is in poor health state & condition.
HBRC has not recognised this fact because there is no adequate sampling of the key indicators and other contaminants are not being monitored.
"we cannot manage what we do not measure" David Ray (*NIWA*)

It is of limited value to recommend water quality guidelines & standards without coupling these guidelines to a robust design, methods and frequency of sampling and analysis which is required to obtain results that have fully measured all, aspects which can effect the health & condition of freshwater

Fixed monitoring sites are not accurately measuring the health & condition of the river for some contaminants

There is no doubt that contaminants in sediments play a most important role in the health & condition of rivers/streams, which are not being monitored in freshwater.

"Anoxia also results in chemical release of sediment bound phosphorus" Ref: 22.11 Freshwaters of NZ

"Macrophytes are able to acquire their nutrients from both water and the substrate sediment. High biomass can develop <u>despite low nutrients concentrations in the water column</u> if the sediments contain adequate nutrients." Ref: Page 16 Water Quality Guidelines No. 1 – Ref: *2 HBEWG [My underlining]
Some of the results do show very low contaminant concentrations from the water column but as said at the meeting the Tuki Tuki River has very high alga growths, which makes the river not fishable & unsafe for recreational use for many months. This is not being recorded by the HBRC
Also stated at the meeting by several people that the Tuki Tuki River smells rotten, has an pungent odour, a strong musty smell, smells similar to Lake Tutira during its long periods of algal bloom

Water movement can resuspend sediments on the ocean, river/stream beds & lagoons which can cause any bacteria living in these sediments to be resuspended back into the water column.
"These lagoons can have up to 9,800 times more bacteria in sediments than the overlying water so sediments could prove to be a significant source of bacteria into the waterway." Ref: page 23 The State of our Environment HB 2007 HBRC

This "quoted" data clearly shows that sediments in freshwaters are also a major factor to be considered to be sampled to ascertain a complete measurement of all contaminants, which can effect the Tuki Tuki River health & condition.

"fine suspended particles may act as carriers of other pollutants, notably sorbed phosphorus and various trace organic and metal biocidal materials" Ref: 11.2 Freshwaters of NZ.

If suspended solids are not (which may the case) being tested especially for phosphorus then this is another area of phosphorus going undetected therefore again the true state of the Tuki Tuki River condition may not being measured

It is obvious that heavy suspended solids settle out of the water column quicker so that these SS will be in the lower water column. These sediments may contain more heavy metals and nutrients/contaminants.
"Most metals present in municipal sewage effluents are absorbed onto particulate matter." Ref: NCC Bioresearches 23 June 1995
trp – 73

A number of regional councils use the RMA Third Schedule Water Quality Classes which is an excellent way to protect rivers and stream for many essential purposes – AE, F, FS, SG, CR, WS, I, IA, NS, A, C it seems that Waikato, Northland, Wellington, Canterbury, Horizons, Tasman, Marlborough, Nelson, West Coast, Otago & Southland have adopted this position.

We see that there is a requirement to increase the frequency to fortnightly monitoring of the parameter of Biological

- Macro invertebrates
- Periphyton plus all other types of algae
- Chlorophyll *a*

In more sites in mid to lower reaches of the Tuki Tuki River because that's where part of the problem is as discussed

"important to measure the characteristics of the biological components of the ecosystem as well as the physical and chemical water quality characteristics, to be able to confidently assess whether an important change has occurred or is likely to occur." Ref: 3.1-19 ANZECC 2000

In table 4 as discussed at the meeting review of monitoring, sampling, design & method we see this as a fundamental issue to maintain & enhance the 'ecological integrity' of the freshwater ecosystem.

The RRM Plan needs to be updated to at least ANZECC 2000 NOTE: ANZECC 2000 is now being reviewed
As clearly shown at the meeting our sheer frustration is that the HBRC informs us the 5.4 Surface Water Quality Guidelines are not enforceable. (Which we disagree with because of RMA s84)
We have found that discharges of effluent at the end of mixing zones breach the HBRC – RRMP.
So according to HBRC CHBDC cannot be held responsible for breaching 5.4 Surface Water Quality Guidelines of the HBRC – Regional Resource Management Plan.
This is sad for us because if the HBRC had enforced its RRMP the health & condition of the Tuki Tuki River would be better today
Some of the issues of concern are monitoring, land use, enforcement and plan change required

We bring to your notice you have missed putting your Dr in front of your name page 2
Table 4 – 11 spelling the word 'States'
Table 4 – 19 as given to you at meeting there is a mistake in the RRMP. ANZECC 2000 for stock water is 100 per 100 mL so we are not suggesting to revise this figure we ask to have this figure corrected.
Table 2 Policy 71,72, 73 we have raised the issue with you that there is no numeral figure for temperature

Best Wishes for the New Year

Yours sincerely,
D.W. Renouf

David Renouf
603A Ballantyne Street, Hastings 4120
Telephone & fax 06-8783239
Attached Hyporheic zones 32.4 – 32.5 Freshwaters of NZ

72 -Trp - 74

PS – A concern which we have is the waste of money on duplication on managing fresh/marine waters of NZ. We would like to see one document to manage the fundamentals of water quality in NZ because of cost and consistency

2B. Letter of 14th January

14th January 2009

Dr Kit Rutherford
NIWA PO Box 11115. Hamilton

Subject: Review of monitoring in the Tukituki catchment, Hawke's Bay – Revised January (3rd) 2009

Dear Dr Kit Rutherford
Hawke's Bay Environmental Water Group (HBEWG) has issues with the January revised DRAFT because the revised draft contains new information some which HBEWG strongly disagrees with. Under point 3 of the review it now contains at least 15 new issues specifically aimed at HBEWG this is a complete change from the positive attitude in the first draft.
We require that each issue raised in the file 'not just mention it in table 4' (some are not) be addressed. E.g. Heavy Metals, Trout Habitat, the position of low flow minimum sites which are not protecting the ecosystem, HBEWG 14th December 2007 letter to Darryl Lew of HBRC we request that this letter be dealt with. HBEWG File Ref*34

3. Table 4. – 10 Pah Flat 'Stream' – correction required

The purpose of this review was to establish the health & condition of the Tuki Tuki River to seek solutions to all/any problems and not to waste time on trivial matters

HBEWG makes the following statement that the data, information in the file was just collected & compiled 'collated' by the HBEWG and it was all referenced and copies of that Ref: were attached. HBEWG attached the page, which included the full text of where the quote was taken from. This is not normally done. This was done so that the quote could be read in the full context otherwise in some cases the 'quote' may be taken out of context. HBEWG thought this would be helpful! Especially when quoting case law

The scientific data 'collated' & referenced in our file seems to be questioned & in some cases ignored yet it is from robust & scientific sources – qualified people

Because of this fact we cannot accept that this referenced data from the following is not being accepted, this is not our data, HBEWG only compiled & 'collated' this data some of which is set out below

- Freshwaters of New Zealand – Olsen and Townsend (2003) found higher concentrations of hyporheic

(25 cm depth) dissolved oxygen, ammonium and phosphorous in the Kye Burn.
Data from Larned (2002) Figure 32.4 shows substantial differences between sampling edge & centre. Larned (2002) collected surface and hyporheic (30-50 cm deep) – Hyporheic water was typically enriched with nutrients, particularly ammonium and phosphorous (Fig. 32.4) –
[NOTE: Waitaki River, South Canterbury, in April 2002 – **<u>'NOT A LAKE'</u>**].
"the hyporheic zone has the potential to play a significant role in influencing surface water quality." Biggs *et al.* (2003) Ref: 32.5 Freshwaters of New Zealand

- Case Law – Mahuta & Environmental Defence Society Inc RMAs69(3) 5 NZTPA 73 - 6 NZTPA 344 'Mixing Zones'
- Cawthron Report No 1233
- New Zealand Periphyton Guideline – MFE – Barry Biggs
- Professor in Microbiology Margaret Loutit – "At times faecal bacteria could be detected in the sediments but not in the overlying water"
- Linvil G. Rich
- Ned Norton RM Consultant – Ecological Assessment of Receiving Water – Pah Flat Stream
- Vivienne Cassie Cooper
- CW Hickey Receiving water criterion minimum dilutions required assuming no background contamination
- John Milton Crawford & PD Askey
- Bioresearches – "Most metals present in municipal sewage effluents are absorbed onto particulate matter"
- Water & Wastes Massey University
- Waikato Regional Council documents
- New Zealand Municipal Wastewater **<u>Monitoring</u>** Guidelines – Monitoring Parameters - MFE
- OPUS Waipukurau AEE p 15 – 3 km downstream, p 18, Very High Risk
- EPA identified 129 pollutants - USEPA has identified 22 bioaccumulative chemicals mixing zone ban

trp – DRAFT 2 – 77

- HBRC reports, SOE 2007 "Sediment resuspension – As part of an ongoing study, Council has continued to investigate whether stirring up the sediments on the bottom of streams and lagoons can cause any bacteria living in the sediments to be resuspended in to the water. These lagoons can have up to 9,800 times more bacteria in the sediments than in the overlying water so sediments could prove to be a significant source of bacteria into the waterway." Ref. p 23 HBRC SOE 2007
- Plus Others

HBEWG has presented a sample above of robust scientific data from Olsen and Townsend (2003), Larned (2002), Biggs *et al.* (2003) & HBRC SOE 2007 Robust reasons why the accurate complete state of the river health & condition has not been established in the Tukituki River because the present sampling method & design is not adequate. HBEWG has provided proof from qualified people on this issue

Some of HBEWG other concerns are

1. Mixing Zones – Case Law

Mahuta & Environmental Defence Society Inc RMA s69(3) 5 NZTPA 73 -6 NZTPA 344 'Mixing Zones'
HBEWG is not arguing this point at all because this is 'CASE LAW'
The case law quote is crystal clear
"it is important that 'mixing zones' should not be looked upon generally as areas in which part of the treatment process may occur; otherwise the intention of the act that water quality standards be maintained will tend to be defeated"

Yet clearly in part 3 of the DRAFT "standards/guidelines must be met within the mixing zone – this is not my understanding of case law on this topic" –
HBEWG cannot accept this DRAFT wording because the CASE LAW quote states

"that water quality standards be maintained"

2. Monitoring of the Parameter of Biological

Unless the contents of the river are measured at the same time, as the water column there will be no accurate complete state of the river health & condition established. See quote below
Monitoring of the Parameter of Biological - This is not being accepted as part of the monitoring but there is robust data showing why this is a requirement
HBEWG states precisely our position on this issue because of the following robust data in documents
Again data from other scientific sources from qualified people is not being accepted

This data is from Barry JF Biggs the NZ Periphyton Guideline document
"It is now well accepted that algal chemistry plays a stronger role than water column chemistry in periphyton biology (Lowe, 1996).
Concentrations of nutrients dissolved in the water **may not be a reliable** indicator of the degree of nutrient limitation, or nutrient supply regime to periphyton (Biggs, 1995)"

"what is measured in bulk water samples is just what is surplus to the periphyton's requirements or is being recycled downstream.
Conversely, the concentration of nitrogen and phosphorus within the mat reflects these supply concentrations." Ref: page 87 NZ Periphyton Guideline – Barry JF Biggs 2000

So if not measured the total level of nitrogen & phosphorus will not be known at the same time the water column samples are taken – present sampling is not providing accurate complete measurement of N & P
TRP DRAFT 2 -78

This point is being avoided – robust scientific data from qualified people state precisely that – measuring just the water column "may not be a reliable indicator of the degree of nutrient limitation, or nutrient supply regime to periphyton" Ref: Biggs
We request that this issue be addressed fully
ALGAL CHEMISTRY must be undertaken at the same time as **WATER COLUMN CHEMISTRY**.

If this is not instigated the true / actual level of the concentrations of contaminants will not measured – therefore will not be managed. 'FACT'- The Tukituki River deteriorated condition will continue

Again another piece of robust scientific data that verifies the same robust scientific data
"important to measure the characteristics of the biological components of the ecosystem as well as the physical and chemical water quality characteristics, to be able to confidently assess whether an important change has occurred or is likely to occur." Ref: 3.1-19 ANZECC 2000

This referenced data from a robust document which precisely shows the importance of biological components of the ecosystem being measured at the same time as the water column otherwise as quoted "to be able to confidently assess whether an important change has occurred or is likely to occur." Ref: 3.1-19 ANZECC 2000

3. Sampling – Methods - Design

As stated which has not been addressed that the fundamental crucial part of this issue is having the most adequate robust sampling – method & design to establish the accurate measurements of the health & condition of the Tuki Tuki River which is not being fully done at the moment.
HBEWG state again that this issue has not been fully addressed HBEWG has concerns that this issue is being avoided
"we cannot manage what we do not measure" David Ray (*NIWA*) this fact is being ignored

There are many months that the Tuki tuki River is in poor health and condition.
HBRC has not recognised this fact because there is no adequate sampling of the key indicators and other contaminants are not being sampled.
HBEWG requests that adequate sampling to be undertaken therefore it can be managed

As stated before unless this issue is fully addressed it will be of limited value to have water quality guidelines & standards without being coupling to a robust design, methods and frequency of sampling and analysis which is required to obtain results that has fully measured all, aspects which can effect the health & condition of freshwater.

The following data shows why the Sampling – Methods – Design are not adequate to establish accurate measurements of the health and condition of the Tukituki River. This is the fundamental issue which seems to be avoided

[It was **agreed** at the meeting of the 23rd of December 2008 that bigger/heaver particles of suspended solids were lower in the water column thus were not being sampled.]
Therefore it is obvious that the current sampling is not adequate, we request that this issue be addressed

Some relevant referenced material in HBEWG file

- "fine suspended particles may act as carriers of other pollutants, notably sorbed phosphorus and various trace organic and metal biocidal materials" Ref: 11.2 Freshwaters of NZ.

If suspended solids are not (which may the case) being tested especially for phosphorus then this is another area of phosphorus going undetected therefore again the true state of the Tuki Tuki River condition may not being measured
TRP DRAFT 2 - 79

It is obvious that heavy suspended solids settle out of the water column quicker so that these SS will be lower water column. These sediments may contain more heavy metals and nutrients/contaminants.

- "Most metals present in municipal sewage effluents are absorbed onto particulate matter." Ref: NCC Bioresearches 23 June 1995

- Water movement can resuspend sediments on the ocean, **river/stream beds** & lagoons which can cause any bacteria living in these sediments to be resuspended back into the water column.

"These lagoons can have up to 9,800 times more bacteria in sediments than the overlying water so sediments could prove to be a significant source of bacteria into the waterway." Ref: page 23 The State of our Environment HB 2007 HBRC

There is no doubt that contaminants in sediments play a most important role in the health & condition of rivers/streams, which are not being monitored in freshwater.

- "Anoxia also results in chemical release of sediment bound phosphorus" Ref: 22.11 Freshwaters of NZ

- "Macrophytes are able to acquire their nutrients from both water and the substrate sediment. High biomass can develop despite low nutrients concentrations in the water column if the sediments contain adequate nutrients." Ref: Page 16 Water Quality Guidelines No. 1 – Ref: *2 HBEWG [My underlining]

- At what depth in the water column – if no surface sampling no oil will be detected, often the Tukituki River has an oily surface – if not deep enough heavy suspended solids will not be measured
- At what time of day – there is no 24 hour sampling for D/O – temperature sampling time
- What to sample for – present list is not complete or satisfactory
- Contact recreational sampling. The present depth may not be providing an accurate measurement

Because at the present depth given that the light intensity at that depth most of the faecal coliform may have died off. So when there is turbulence in the waterway again other faecal coliform, which were lower in the water column will rise higher in the water column, & substantial faecal coliform can come from the resuspending of sediments

"The die off measurement has not always been successful as the plume was not always on the surface" Ref: HDC Monitoring Report 22nd August 2002
So if the sampling depth is not deep enough no accurate measurement will be obtained.
Again as HBEWG has stated precisely that unless the sampling method is robust no accurate measurement of the health & condition of the Tukituki River will be established.
We request that this issue be addressed

Point 5 – The DRAFT states "The OPUS report has not been sighted"
Some pages of this OPUS document are in HBEWG file – Ref: *41, *45 & *48

Groundwater quantity
Spelling – HBEWG
The DRAFT states "that groundwater is fully allocated but no data have been sighted"
HBRC 12th September 2007 Ruataniwha Groundwater Takes & Tukituki / Waipawa River Flows p1 "are fully or over allocated, with no water available for new allocation." Ref: HBEWG file *17

A well known highly considered, respected and qualified person has approached HBEWG and has offered to peer review our file

Trp DRAFT 2 80

Seeing that the document is titled 'Review of monitoring in the Tukituki catchment, Hawke's Bay.
HBEWG has to ask monitoring of what?
We request that this issue be addressed.
HBEWG has raised this issue in our file we highlight some of these issues again

- Heavy Metals – Not being monitored

HBEWG Ref* 6 List of heavy metal results which show exceedances being discharged into the Pah Flat Stream which under HBRC RRMP 5.4 this stream is to be managed for aquatic ecosystem
HBEWG Point 14 in file we raise the issue of heavy metals accumulating into aquatic plants, 15 micrograms per litre of copper toxic to certain plants & animals, nitrate levels at 0.01 ppm detrimental to many amphibians.
Also – "There was 10 times more uranium than cadmium in phosphate fertiliser and this contributed 10 percent of the background radiation in soil" Ref: Dairy Exporter April 2006

HBEWG Point 19 – Priority Pollutants
EPA has identified 129 pollutants
Ethynlestradiol at 10 nanograms per/L impacts on male rainbow trout
HBEWG Ref*38 List of monitoring parameters in New Zealand Municipal Wastewater Monitoring Guidelines MFE
The discharges into the Tukituki River have only 4 contaminants in resource consents so the discharger cannot be held responsible for the discharge of the other contaminants accordingly to the HBRC This is not acceptable. See RMA s15

HBEWG Point 35 - Hastings District Council monitors

- 55 contaminants
- 4 species for toxicity
- mussels for 16 contaminants
- sediments for 9 heavy metals

& this is a **MARINE** discharge not a freshwater discharge such as the discharges into the Tukituki River

This amount of HDC monitoring of a MARINE discharge makes a complete mockery of the CHBDC & other monitoring of the Tukituki River. We request that this issue be addressed

NOTE: In November 2001 MFE Survey Technical Paper No. 70 Freshwater HBRC Parameter list contained approx 26 contaminants –
The list contained no sediment sampling for nutrients & faecal coliforms, no fish, mussels, no heavy metals, no pesticides, no oils/greases, no synthetic estrogen, no detergents, surfactants, antibiotics no Giardia, Campylobacter, Hepatitis, Salmonella, Shigella & may not be a full range of algae

Issues HBEWG has raised – Heavy metals, Sediment sampling, fish & Mussels, Ethynlestradiol, pesticides & number of Priority Pollutants not monitored. We request that this be addressed

We request that the Review recommends the complete removal of the Waipawa, Waipukurau, Otane & the two Takapau sewage and effluent discharges from the Tukituki River and tributaries

The review is ignoring Nitrogen Ref: HBEWG point 18(C) 29.316 tonnes per year of TN being discharged into Tuki Tuki River compared to 5.336 tonnes per year of SRP from two oxidation ponds
We request that Nitrogen be addressed in the review because Nitrogen is 5.49 times higher than SRP

Again we request a full copy of the sampling, method and design used on the Tukituki River

Yours sincerely, W D Dodds

Hawke's Bay Environmental Water Group
C/o 603A Ballantyne Street, Hastings 4120
Trp DRAFT 2 77-81

F A. Scott

C I CROMBIE

D.W. RENOUF

D.W. Renouf

2C. Letter of 12th February

12th February 2009
Dr Kit Rutherford
NIWA PO Box 11115
Hamilton

Subject: Issues 1. 'Sewage Fungus' 2. Essential to include **ALGAL CHEMISTRY** at the same time as **WATER COLUMN CHEMISTRY** 3. Pollution worse over 20 yrs. 4. Secchi disc 5. Dr Olivier Ausseil Report

Dear Dr Kit Rutherford
I take this opportunity to inform you of these issues because I am specifically mentioned in the DRAFT.

1. 'Sewage Fungus' - *Sphaerotilus*

DRAFT 06/01/2009 of Review of monitoring in the Tukituki catchment, Hawke's Bay, point 3 p13, states "I disagree with the HBEWG that it is essential to monitor BOD. This may be appropriate where organic wastes containing sugars (e. g. dairy factory effluent) cause problems with 'sewage fungus' but I have seen no evidence to suggest such problems occur in the Tukituki"

"Sphaerotilus is a colourless, filamentous bacterium often associated with waters polluted by organic wastes from dairy factories, meat processing plants, silage leachates and occasionally sewage discharges. The common name for visible growths of such bacteria is 'sewage fungus'." Ref: page 69, Photographic Guide to the Freshwater Algae of New Zealand September 2000 –Stephen C Moore, M Sc (Hons), Otago Regional Council – ISBN:1-877265-09-8

"Polysaprobic (septic water immediately below an outfall with highly concentrated wastes) Periphyton Indicator Taxa Filamentous bacteria dominant (*Sphaerotilus, Zoogloea, Beggiatoa*)" Ref: page 76 NZ Periphyton Guideline

"As the concentration of labile organics increases, the periphyton mat usually becomes progressively dominated by heterotrophic filamentous bacteria such as *Sphaerotilus natans and Zoogloea sp.* (often termed 'sewage fungus') (Biggs 1989). Under high concentrations of organic contamination, the streambed can become smothered with these sewage fungus growths that give the appearance of brownish cotton wool. These growths obliterate habitat for benthic invertebrates and usually smell foul." Ref: page 15.17 Freshwaters of N Z

"Heterotrophic slimes (commonly referred to as 'sewage fungus'), which rely on external sources of carbon for growth." Ref:#p5
"Heterotrophic slimes (sewage fungus) are proliferations of bacteria and/or fungi that may form feathery, cotton-wool-like growths in streams and rivers that have high concentrations of dissolved organic compounds. The main organisms are filamentous bacteria (e. g. white growths of *Sphaerotilus natans* and pink growths of *Flavobacterium*), and fungi (e. g. white growths of *Leptomitus lacteus*)." Ref: # p9, 10
"Unnatural white, pink, or grey growths on river bed." Ref: #p10
"*Sphaerotilus* growths accumulate heavy metals" Ref: # p10
Ref: # Water quality Guidelines No. 1 MFE

The Tukituki River receives
Otane oxidation pond mainly domestic, Waipawa oxidation pond mainly domestic & may have some industry effluent, Waipukurau oxidation pond 51.80% domestic & has meat processing plant effluent, sale yards effluent & landfill leachate, Trade Waste 48.20%, Takapau oxidation pond mainly domestic, Takapau Works meat slaughterhouse discharge.
Landfill Leachate can have 1150 g/m^3 of Total Organic Carbon which means the BOD level is substantial
Silage leachate & dairy shed discharges onto and into land alongside river
Trp 73

Appendix 1: Glossary – Sewage fungus - Ref: Page 120 NZ Periphyton Guideline
"Filamentous bacteria (predominantly *Sphaerotilus*) that proliferate when there are high concentrations of low molecular weight (dissolved) organic matter such as sucrose in the water. They form mats that look like cotton-wool under water. Sometimes they have a pinkish colouration on the outside."
The point of this information is to indicate that there is a possibility that sewage fungus may be present in the Tukituki River therefore because of that possibility having BOD_5 at a level which can control sewage fungus can only be beneficially to Tukituki River
Landfill Leachate can have up to 1150 g/m^3 of TOC which means the BOD level can be substantial

2. Essential to include **ALGAL CHEMISTRY** at the same time as **WATER COLUMN CHEMISTRY**
Measuring just the water column "may not be a reliable indicator of the degree of nutrient limitation, or nutrient supply regime to periphyton" Ref: NZ Periphyton Guideline – MFE – Barry Biggs

In the DRAFT of 06/01/2009 –
"Table 4 Issue 1. I disagree with the HBEWG that it is essential to include algal chemistry in monitoring."
Because of this statement in the DRAFT, this issue is set out more clearly & precisely with "REFERENCED" data again from NZ Periphyton Guideline – Prepared for Ministry for the Environment by Barry J F Biggs, *NIWA*, Christchurch, June 2000. Published by the Ministry for the Environment PO Box 10362 Wellington New Zealand June 2000 ISBN 0 478 09076 5 –

[Obviously this is NOT HBEWG material so it cannot be continued to be ignored or linked to HBEWG]

"Periphyton is the slime and algae found on the bed of streams and rivers." Ref: page 10
"Periphyton mats are very efficient at collecting silts (Graham 1988; **Davies-Colley** *et al*, 1992; Jowett and Biggs,1997). Thus periphyton may be useful monitors of suspended solids concentrations in the water column." Ref: NZPG page 75

Therefore when water column samples are taken below any periphyton for suspended solids (which also contain other contaminants) this water **column** sample is not an accurate measurement of the health & condition of the river because the periphyton is containing suspended solids as well as other contaminates
The periphyton sloughs off and is not measured for any contaminates which it contains.
Again no accurate/complete measurement of the health & condition of the river is being established.

The next quote also shows clearly & precisely why
ALGAL CHEMISTRY must be undertaken at the same time as **WATER COLUMN CHEMISTRY**
"It is now well accepted that algal chemistry plays a stronger role than water column chemistry in periphyton biology (Lowe, 1996)."
"Concentrations of nutrients dissolved in the water may not be a reliable indicator of the degree of nutrient limitation, or nutrient supply regime to periphyton (Biggs, 1995)"
"what is measured in bulk water samples is just what is surplus to the periphyton's requirements or is being recycled down stream." Ref: NZPG page 87

"the concentrations of dissolved nutrients measured in solution mainly reflecting nutrients that are left over after the periphyton have removed what they need and not the supply concentration" Ref: NZPG page 36

"Conversely the concentration of nitrogen and phosphorus within the mat reflects these supply concentrations" Ref: NZPG page 87
If these mats are not measured for N & P no one will know what the actual/true health & condition of the Tukituki River is. The true concentration level of nitrogen & phosphorus will never be established

This leaves no doubt that ALGAL CHEMISTRY must be undertaken at the same time as WATER COLUMN CHEMISTRY- otherwise the true/actual measurement of the health & condition of the Tuki Tuki river will never be established therefore will not be managed
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I therefore must state in the strongest terms that this issue be seriously reconsidered because of the robust source of evidence provided from Barry J F Biggs *NIWA* Christchurch.

Measuring biomass – "highest biomass is often found at low velocities and any increase in velocity tends to result in major reductions in biomass because of the drag on the filaments." Ref: NZPG Page 47
[As we have already stated that the current locations for sampling biomass may not be suitable]

3. Pollution worse over 20 yrs.

Article in HB Today 5th Feburary 2009 – Rivers run foul from farming run-offs
"The microbial pollution is of particular concern for reducing suitability of our rivers for swimming," said Dr Rob Davies-Colley, principal aquatic pollution scientist at the National Institute of Water and Atmospheric Research. (*NIWA*)
"Nitrogen and phosphorus levels have increased at many sites due largely to diffuse pollution from pastoral farming with increased stocking rates and use of fertilisers, and conversion of land used for sheep/beef farming to dairy or deer farms." Ref: Dr Rob Davies-Colley

We raise the issue of that in the RRMP there is no N kg/ha/y in Rule 11 – this needs to be based on plant uptake amount. Ref: point 8 & 44 in our file – we request that this issue be addressed

4. Secchi disc

- Clarification to what was said at the meeting 23rd December 2008
"a Secchi disc, a white (or black-and-white) disc that is observed vertically" "Measurement protocol (reference) Extinction depth of Secchi disc observed vertically (Smith 2001)" Ref: 21.10 Freshwaters of NZ

"Another disadvantage is that the Secchi disk cannot be used in most shallow, clear rivers." Ref: Water Quality Guidelines No. 2. page 49

The data also mentioned that the results obtained by a vertical measurement is different from a black disc viewed horizontally because of the higher density of light with the horizontal measurement.
Also why would you measure a water depth of 150 to 200 mm (which is approximately the width of this page) for swimming?
So it is plainly obvious that you cannot swim in 200 mm of water so measuring for clarity when the depth is only 200 mm which is not swimmable therefore an accurate measurement of clarity for recreational use cannot obtain.
Swimming places/holes are areas of deep water where excellent vertical clarity is required for safety
Request that issues of design & methods of monitoring be addressed to protect recreational users

5. Dr Olivier Ausseil – Water Quality in the Tukituki catchment. State, trends and contaminant loads
Seeing that this report in many areas is in the Draft further issues & Dr Olivier Ausseil recommendations need to be considered for including into Draft
E.g.
"The estimated annual SIN load in the Tukituki River at Shagrock varied between 1,500 and 3,300 Tonnes per year, depending on the year and the calculation method. Annual loads at the two lower catchment sites (Red Bridge and Black Bridge) were estimated between 1,400 and 2,400 T/Y." Ref: page 38.
"Nutrient load analysis indicates that the upper catchment (above SH50) yields approximately 6 Tonnes of DRP and 200 to 300 Tonnes of SIN per Year." Ref: page i

Guideline for SIN Load is 8 Kilograms day – Ref: Page 11 Appendix Dr Ausseil Report
At Shagrock the SIN Load is 9.04 Tonnes a day
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"If a management objective is to reduce the frequency and duration of algal blooms, managing DRP inputs to the system is an obvious target-this is consistent with the RRMP which puts emphasis on P management. It should be noted however, that managing only one nutrient is fraught with risk (Wilcock et al. 2007), particularly as some sites in the catchment appear to switch to SIN-limited conditions during periods of low river flow." Ref: page 48

In the Draft under 5.4.5 "Management of only one nutrient may be a risky strategy."
Because of the Data (Appendices page 5 – Dr Ausseil) on the Mangaonku Stream at Tikokino Rd showing TN max of 3.19 mg/L and 0% compliance where as TP has 93% compliance indicates clearly that managing only one nutrient is fraught with risk. N needs to be managed not P

"Ammonia can be toxic to many aquatic species, and is a common pollutant in treated domestic, agricultural and industrial wastewater discharges. In aqueous solution, ammonia exists in two chemical forms: the ammonium cation (NH_4^+) and un-ionised ammonia (NH_3). The respective proportion of these forms is determined by a chemical equilibrium governed by pH and temperature." Ref: page 12

"SIN is the sum of ammonia, nitrate and nitrite nitrogen." Ref: page 30
"($SIN = NO_3 - N + NO_2 - N + NH_4 - N$)" Ref: Page 103 NZ Periphyton Guideline

NOTE: Recommended water quality guidelines for unionised ammonia and TAN – ANZECC 2000
Ammonia (NH_3/NH_4^+) & Total Ammonia Nitrogen (TAN)
<0.025 mg/L pH >8.0 cold freshwater
0.0 mg/L pH <8.0 cold freshwater
Ref: page 9.4-31 ANZECC 2000
Mangaonku Stream at Tikokino Rd - pH min 7.0 – max 7.3 Ref: Appendices page 5 – Dr Ausseil

Request that SIN & Unionised Ammonia & TAN be included into RRMP

"we cannot manage what we do not measure" David Ray (*NIWA*)
Meeting of the 23rd December 2008 in our comments on the DRAFT HBEWG requested that robust details of sampling methods & design are included into this 'Review of monitoring in the Tukituki catchment, Hawke's Bay'
In the letter of the 6th January 2009 I asked HBRC what changes have been made after 2005 to sampling and what are the current design & methods of sampling.
Letter of the 14th January 2009 HBEWG state precisely that unless the sampling method is robust no accurate measurement of the health & condition of the Tukituki River will be established.

Below are some reasons why there should be a review of the design of sampling, design of measuring & method used on the Tukituki River
Examples:
One -"Dissolved oxygen concentration varies diurnally, with maximum values generally late afternoon and minimum values at dawn. Thus, only measurements taken early in the morning, or continuous monitoring, can provide some useful measure of the daily minimum DO concentration actually occurring in the river. Ref: p 10 Dr Ausseil Report.

Two - Faecal indicator bacteria may be lowest towards mid-afternoon after a decent dose of solar radiation just into the top of the water column, and there are daily variations in quality & quantity discharges into the river.

Three – Cyanobacteria are able to regulate their buoyancy and maintain an optimal depth in the water column
Trp 76

Four – "Natural variations in surface waters and groundwaters, whether flowing or standing, can affect the values of physical and chemical indicators. For example all water bodies can form vertical or horizontal layers of differing temperature or salinity that may or may not need to be sampled separately, according to the sample plan." Ref: 7.4-2 ANZECC 2000

Five – "Physico-chemical and biological indicators should be regarded as complementary to each other." Ref: 7.1-2 ANZECC 2000

Six – There may be spatial variation *within* a site that needs to be quantified in the monitoring program, because otherwise the estimates of the chosen measurement parameter may be imprecise or even inaccurate. For example, in thermally stratified waters the depth of sampling is important because the concentrations of many measurement parameters (e.g. hydrogen ions, dissolved oxygen, nitrate, hydrogen sulfide, plankton) can vary greatly between the top and bottom layers.
In rivers, samples taken from the edge rather than from mid-stream are likely to contain quite different amounts of suspended material and therefore different amounts of various compounds bound to the particulate matter. In benthic sampling for biological parameters (e.g. invertebrates, algae) or for sediments, the habitats or sediment types may vary at a site." Ref: 3-12 ANZECC 2000

Seven – "When measuring parameters are being sampled in the water column, it is sometimes assumed that the water is well mixed and that a mid-water or mid-stream sample will be sufficiently representative. This may not be the case. Even in fast-flowing mountain streams, water can be observed flowing upstream in eddies. In larger rivers, tributary water may not mix fully with the mainstream for hundreds of metres or even kilometres. In estuarine waters, salinity may be significantly stratified, and all water bodies can have gradients of redox potential and temperature." Ref: 3-13 ANZECC 2000

Again we request a full copy of the design of sampling, design of measuring & method used on the Tukituki River

Yours sincerely,
D.W. Renouf.
David Renouf
603A Ballantyne Street, Hastings 4120
trp 77

PS. Photo taken 11/02/2009 – Lower Tukituki River.

2D. Letter of 16th December

0/c

Fish & Game
NEW ZEALAND

Ref: 2-01-03

16 December, 2008

Helen Codlin
Group Manager – Strategic Development
Hawke's Bay Regional Council
Private Bag 6006
NAPIER 4142

Dear Helen

10 YEAR PLAN ISSUES

Thank you for the opportunity to meet and discuss the few issues that I have identified in the discussion documents relating to the draft 10 year plan. As discussed we are generally supportive of the forward thinking approach of the Council and appreciate the opportunity to provide feedback on the matters we see need more discussion around and debate over. This is especially so now that I have received your summary letter that continues to overlook the significant matters I raised with you.

There is no doubt that water is the number one issue for this region. The sustainable management of water resources is a topical matter wether you are a consumptive user or a statutory manager like Fish and Game. That the region lacks certainty in water management is creating problems for those who wish to establish businesses around it as much as it is for groups like Fish and Game. As you might recall our outstanding issues on the development of the Regional Plan were flow setting and allocation for the regions rivers. Our concerns were focused on the flow setting and allocation process. We agreed to resolve the plan appeal through a side agreement that then saw a commitment from the Hawke's Bay Regional Council to address the lack of robust science behind flow setting and allocation for the region. This was in 2006 and we have yet to see any progress on this issue despite a number of consents coming up for renewal in both the Tukituki and Ngaruoro rivers that would have benefitted from this work. I see that there has been provision made in the draft costings and outline of proposed work to deal with this issue through additional science and subsequent plan variations. Fish and Game New Zealand support this approach and suggest that the money allocated to it, though substantial, could be viewed as an investment in the future development of the region through resolving the issues of certainty around supply.

While the issues around the supply of consumptive use of water are significant and should have a priority in the future management of the region, an issue that is hugely significant to Fish and Game and the region generally that has not been addressed is the one of sustainable land use. That this issue has not been specifically identified and some consideration put to it for the next

Statutory managers of freshwater sports fish, game birds and their habitats

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10 years is staggering. After the lengthy discussions with both council staff and councillors themselves on this issue I would like to think that this is merely oversight and can be addressed through the submission and subsequent review process on the 10 year plan.

You will no doubt be aware of the significant concern that this organisation has nationally around the impacts of intensive land use (often agriculture) on water quality. While this region certainly does not face the issues that Southland or the Waikato do there are nonetheless areas of significant degradation of water quality as a result of inappropriate land use within a catchment. I am certain you will be aware of the issues that surround the upper Mohaka River where this particular problem is about to boil over. The upper Mohaka situation provides a graphic example of the scale of the problem. We are aware that the issue is at this stage confined to certain locations, but other areas where changes in water quality are becoming evident as a result of land use changes include the Ngaruroro River (Hawke's Bay Dairies) and the Ruataniwha basin as the water availability issues are resolved and more irrigable land become available.

We find it surprising that the Hawke's Bay Regional Council has not made provision for addressing this issue through your 10 year plan process. The Hawke's Bay Regional Council is in real danger of being labelled a laggard on this issue. While the rest of the country takes action to deal with it, we seem intent on pursuing an approach that has failed to deliver anything to date. I am sure you are aware of the recent Environment Waikato variation five outcome for Lake Taupo which is a mere 30 kilometres from the Mohaka catchment. I am sure you will also we well familiar with Horizons One Plan and that ECan are also now investigating land use rules as a means to addressing intensification issues. This stuff is not new to Regional Council's and is certainly not new to Hawke's Bay. It is our view that the current low key, education based approach is inadequate and as likely to work against primary producers as much as groups such as ours.

The response of a farmer in the Mohaka catchment to the issue of land use intensification epitomises why education needs to be backed by rules to ensure compliance with minimum standards. Alan Crafar who farms a large portion of the Taharua River (a tributary of the Mohaka River) was quoted recently in the Dominion Post as suggesting he was going to pipe effluent into the Environment Bay of Plenty catchment to circumvent the one rule the region has regarding disposal of animal effluent to land. His attitude was one of finding a way around one of the few obstacles to his aim of farming as many dairy cattle in the Taharua catchment as he possibly could. I would suggest to you that this demonstrates clearly why the Environment Court supported the EW variation five and why this region needs to make provision for a similar approach to intensive land use. To suggest that this core issue can be resolved through an education based approach is somewhat naive in today's resource management approach. The Resource Management Act speaks of setting baselines and enabling communities above that. It is the function of Regional Councils to develop science and policy that sets those baselines. Without these we are exposed to the level of those who contribute the least and we end up in a situation like the one we are currently facing in the Mohaka catchment.

Fish and Game New Zealand, Hawke's Bay Region has invested significant time and money into increasing our knowledge and understanding of the upper Mohaka River and associated instream ecology. This work is a collaborative project with Hawke's Bay Regional Council staff, Envirolink and Cawthron Institute. The objective of the work is to draw out the linkages between the observed changes in water quality and the perceived decline in the Mohaka trout fishery. As you may be aware the Mohaka trout fishery has been recognised as nationally outstanding and is specifically protected by a Water Conservation Order. It is our expectation that out of this more intensive monitoring/research will come a management response. It is the 'so what?' scenario we discussed. That we spend large amounts of time and money establishing cause and affect with no subsequent response would be damaging for the credibility of all involved. It is our view the Hawke's Bay Regional Council needs to specifically define the problem and set aside resources to address it in the 10 year plan. This would signal a strategic and forward thinking approach rather than being faced with dealing with it as a reactionary issue when the region is forced into addressing it as public pressure mounts.

Finally it is my understanding that your Council had in fact given instruction that the draft policy framework around the issue of land use be developed. The land use report developed by Chris Reed set out a direction and proposals for plan variations and this formed the basis for implementing these changes. Why has this directive not been incorporated into the final 10 year planning process and resources directed to completing this work?

Please accept these comments as our first round of discussions as I intend to appear before and speak to your Council on these matters when the formal submission process begins.

Yours sincerely

Iain Maxwell
Regional Manager
E-mail: imaxwell@fishandgame.org.nz

HBRC re 10yr plan.doc

2E. Response of 13th March

HBRC09203

13 March 2009

Hawke’s Bay Environmental Water Group
C/o David Renouf
603A Ballantyne St
Hastings 4120

Dear David

Thank you for your letters of 14 January, 12 February and the Fish & Game letter of 16 December. My apologies for not replying earlier.

Concerning your letter of 14 January.

‘…we require that each issue raised in the file be addressed (not just mentioned in Table 4)…’ I have discussed issues where I have some specialist knowledge, and where the issue raised is relevant to the terms of reference (TOR) set by Council for my review.

‘…the purpose of the review was to establish the health & condition of the Tukituki River, to seek solutions and all/any problem…’ These are not the TOR set by Council - they are much broader. I refer you to the TOR set out in my report.

‘…the scientific data collated in our file seems to be questioned and in some cases ignored…’ I read your file carefully and was already familiar with much of the original material. I refute your suggestion that I have ‘…ignored…’ material. However, some issues did not lie within my TOR, and I focused on issues that, in my opinion, are the most important.

I have ignored some commentary by HBEWG where, in my opinion, it is clearly erroneous. In my 2nd draft I make the point that I regard the HBEWG as a group of informed lay folk who do not have a sound technical training in some issues. I also went on to say that, in my opinion, this is not grounds for Council to ignore the issues raised by Group. HBEWG makes some very good points. However, on occasions the arguments advanced do not stand up to technical scrutiny. This is not intended as a criticism of the HBEWG.

‘…accurate complete state of river health & condition has not been established …because… sampling method & design is not adequate…’ HBEWG list a number of things they would like to see monitored routinely. There is clear merit in some of these suggestions and I have highlighted things that, in my opinion, Council should consider.

However, some suggestions by HBEWG are, in my opinion, in the ‘…nice to know…’ rather than the ‘…essential for wise management…’ category (e.g., routine monitoring of nutrient concentrations in the hyporheos and heavy metals/pathogens in the sediments). Council has a limited budget for monitoring. As we discussed at our meeting in December, I believe Council monitoring should aim to identify problems and assess the effectiveness of policy put in place to solve them. I would not want to see Council waste time/money on monitoring which did little more than confirm the existence of known problems.

Note that the TOR of my review do not extend to addressing whether, having identified a problem, Council acted in a timely manner to solve that problem. HBEWG has argued that Council has failed to act quickly enough on known problems (e.g., Waipukurau sewage, cattle in streams, land use intensification, monitoring of irrigation abstraction etc.). This is an important question but not one that I was asked to address.

'…concentrations of nutrients dissolved in the water column…might not be a reliable indicator of the degree of limitation…' This is a widely accepted view. It does not mean that water column concentrations have no value – simply that they must be interpreted carefully. I am satisfied Council is not mis-using water column nutrient data. I do not advocate routine (e.g., monthly) monitoring of algal chemistry. I do support Council's investigations of nutrient limitation.

'…recycled downstream…' Council is aware that nutrient recycling is important in the Tukituki. They have asked for advice on this topic which has been delivered via an Envirolink Small Project (Rutherford 2009).

'…there are many months when the Tukituki is in poor health and condition…' There are few people who would dispute this. The debate is about: (1) what steps is the community prepared to take to remedy the situation, and (2) will these steps be cost/effective.

'…HBRC has not recognised this fact because there is no adequate sampling of key indicators…' I do not agree. I think the current monitoring identifies several key issues. I believe Council has enough information to seek cost/effective remedies. I would not like to see (scarce) Council resources diverted from solving problems into detailed monitoring of known issues. Would HBEWG?

'…surface samples may not provide an accurate measurement of public health risk…because given the light intensity at that depth most of the faecal coliforms may have died off…' I do agree with this assessment in a riverine environment where vertical mixing is rapid.

'…suspended particles…carry other pollutants…can be resuspended…play a role in health & condition…' I agree with these statements. A case can be made for Council to investigate the threat to health & condition posed by resuspended, contaminated (e.g., by heavy metals and/or pathogens) sediment. However, I do not believe it is something that should be routinely monitored.

'…groundwater is fully allocated…' My understanding is that <u>surface water</u> is fully allocated.

'…request the complete removal of sewage and effluent discharges…' It is well beyond my TOR to make this recommendation.

'…request monitoring heavy metals, ethynlestradiol, pesticides & a number of priority pollutants not monitored…' A case could be made for an investigation of some of these pollutants. This might involve a desk study of potential risk and, if the risk is high, field sampling. It is my understanding that Council has undertake risk analyses of pesticide in orchard areas.

'…request monitoring fish, mussels…' Where toxicity problems are known or likely to occur such monitoring could be considered.

'…request a full copy of the sampling method and design…' These are set out in several Council documents. I Do not think my review should include such details.

'…standards must be met within the mixing zone…' I have already stated my opinion to the contrary. However, I am not a lawyer. Perhaps this issue merits a legal opinion.

Concerning your letter of 12 February.

'…sewage fungus…' It is my understanding that the main issue with periphyton in the Tukituki relates to aquatic plant growth stimulated by nitrogen and/or phosphorus. In some places (e.g., near point source discharges) the periphyton may contain a high proportion of filamentous bacteria stimulated by dissolved organics. The reports sighted suggest, however, that sewage fungus is not a widespread or important problem in the Tukituki. If the HBEWG have evidence to the contrary, then I suggest they provide this to Council.

'…algal chemistry…not just water column chemistry…' This issue was discussed earlier.

'…pollution worse over 20 years…' There is clear evidence nationally of deteriorating water quality, including microbial pollution and increased nitrogen and phosphorus. Council monitoring results for the Tukituki are consistent with national trends. In my view the question is not '…is there a problem…' rather it is '…what can/should be done about it…'

'…secchi disc (vertical) versus black disc (horizontal)…' Horizontal black disc measurement is the standard method for shallow rivers.

'…Ausseil draft report…' This report is discussed in my review along with a number of other Council reports. Its contents have been considered. I think it is very valuable analysis of the strengths/weaknesses of monitoring data for the Tukituki.

'…N needs to be managed as well as P…' I agree.

'…ammonia toxicity…' This is an issue close to the discharge point of treated sewage and meat works effluent. The ANZECC guidelines (quoted) are commonly used to determine the extent of the non-compliance zone. Ammonium is rapidly oxidised to nitrate or lost to the atmosphere so that it is rarely found in high concentrations in streams except near point discharges.

'…diurnal DO measurements…' Useful information about plant photosynthesis/respiration, and severe DO depletion at night, can be obtained by deploying continuous DO monitors (e.g., Datasondes). Council could consider deploying Datasondes during summer low flows. They are likely to confirm problems with high periphyton biomass rather than identify new issues.

'…faecal indicators may be lowest towards mid-afternoon…' The public health risk protocols recommend sampling where and when bathing occurs. Council follow the standard protocols.

'…cyanobacteria regulate their depth…' This is true of lake species. Those of concern in the Tukituki are attached to the bed and do not regulate their depth.

'…all water bodies can form vertical layers…' This is not the case in rivers where vertical mixing is rapid. The hyporheos could be regarded as a separate 'layer' from the overlying water.

'…physico-chemical parameters and biological indicators are complementary…' I agree. Some biological indicators are difficult and expensive to monitor (e.g., fish numbers) although some are more tractable (e.g., mussel physiology and fish health). Physico-chemical parameters are useful surrogates for ecosystem health when carefully selected and interpreted. Council could consider monitoring mussel and fish health.

'…spatial variation within a site…' In most rivers, vertical and horizontal mixing means that sampling at a single point is sensible. This is not the case close to a point source and deficiencies in sampling below the Waipukurau oxidation ponds have been identified.

'…photo 11/2/09…the algae is not being measured…' I am sure Council is aware of unsightly proliferations like this during summer low flows. The problem has been identified – the question is how to improve things.

Kind regards.

Kit Rutherford
Principal Scientist – Freshwater

Reference

Rutherford, J.C. (2008). Catchment Sensitivity, Nutrient Limits and Nutrient Spiralling in Hawke's Bay. Envirolink small advice grant.