BEFORE A HEARINGS PANEL OF THE GREATER WELLINGTON REGIONAL COUNCIL AND MASTERTON DISTRICT COUNCIL

IN THE MATTER	of resource consent applications to Greater Wellington Regional Council pursuant to section 88 of the Resource Management Act 1991
AND	
IN THE MATTER	of a Notice of Requirement to Masterton District Council pursuant to section 168, 168A and 181 of the Resource Management Act 1991
BY	Masterton District Council
FOR	the proposed upgrade of the Masterton Wastewater Treatment Plant

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SUPPLEMENTARY STATEMENT OF EVIDENCE OF CHRIS HICKEY, JAMES COOKE, AND GREG RYDER
ON BEHALF OF MASTERTON DISTRICT COUNCIL

RESPONSE TO OFFICERS' REPLY

Subject Area: Discharges to surface water

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1. INTRODUCTION

1.1 This supplementary evidence has been prepared in response to matters raised in the Officers' reply, and in particular the matters addressed in paragraph 17, subparagraphs a –f of their submission.

1.2 As with the Officers' reply, our response has been prepared jointly by consensus between Dr's Hickey, Cooke and Ryder.

1.3 In order to be as helpful as possible to the commissioners, we have indicated where we agree with the comments made in the Officers' reply, as well as areas where we disagree.

2. EXISTING RECEIVING WATER EFFECTS

Makoura Stream

2.1 We agree that the existing wastewater discharge is having significant adverse effects on the Makoura Stream but while the Officers' recommendation that the existing discharge be removed from the Makoura Stream as soon as possible has merit, there are other factors to consider which Mr Archer will address.

Ruamahanga River

2.2 We agree that there are currently water quality issues in the Ruamahanga River at Wardells Bridge, and that these relate to conspicuous changes in colour and clarity, increased indicator bacteria and nuisance periphyton growths – all of which occur in the partially mixed area downstream of the Makoura Stream confluence. However, we consider that the combination of the proposed management measures, i.e. : elimination of low flow discharges with an intermittent flow-triggered discharge; changes to discharge location; diffuser to improve mixing; and new lined ponds; will largely eliminate the currently observed effects, downstream of the RMZ.

2.3 We concur with the Officers that increased periphyton growth rate will occur at Wardells Bridge as compared to a no discharge scenario, but do not agree with the Officers continued implication that this *per se* constitutes an adverse effect (paragraph 25). Periphyton constitutes the base of the food chain and additional quantities can stimulate macroinvertebrate biodiversity and abundance. Studies on the impacts of pond effluents on river ecosystems during summer low flow conditions (Quinn & Hickey 1990, 1993) indicated that a subsidy-stress response will occur with invertebrates depending on the quantity (concentrations) of various organic and nutrient constituents (invertebrate biomass/diversity increases with small increases in periphyton (subsidy) but decreases with large increases in periphyton (stress). Extending this understanding to intermittent discharge is beyond those studies and requires site-specific analysis and professional judgment. The subsidy-stress approach has been applied to our predictions for future Ruamahanga River effects. What is clear, is that there will be significantly lower potential for periphyton growth downstream of the discharge point as compared to the current situation, because the discharge will not be occurring at critical times and flows.

2.4 We have not proposed that periphyton biomass measurements as Chlorophyll *a,* be "disregarded" as suggested by the Officers (paragraph 26). Rather, we have cautioned the general applicability of this measure in relation to use downstream of pond discharges and particularly as a compliance condition. Dr Hickey, in his further supplementary evidence (paragraphs 9.8,9.9), has highlighted the predominance of mat growths upstream of Wardells Bridge, including the seepage area, and the potential to use the MfE guideline for mat growth Chlorophyll *a*.

2.5 We would agree that collection of periphyton biomass measurements in association with benthic macroinvertebrate measurements is highly relevant, but maintain that the majority of monitoring should be visual assessment of periphyton cover.

3. RUAMAHANGA RIVER - EXISTING CONDTIONS

Water quality

3.1 We agree with the Officers' assessment of existing water quality (paragraphs 28-30).

Native fish

3.2 We agree that poor water quality is a possible contributor to low native fish abundance in the vicinity of the existing discharge and also that it is unlikely to be a major factor.

3.3 While research studies have established thresholds for native fish thermal and turbidity tolerances (eg. Richardson et al 1994, 2001a), studies to quantify avoidance from elevated ammonia and low dissolved oxygen, as might occur from pond discharges, have not identified more sensitive trigger levels for concern (Richardson et al 2001b). The fact that Perrie has found healthy populations of native fish in headwaters of other rivers which experience similar low flows and high temperatures to Ruamahanga, may be related to the distance/time that diadromous fish have to swim through unshaded reaches in the Ruamahanga compared with these other rivers. This data would require a more rigorous analysis to enable establishment of potential causal linkages and the implementation of management measures.

3.4 We note that even if the discharge does have an effect on fish populations (which has certainly not been established) in the future the discharge will not be occurring for a significant portion of the time (66%) on average during the summer season and for some of the winter season.

Hydrology – 'flushing flows' and the accrual period

3.5 We disagree with the suggestion that we have focused on typical average conditions with respect to freshes and accrual periods. As discussed in Dr Hickey's evidence (paragraph 8.16), the flushing lows and accrual period were based on experimental observations, which demonstrated the efficacy of flushing flows at resetting the algal communities (see Figure 1 at end of this evidence). This site-specific study provided both biomass (Chlorophyll *a*) and river DRP measurements to allow a calibration of the periphyton DRP concentration/response model. NIWA used the **slope** of the MfE relationship for the summer accrual time to link the observed existing condition to a future lower DRP condition (using upstream and downstream data with a maximum accrual period of 16d, NIWA 2003). This summary table is reproduced (with updated calculation) together with a further description of the filter period applicability to the summer accrual period ,in Dr Hickey's further supplementary evidence (paragraph 2.4).

3.6 We are concerned that the Officers appear to be interpreting the 'flushing flow' to require at least three times the median flow and citing the research of Clausen and Biggs (1997) (paragraph 33). Clausen and Biggs (1997) was a correlative study with a wide range of hydrological variables. The three times the median flow value was one of a number of hydraulic variability variables that were statistically significant for the rivers studied. Their study was the basis for the MfE (2000) periphyton guidelines to provide general guidance across a range of various river types. It does not necessarily relate to crucial scouring thresholds for periphyton in an individual river. The scour of periphyton is mechanistically related to the instantaneous flow rate, not an annualized daily median flow (NIWA 2003).

3.7 We have in our subsequent analysis addressed the distribution of accrual periods. This is an important consideration to provide a measure of the likelihood of extreme duration accrual events occurring. Figure 2 (see end of evidence) reproduces the analysis of accrual periods. Dr Hickey used this analysis, together with periphyton predictive modeling to estimate the frequency and duration of periphyton blooms. He concluded in his evidence that (paragraph 8.18): "*The frequency and duration of predicted nuisance growths would be considered low, generally only occurring for a small fraction of the summer season*." This prediction is supported by current monitoring data.

3.8 The Officers' observations based around their Figure 1, far from discrediting our approach, actually serves to illustrate the scheme design. They argue that during an extreme low flow year there would not be sufficient events to reach a 'flushing flow' threshold of three times median flow. We argue that neither would there be any direct discharge from the MWTP for the vast majority of the time indicated in Figure 1. This is precisely what the scheme design is intended to achieve. During long periods of low flow, MWTP effluent will not be discharged, so any periphyton accumulations that required scouring would not be caused by the MWTP. Effluent will be discharged when there are freshes above median flow, and more effluent will be discharged when flows exceed 3 times median flow when conditions would not be conducive to periphyton growth, and, by the officers' own argument, scouring could be expected in any case.

3.9 We note from our monitoring records that during the extreme low flow period (10 year recurrence period) shown in the Officers Figure 1, our monthly monitoring results for the existing continuous discharge showed occurrence of a 'nuisance' filamentous bloom (58% bed cover, c.f., guideline of 30%) on only one of the five monitoring occasions in this summer period. The mat cover did not exceed the guideline on any occasion.

3.10 Elimination of the direct MWTP discharges at flows less than median, will significantly reduce the extent of periphyton growth under such low flow conditions.

Periphyton

3.11 We agree with the Officers' assessment that stable low flow conditions is when periphyton accumulations would be expected to be the greatest issue, but point out that during such stable low flows, there will be no discharge from the MWTP after the upgrade.

3.12 We agree that there are limitations to the standard periphyton cover assessment used by NIWA (and GWRC). A competent scientist can find such limitations in virtually any field ecological assessment technique particularly where it is applied in a routine monitoring situation. Standard ecological monitoring techniques are inevitably a trade off between effectiveness and costs. Nevertheless the techniques used by NIWA are the most oft-used technique for assessing periphyton cover in New Zealand at the current time. We have no doubt that better techniques will evolve and the technique that GWRC is “considering moving to” may provide a better measure of periphyton in riffle habitat, albeit at higher cost. A comparison of the two techniques published in peer reviewed scientific literature will be required before it can be assessed whether it is a cost-effective replacement for the technique used currently. Until this occurs, however, we suggest that it is irrelevant to argue of the merits or otherwise of a particular technique within a forum such as this consent application.

3.13 We agree that benthic cyanobacterial mats are a problem in many recreational rivers in the Wellington Region (and indeed nationally) and that the 60% cover threshold for nuisance growths of algal mats does not relate in anyway to the health risk from cyanobacteria toxicity. However we disagree with the inference in the officers' arguments that the incidence of cyanobacterial mats is directly related to the MWTP discharge. The Officers' own data showed the cyanobacterium *Phormidium* dominated the algal biomass both <u>upstream</u> and downstream of the MWTP (paragraph 39). They also report *Phormidium* growths in the Hutt River where there are no wastewater discharges. We note that significant cyanobacteria growths (including *Phormidium*) have been reported in the Hutt, Otaki, Waikanae, Mangaroa and Wainuiomata rivers (GWRC report to Council 07.130) and that the problem is sufficiently severe for access restrictions to be placed on 60% of rivers in the western Wellington region. Report 07.130 notes: “The presence of extensive mats of *Phormidium* sp. in multiple rivers of varying nutrient status, including the relatively pristine upper reaches of the Otaki and Wainuiomata rivers, is consistent with its widespread distribution reported in the literature. Overall, it is concluded that the climatic and hydrological conditions experienced during spring had the most significant influence on the proliferations of *Phormidium* sp. in 2005/06; in particular, the lack of ‘flushing’ flow events and extended period of stable, low flows.” This is consistent with other reports that climate is the principal trigger for cyanobacterial blooms (or mats) and that nutrient status is not a significant causative factor.

3.14 We conclude that the proposed MWTP upgrade will make little difference to the incidence and severity of cyanobacterial mats in the Ruamahanga River, but that if anything, removing the direct discharge from the river at times when the river is experiencing low flow conditions, certainly will not lead to a worsening situation.

3.15 We are unable to comment on the likely effectiveness of the proposed compliance monitoring as we have not been able to view and assess the proposed assessment protocol.

4. LAKE ONOKE FLUSHING

4.1 We acknowledge and accept the information provided by Mr Gunn and by the Council Officers that the outlet from Lake Onoke is blocked for ~25% of the time during summer. However we do not accept the inference made by the Officers that MWTP discharge post-upgrade could lead to or significantly contribute to eutrophication of Lake Onoke.

4.2 For the extreme situation (January-February 2008) shown in Figure 2 of the Officers' reply, our discharge model predicts that at most 45,014 m^3 of wastewater would have been discharged during the period in question (discharge rules only permit discharge at flows >12.3 m^3 /s). We further estimate (using the relationship discussed in Dr Cooke's evidence, paragraph 5.6 and Figure 4) that had the upgrade been implemented at that time, the MWTP discharge could have contributed no more than 9.4% of the phosphorus load to Lake Onoke during the duration of the blocked lake outlet. The phosphorus concentration of Lake Onoke water is also likely to be supplemented (in addition to inflows) by release from anaerobic lake sediments. Thus we conclude that preventing the MWTP discharging when the lake outlet is blocked, will have little if any environmental benefit.

5. MIXING AND DILUTION

5.1 The Officers' reply misrepresents what was stated in paragraph 4.1 of Dr Cooke's evidence. In subparagraphs (a) through (c) Dr Cooke listed the key elements of the proposal and stated (subparagraph d) that *"<u>Together</u> these improvements will result in a significant improvement in aesthetic impacts and reduction in health risk."* In other words it was never intended to imply that the minimum dilution ratio of 30:1 would produce this result in isolation but that together with the new discharge location, diffuser, and discharge rules that would be the case. The Officers are correct that it is the applicants intention to ramp up the rate of discharge proportionally with river flow at the minimum dilution ratio to the maximum possible (1200 l/s). This is a key part of the design and has been factored into the Monte Carlo simulations described by Dr Hickey (paragraphs

6.29-6.44), which demonstrate that the discharge will meet design water quality targets after reasonable mixing. These simulations include a range of dilutions appropriate to the reasonable and full mixing conditions. We also stress that the 30:1 dilution is the minimum that will be achieved and that under most circumstances dilution rates will be very much greater (see supplementary evidence by Humphrey Archer).

5.2 The 30:1 to 50:1 dilution ratio for the discharge of oxidation pond wastewater recommended by Quinn and Hickey (1993), and cited in paragraph 50 of the Officers' reply was for a continuous discharge including periods of low flow. The MWTP upgrade is for an intermittent discharge above median flow. Under this regime the future discharge will have greatere than 60x dilution for more than 90% of the time (see supplementary evidence by Humphrey Archer). We therefore feel comfortable that the minimum 30:1 dilution ratio together with the new discharge location, diffuser, and discharge rules, is sufficiently conservative to protect aquatic life.

Direct discharge to the river during winter

5.3 We would be supportive of applying a higher flow trigger or using a higher dilution ratio for flows between half-median and median flow in the 'shoulder' season. The practicalities of these restrictions and the period would need to be assessed. We understand that Mr Archer will be addressing this. However, we remain of the view that even without such changes, the proposed discharge regime should not cause any more than minor adverse effects on water quality during the winter period.

5.4 So far as periphyton is concerned we note that the proliferation of periphyton is largely associated with summer periods of high light and temperature and low river flows. We remain of the view that the proposed discharge regime will not cause any more than minor adverse effects with respect to periphyton growth during winter.

5.5 So far as clarity is concerned, it is accepted that the discharge will have a greater impact at flows between median and half median. However we are satisfied that it will not cause any conspicuous change to clarity beyond 300m even at half median flow. By Wardells Bridge the changes are likely to be negligible.

5.6 We do not agree with Fish and Game that such changes are likely to have any more than minor effect on trout foraging. Such effects if any would be limited to the area within the mixing zone.

Direct discharges to the river during summertime "freshes"

5.7 The Officers' reply submits that direct discharges during summertime freshes may promote more vigorous periphyton growth during periods of low flow. We fail to see the merit in this argument because as stated in Dr Hickey's evidence, the travel time from Wardell's Bridge to the sea is only 44h at 12.3 m^3/s and 12 h at 143m^3/s (the peak flow in Figure 4 of the Officers' reply). It also ignores the fact that during the fresh documented in Figure 4 of the Officers' reply, nearly 67% of the total phosphorus passing Wardell's Bridge would have been derived from sources upstream of the MWTP (calculated from relationship discussed in paragraph 5.6 of Dr Cooke's evidence). Furthermore, the pre-existing condition of the periphyton would have been largely, if not solely, determined by nutrients, water temperature and clarity, outside the times of discharge.

5.8 Based on our field measurements, we would expect a flow of 3x summer median (ie. about 20 m^3/s) to efficiently scour the algae (see Figure 1), as would be expected for this event on 2 February. We have included the extended hydrograph for this low-flow period (Figure 4) and the periphyton assessment data taken 21 days after the flood event on 23 February 2007, at a river flow of 2.5 m^3/s. These results showed that the Wardells periphyton was: 7.7% filamentous cover (ie 26% of guideline); 31% mat (ie. 52% of guideline); and the Chlorophyll *a* 55 mg/m^2). The downstream (Wardells) periphyton cover is higher than upstream for both filamentous and mat, however the continuous discharge situation has not caused guideline exceedance for this period.

5.9 In response to a question from Mr van Voorthuysen about nutrients in the intermittent discharge being available only for short periods, the Officers responded that the nutrients would be adsorbed or settle in the river sediments and then be available for periphyton growth when the discharge ceased.

5.10 We agree with the Officers that the available phosphorus in the effluent (~80% DRP) would be quickly adsorbed to river sediments upon discharge, and that this adsorbed P (measured in the TP analysis) would be potentially be available for periphyton growth. In fact an atom of P discharged from MWTP in soluble form (DRP) could be expected to cycle several times between the aqueous phase (river water) sediments, and biota (including periphyton) before it reached the sea.

5.11 However we point out that with the discharge rules post-upgrade, most MWTP effluent will be discharged during freshes or flood events, which will result in reduced travel times and lower settling rates than would be the case for discharge under low flow conditions. Furthermore, in such flows sediment will normally be entrained and move downstream.

5.12 In addition, we point out that exactly the same scenario will apply to phosphorus from upstream diffuse sources. It too will cycle between aqueous, sediment, and biotic phases. Periphyton will not distinguish between an atom of phosphorus sourced from MWTP effluent and one arising from farm runoff providing it is available for uptake. The total phosphorus analytical test used by both MDC and GWRC (acid persulphate), is designed to include phosphorus adsorbed to sediments (and therefore potentially biologically available) but not absorbed phosphorus (contained within sediment particles and therefore not biologically available.

5.13 The Officers' concern seems in part to relate to the possibility of some years where there are flows above median but of insufficient magnitude to scour periphyton growth. There was some discussion with the Panel, as to whether in these situations, pulses of nutrients from the discharge would stimulate nuisance growths. We make the following points:

- Such flows are unusual. Usually flows above median will peak at or above scouring velocities.
- Nuisance growths are more likely to occur in periods of sustained low flow than in the above situation.
- The applicant is proposing only to discharge when a fresh is predicted to last for more than 6 hours. Such freshes will normally be of sufficient magnitude for scouring to occur.
- The pulses that occur will have a transitory effect, which is minor in comparison to the pre-existing conditions that have promoted any periphyton growths.
- The maximum discharge rates used for the purpose of assessing effects are much higher than the rates which apply on average.
- The applicant has now propose a protocol to where practical reduce discharge rates and/or duration during recessions.
- Nutrients (including enriched sediments) will be rapidly moved downstream for most of the period of discharge.

Mixing zone

5.14 We agree with the Officers' submission that all issues have been resolved on this issue. We agree that there is merit in carrying out a one off mixing study once the full upgrade is in place. We do not agree that it is necessary or appropriate for the conditions of consent to specify a dilution rate. The purpose of the mixing study would be to confirm that the predicted dilution rates are approximately correct (within 20%). They should not be compliance limits, since there is no apparent correlation with adverse effects. Periphyton growth and clarity measures are more appropriate ways of assessing adverse effects. If dilution rates are significantly less than predicted, then that would trigger a review by the consent holder of the operation of the diffuser. Enforcement action would only be appropriate if there was also evidence of likely adverse effects.

6. NUTRIENT AND PERIPHYTON STANDARDS

6.1 We do not accept that limitation of periphyton nuisance growths by dissolved inorganic nitrogen (DIN) has been demonstrated for the Ruamahanga River. As such, we do not consider that inclusion of both DRP and DIN limitations are appropriate. The opinion of the Officers (paragraph 63) is not supported by any data analysis which we are able to review on this matter. It is important that any nutrient limitation data should relate to a growth period and not to data points from single sampling occasions.

6.2 The nutrient load considerations relate specifically to Lake Onoke rather than Ruamahanga River. We have addressed Lake Onoke flushing and nutrients in Section 4 of this response and consider that future nutrient loads from the MWTP will be low during summer outflow blocking events.

6.3 The paucity of data and information on the water quality issues in Lake Onoke makes assessment of nutrient load and limiting nutrient considerations very speculative. We consider that hydraulic flushing is a key component of this lake. A successfully calibrated model for lakes with high flushing has been developed and validated in New Zealand (Pridmore & McBride 1984). We would suggest that this be applied to water quality data collected from Lake Onoke.

6.4 We do not dispute the value that the Officers place in the generic guidance given in recent expert opinion (Wilcock et al. 2007), with Dr Hickey being a contributing co-author. However, we have emphasised the need for <u>effects-based</u> information based on specific data gathered for the Ruamahanga River, as a basis for the management decisions. The AEE, and our evidence, has focused on the Ruamahanga River because we consider that is the location where potential effects have the potential to occur. Our limited information on Lake Onoke has indicated that concerns should be low.

In-river nutrient standards

6.5 Dr Hickey has addressed in his evidence (and supplementary and further supplementary evidence) the approaches taken to derive site-specific nutrient guidelines for the Ruamahanga River. He has further addressed the nature of the calibration process used in relation to 'flushing flows' in section 3 of this submission.

6.6 The Officers place emphasis on the 'filter' period (paragraph 66), which Dr Hickey acknowledged and showed in his evidence was a key factor influencing the inter-flood or 'accrual' period calculation. This filter is not fixed and varies between various studies. Notably, a 10d filter period was used for the River Environment Classification studies for New Zealand rivers (Snelder et al 2005). As noted in section 3.4, a site-specific calibration was used in Ruamahanga River for summer data, a 1-day filter period for accrual time calculation and utilizing the slope of the MfE relationship for site-specific DRP assessment. Dr Hickey considers that this is a valid site-specific approach based on the experimental data as measured in the Ruamahanga River.

6.7 Dr Hickey has acknowledged in his further supplementary evidence (paragraph 2.4) that an error was included in the original DRP/accrual rate calculation because of an incorrect coefficient used. He noted that for a 13 d accrual period the site-specific DRP guideline would be 0.066 g/m^3. He recommends that (paragraph 2.7): "*On the basis that assessments have been made relative to compliance with a 30 mg DRP/m^3 threshold, We recommend that this should still remain an appropriate assessment benchmark (not a compliance standard, but a trigger for further investigation and possible review if not met).*"

6.8 We consider that use of a calibrated site-specific guideline is preferable to use than a generic guideline, where sufficient data is available. However, given the lack of prescriptive and validated methods for site-specific guideline development, we consider that the compliance for this integrated land irrigation and intermittent discharge regime should only be on receiving water nuisance growth development (with reference to an upstream condition). Monitoring should include nutrients and form the basis of future 'calibration' and application for similar management schemes.

6.9 The Officers have referred to a proposal to include a DRP standard of 0.015 g/m^3 in the Regional Plan. We have not seen the analysis to support such a standard for the Ruamahanga River. We simply comment that DRP standards if included in the plan, will need to be specific to particular water bodies. We do not consider that 0.015 g/m^3 is appropriate for the main stem of the Ruamahanga River. However, the time to debate this is via the plan process. We do not consider that it is appropriate to pre judge that debate by imposing that standard on the current consent.

6.10 The Officers have suggested DIN guidelines based on a 20% increment from upstream conditions (paragraph 70). We do not consider that this is a robust effects-based management approach for deriving a compliance guideline. As noted earlier (paragraph 6.1), we do not consider that the available data justifies the need for receiving water DIN standards.

Nutrient load standards for discharges to the river

6.11 We agree with the Officers that a total maximum daily load restriction is not warranted.

7. WASTEWATER QUALITY STANDARDS

7.1 The Officers and the applicants experts are in agreement with the concepts.

7.2 We are, however, concerned with the proposed continuance with "rolling percentile standards". We do not consider that this is consistent with the Municipal Wastewater Guidelines or with protection of receiving waters.

8. MONITORING

8.1 We have no objection to the requirement for upstream and downstream monitoring of dissolved nutrients and periphyton cover.

8.2 We have no objection to the requirement for receiving water monitoring and biological monitoring upstream, 300m downstream, and at Wardells Bridge, provided access issues can be addressed and there is an appropriate review clause in the consent to ensure that the monitoring is producing results that are of value. Whilst it is appropriate to monitor periphyton cover at 300m, we do not agree that monitoring of water quality is necessary at this point, as the concentrations can be reliably calculated from the effluent monitoring and discharge information, together with upstream monitoring. Monitoring upstream and at Wardells Bridge will be sufficient to detect the impact of the both the direct and diffuse discharges.

8.3 We note and agree with the changes recommended by the Officers with respect to the frequency of wastewater and receiving water monitoring for the interim discharge, and reducing the number of receiving water monitoring sites (paragraph 77).

8.4 We have no objection to the modifications in recommended monitoring requirements made in response to matters raised by Department of Conservation and Fish and Game Council (paragraph 80) provided there is an appropriate review clause in the consent to ensure that the monitoring is producing results that are of value.

8.5 We agree with the Officers that continuous dissolved oxygen monitoring at the boundary of the reasonable mixing zone and at Wardells Bridge is not necessary. Because it is unnecessary, the applicant does not plan to meet the costs of equipment and installation as proposed in paragraph 80.

9. TERM OF CONSENT

9.1 We have no comments to make on the proposed term of consent, except to say that it can not be justified on the basis of potential ecological values.

Dr Chris Hickey
Senior Principal Scientist
NIWA

Dr Jim Cooke
Director
Diffuse Sources Ltd

Dr Greg Ryder
Director
Ryder Consulting Ltd

23 March 2009

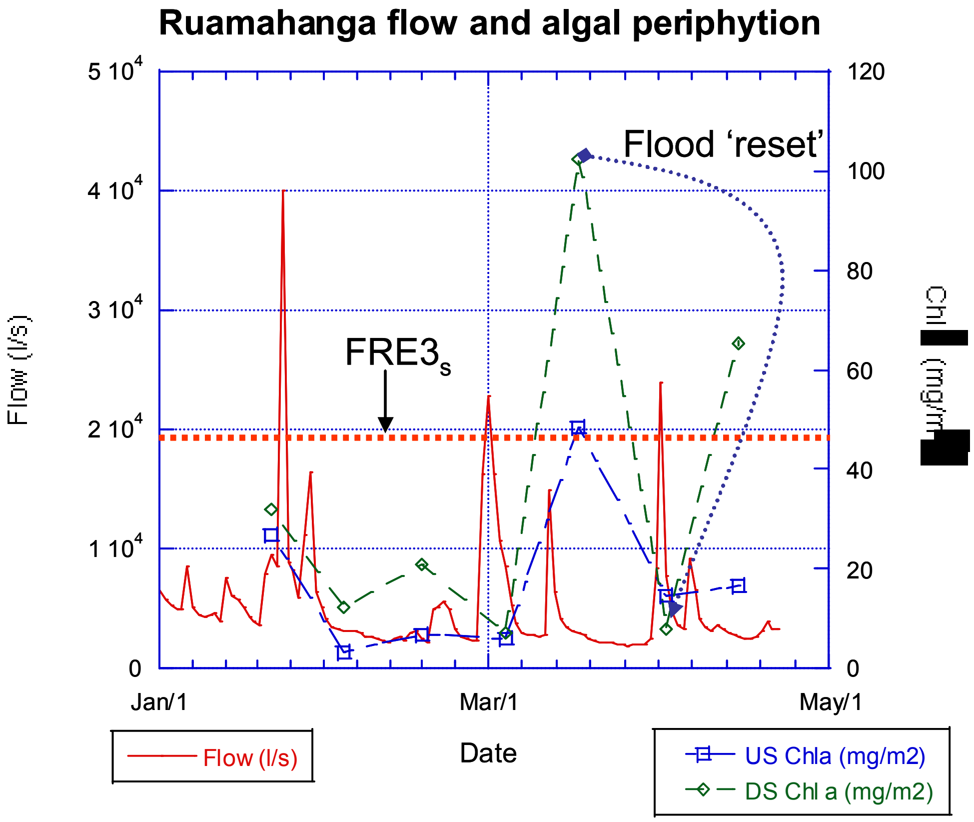


Figure 1. Ruamahanga River flow and Chlorophyll a at upstream (RUA_1) and downstream (RUA_2) sites during summer 2003 (from NIWA 2003, presented in Hickey evidence)

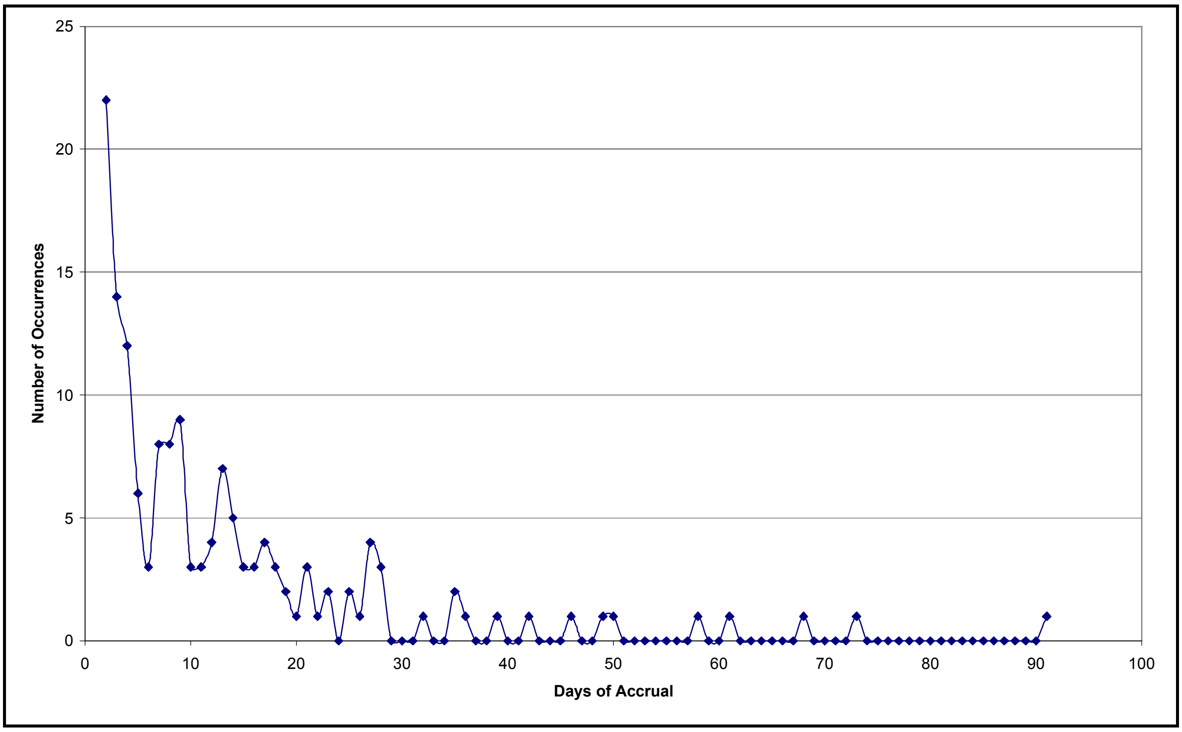
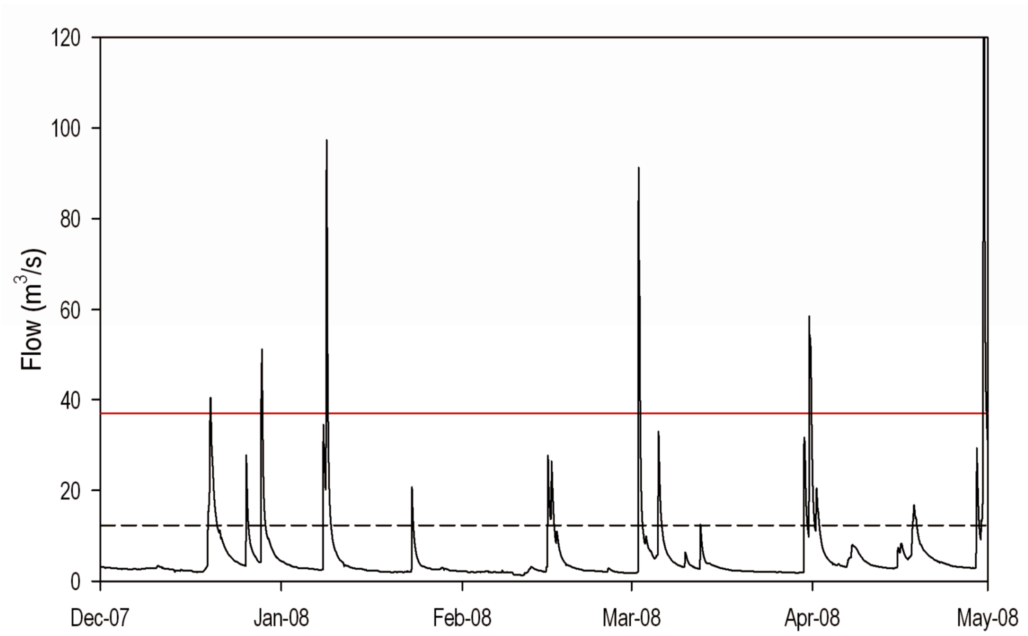


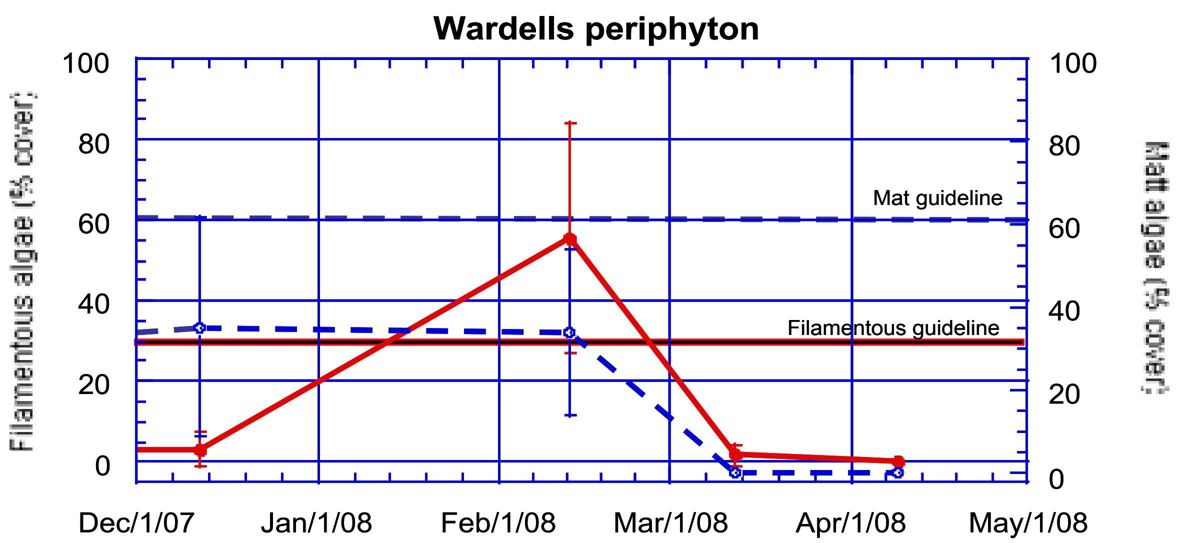
Figure 2. Frequency of accrual period durations for summer (1989-2003) (Beca data) (from NIWA 2004)

A



Officers supplementary evidence: Figure 1: River flow hydrograph for the Ruamahanga River at Wardell's Bridge, December 2007-May 2008. The solid line indicates a threshold of 37 m^3/s (three times median flow) which is the estimated flow required to flush algae from the river bed (following Clausen & Biggs 1997). The dashed line represents the proposed summer discharge threshold (12.3 m^3/s).

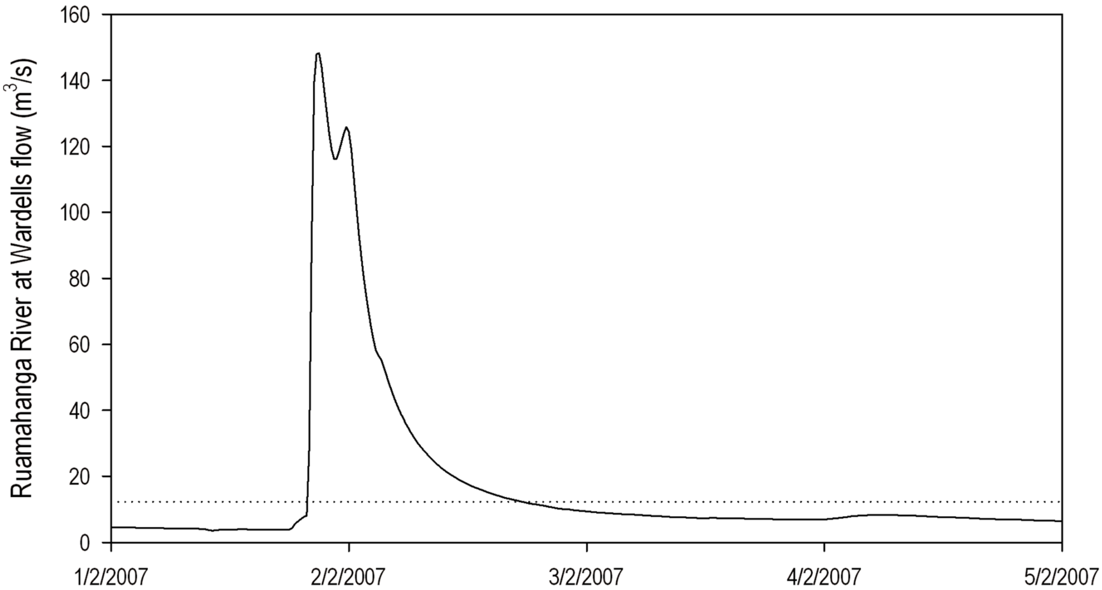
B



Date	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Ave_F	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	Ave_M
12-Dec-07	0	0	0	5	10	10	5	2	0	0	**3.2**	20	40	50	50	60	80	40	10	2	2	**35**
9-Jan-08	-	-	-	-	-	-	-	-	-	-	**F**	-	-	-	-	-	-	-	-	-	-	**F**
13-Feb-08	10	10	80	80	80	60	80	50	50	-	**56**	10	10	50	15	20	40	60	50	50	-	**34**
12-Mar-08	0	0	0	0	5	5	-	-	-	-	**1.7**	0	0	0	0	0	0	-	-	-	-	**0**
9-Apr-08	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	**0**

Figure 3. Ruamahanga River at Wardells Bridge flow hydrograph (A, from Officers supplementary) and nuisance growth abundance data (B, NIWA data, Figure 4 from Hickey evidence. 'F' indicates flood and unable to sample)

A



Officers supplementary evidence: Figure 4: A summertime flood in the Ruamahanga River in February 2007. The dotted line represents the proposed discharge threshold .

B

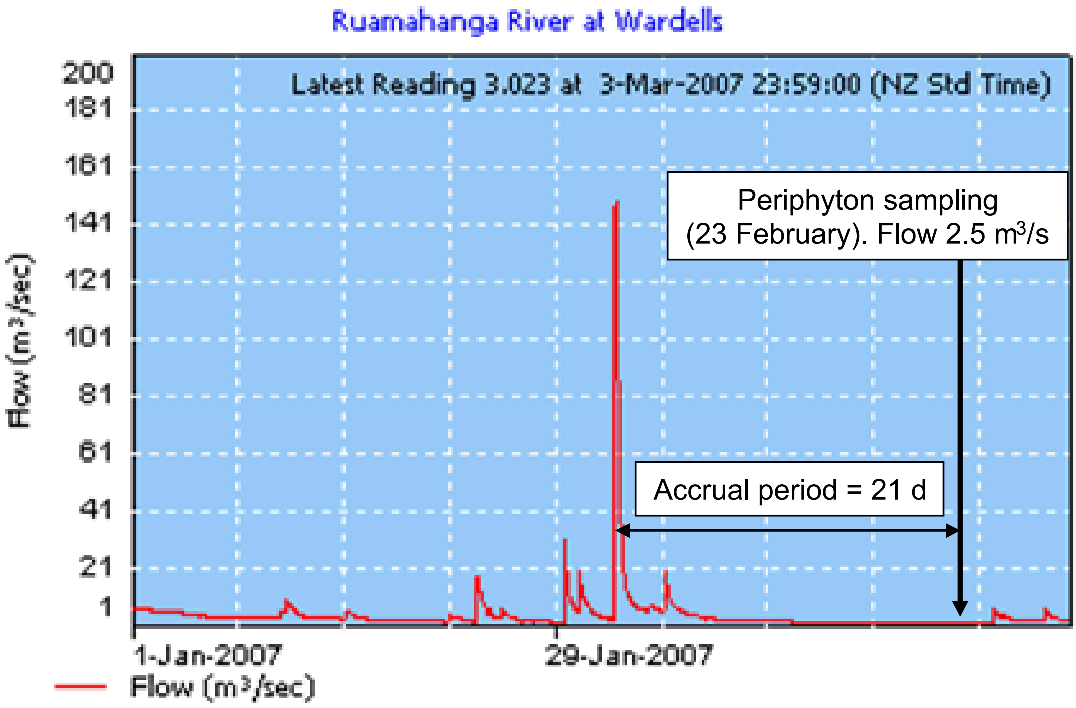


Figure 4. Ruamahanga River at Wardells Bridge flow hydrograph (A, from Officers supplementary Figure 4) and extended data corresponding to nuisance growth data provided in Table 1.

Table 1 Periphyton assessment data for Ruamahanga River at three sites (RUA 1, RUA 2 (Wardells Bridge) and RUA 3 (800m downstream Wardells) from 23 February 2007 (NIWA).

Ruamahanga River: Periphyton (% cover)
RUA 1 23/2/07

		LB								RB	
upstream		1	2	3	4	5	6	7	8	9	10	Rep average
1	filamentous	0	5	5	5	2	3	5	5	5	5	4
	mat	90	80	75	75	60	35	20	15	10	3	46.3
2	filamentous	5	10	2	5	10	10	10	5	2	0	5.9
	mat	40	20	10	10	15	10	10	10	5	0	13
3	filamentous	1	5	5	3	3	2	1	1	2	0	2.3
	mat	30	35	25	20	20	15	5	5	0	0	15.5
downstream									**RUA1 site average**		**Filamentous**	**4.1**
											Mat	**24.9**

RUA 2 23/2/07 (Rated flow = 2.5m3/s)

		LB									RB	Rep average
upstream		1	2	3	4	5	6	7	8	9	10	5.5
1	filamentous	3	5	10	15	20	20	10	5	2	1	9.1
	mat	5	50	20	60	50	45	30	30	20	15	32.5
2	filamentous	1	2	5	10	10	10	10	5	0	1	5.4
	mat	5	20	40	55	45	60	40	35	25	20	34.5
3	filamentous	2	5	15	20	15	15	10	2	0	1	8.5
	mat	0	10	45	60	40	35	45	25	5	3	26.8
downstream									**RUA2 site average**		**Filamentous**	**7.7**
											Mat	**31.3**

RUA 4 23/2/07

		LB									RB	Rep average
upstream		1	2	3	4	5	6	7	8	9	10	5.5
1	filamentous	5	5	5	10	5	2	0	1	1	0	3.4
	mat	50	20	10	5	5	2	2	0	0	0	9.4
2	filamentous	5	10	5	2	1	1	2	10	5	5	4.6
	mat	10	20	20	10	0	0	0	3	1	10	7.4
3	filamentous	5	5	3	3	1	5	10	15	10	3	6
	mat	30	20	5	2	5	1	5	5	3	5	8.1
downstream									**RUA4 site average**		**Filamentous**	**4.7**
	LB:Left Bank										**Mat**	**8.3**
	RB:Right Bank											

Chlorophyll *a* & Ash free dry weight (AFDW) (Cawthron data from 22 February 2007

	Chlorophyll a (mg/m^2)	AFDW (g/m^2)
Rua1	9.8	1.6
Rua2	55.2	6.8
Rua4	41.5	5.4

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