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REGIONAL COUNCIL

Masterton Wastewater Treatment Plant resource consent applications

Technical review of discharges to surface water

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File: WAR090066

Date: 9 February 2009

Contents

Summary

1. This technical report discusses the surface water quality aspects of proposed discharge activities associated with the upgrade and continued operation of the Masterton Wastewater Treatment Plant (WWTP).

2. The existing wastewater discharge is having significant adverse effects on the Makoura Stream which has insufficient flow to assimilate the discharge. These adverse effects include a conspicuous change in colour and clarity, significant increases in contaminant concentrations, reduced dissolved oxygen concentrations and a severely degraded macroinvertebrate community downstream of the discharge.

3. The existing wastewater discharge is also significantly affecting the Ruamahanga River. The principal effects include a conspicuous change in colour and clarity, increased indicator bacteria, dissolved nutrient concentrations and periphyton biomass, and a lower quality macroinvertebrate community downstream of the discharge.

4. The proposed upgrades to the Masterton WWTP and changes to the discharge regime mean that the adverse effects associated with the existing discharges will be reduced significantly, with the Ruamahanga River at Wardell's Bridge expected to be suitable for contact recreation as a result. While this is a clear step in the right direction by the applicant:

- It is expected to take up to five or six years for the land irrigation area to be completed, meaning the discharge will continue at river flows less than median in summer in the interim period;
- The Ruamahanga River will continue to receive a direct discharge for 30% of the time in summer (on average) and will remain the principal receiving environment for the majority of the year, with more treated wastewater discharged to the river than irrigated to land;
- The proposed treatment upgrades are only predicted to improve the quality of the discharge by reducing bacteria counts (and possibly ammonia concentrations) during summer, and may result in higher bacteria counts during winter;
- The proposed minimum river flow to effluent dilution ratio of 30:1 will provide less dilution in the river than at present and is insufficient to ensure that dissolved reactive phosphorus receiving water quality guidelines can always be met;
- The proposed maximum instantaneous discharge rate of 1,200 L/s is significantly higher than the existing 700 L/s and will enable a greater contaminant load to be discharged to the river; and
- There is significant potential for greater than anticipated nutrient inputs (and associated effects on instream periphyton growth and potentially macroinvertebrate communities) into both the Makoura Stream and the

Ruamahanga River via seepage through groundwater underneath the proposed land irrigation area and the base of the new oxidation ponds.

5. Lake Onoke is the ultimate receiving environment for all discharges from the Masterton WWTP. This needs to be taken into account because the lake is showing signs of eutrophication.

6. Despite serious concerns with some aspects of the applicant's proposal, we believe from a surface water quality perspective, resource consents 27160-27163 of application WAR090066 can be granted subject to strict conditions that:

   (a) Require removal of the direct discharge to the Makoura Stream as soon as possible;

   (b) Restrict the maximum daily wastewater volume (or nutrient load) discharged to land and the Ruamahanga River;

   (c) Control the quality of wastewater discharged to both land and the Ruamahanga River;

   (d) Require comprehensive monitoring of water quality in both the Ruamahanga River and Makoura Stream, including at times where there is no direct wastewater discharge into the Ruamahanga River;

   (e) Require regular reporting of monitoring results, together with a comprehensive annual monitoring report summarising compliance with resource consent conditions; and

   (f) Establish clear receiving water targets which, if breached, trigger a review of the applicant's operation of the Masterton WWTP and/or the relevant consent(s).

7. We have recommended consent conditions along these lines. In terms of setting restrictions on the maximum daily wastewater volume and/or nutrient loads for the discharge to the river, our approach has been to limit the average daily dry weather discharge volume based on current and predicted (2015) wastewater flows, along with the maximum instantaneous discharge rate, based on the existing peak wet weather flow (i.e., 700 L/s). We recognise that such restrictions may have implications for the viability of the proposed WWTP operation as additional discharge to land and/or storage is likely to be needed. This will need to be discussed at the hearing. In particular, we require clarification from the applicant on the rationale for and intended application of the minimum dilution ratio and maximum instantaneous discharge rate. Discharge quality standards may also need to be discussed at the hearing as some of the standards proposed by the applicant represent a significant increase in existing contaminant concentrations.

A Introduction

1. Masterton District Council (the applicant) has applied for resource consents relating to the upgrade and continued operation of the Masterton Wastewater Treatment Plant (WWTP). The application was lodged on 15 August 2008[1]. Although various consents have been applied for, this report comments on just four:

   (a) WAR090066 (27160) – to discharge treated wastewater (effluent) to the Ruamahanga River;

   (b) WAR090066 (27161) – to discharge stormwater runoff from the wastewater irrigation land to the Makoura Stream and Ruamahanga River;

   (c) WAR090066 (27162) – to discharge treated wastewater (effluent) to land via an irrigation system; and

   (d) WAR090066 (27163) – to discharge partially treated wastewater (effluent) to land and groundwater through the base of the existing oxidation ponds and new oxidation ponds.

2. The duration sought for the consents is 35 years.

3. This report discusses the technical aspects of the proposed activities in relation to **surface water quality**. The report includes:

   (a) A brief description of the proposed discharge activities and the receiving environment;

   (b) An evaluation of the observed effects of the existing discharges and anticipated effects of the proposed changes to the discharge activities; and

   (c) Recommendations on the consent applications, including consent conditions.

4. Issues relating to soil and groundwater quality associated with discharges to land are addressed in a separate technical report prepared by Hamish Lowe (Duffill Watts Limited). Key points from this report have been incorporated here where relevant. Mr Lowe's report also addresses discharges associated with the decommissioning of the existing oxidation ponds.

5. This technical report is to support the Greater Wellington section 42a officer's report and therefore a full description of the proposed activities and the planning aspects relevant to the applications will not be repeated here.

[1] The original application (WAR070077) was lodged in May 2007 to replace Resource Consent WAR 020074 which expires in January 2010. Following modifications to the proposed WWTP operation (principally the construction of new oxidation ponds and the incorporation of additional land for irrigation), WAR070077 was replaced by the current application (WAR090066).

B Planning aspects relevant to the application

6. Legislation, regional plans and rules and guidelines relevant to the applications under consideration include:

   (a) The Resource Management Act (RMA) 1991 and its amendments;

   (b) Greater Wellington's Regional Policy Statement, 1995 (RPS); and

   (c) Greater Wellington's Regional Freshwater Plan, 1999 (RFP).

7. The management of the water quality of the Makoura Stream is specified in the RFP as needing enhancement for aquatic ecosystem purposes.

8. The management of the water quality of the Ruamahanga River in the vicinity of the Masterton WWTP discharge is specified in the RFP as being for contact recreation purposes and trout angling.

C The proposed activity

9. The Masterton WWTP services the township of Masterton (estimated population 17,673 in 2006), discharging on average 15,750 m^3/day of treated wastewater into the lower reaches of the Makoura Stream (a tributary of the Ruamahanga River) at Homebush, 5 km southeast of Masterton. Actual wastewater flows vary greatly, from 7,980 m^3/day in dry weather to over 60,000 m^3/day in peak wet weather events (maximum instantaneous discharge rate 700 L/s). The variation in wastewater flows is attributed to very high groundwater inflow and stormwater infiltration (I & I) rates; three times higher than what would typically be expected for a municipal system of this scale. As a result of significant I & I, the contaminant concentrations in the raw inflow to the WWTP are significantly lower than typical domestic wastewater. Industrial inputs are also low, making up less than 5% of the average daily flow.

10. The applicant proposes to upgrade its existing wastewater treatment and disposal operation so as to reduce the effects the wastewater discharge is currently having on the Makoura Stream and Ruamahanga River. The proposed upgrade involves the establishment of a land irrigation system that will result in a reduction in the volume of wastewater discharged to the river. Key components of the proposed upgrade include:

    (a) The establishment of new clay-lined oxidation ponds, with increased capacity to reduce pathogen levels and store wastewater at times when irrigating wastewater to land or discharging to the river are not appropriate;

    (b) The establishment of a 97 ha border-strip land irrigation system to receive treated wastewater by border-strip irrigation; and

    (c) The cessation of direct wastewater discharges to the Makoura Stream with a new discharge outfall constructed directly to the Ruamahanga

River incorporating a diffuser to enable rapid mixing of wastewater discharged to the river.

11. Under the proposed new discharge operation, which the applicant states may not be operational until mid 2015 (worst-case), irrigation of treated wastewater to land will occur whenever soil conditions allow with no direct discharge to the Ruamahanga River when:

    (a) The river drops below median flow of 12.3 m^3/s in summer (1 November to 30 April) or half median flow of 6.1 m^3/s in winter (1 May to 31 October); or

    (b) The river flow is less than 30 times greater than the discharge rate (i.e., minimum dilution of 30x); or

    (c) The river flow is greater than 300 m^3/s.

12. The applicant states that the maximum wastewater discharge to the Ruamahanga River at any time will be 1,200 L/s.

13. During the initial stages of the five to six year WWTP and land irrigation construction phase, treated wastewater will continue to be discharged to the Makoura Stream. Once the land irrigation system is at least partially operational, and up until such time as the full 97 ha land irrigation area is in use, treated wastewater will be discharged directly to the Ruamahanga River whenever river flows are above half-median (6.1 m^3/s) in summer and winter.

14. Excess wastewater runoff from the land irrigatation area will be collected in a “wipe-off drain system” and discharged to groundwater via infiltration beds, recycled to the oxidation ponds or, during rainfall, discharged directly to the Makoura Stream. Stormwater runoff will be collected by drains and channelled to either the Makoura Stream or the Ruamahanga River.

15. When conditions are unsuitable for wastewater to be discharged to land and/or water, the wastewater will be stored in the oxidation ponds (two days of reserve storage).

16. The applicant has acknowledged the need to reduce I & I rates as being imperative to improving the functioning of the Masterton WWTP. We understand that $3.7 million will be allocated to this issue over the next 10 years.

17. The applicant proposes to monitor the volume and quality of the wastewater discharge, and the quality of the receiving environment (soils, groundwater and the Ruamahanga River). However, no monitoring of Makoura Stream is proposed and no receiving water standards are proposed, only discharge quality standards. In addition, the applicant seeks no restrictions on the volume of effluent that can be applied to land.

Provided information

18. Apart from a number of points discussed in this report, the applicant's Assessment of Environmental Effects (AEE) is relatively informative and suitable for its purpose.

19. A significant number of background and technical reports were provided with the AEE, reflecting both the complex and evolving nature of the proposal. The volume of written material provided and time constraints have limited our ability to review all of the information. The reports we have consulted in whole or part to prepare this report include:

- ESR (2007). *Masterton Wastewater Upgrade: Health Impact Assessment*. A report prepared for Beca Carter Hollings and Ferner Ltd.

- HortResearch (2007). Green, S. *Modelling the environmental effects of wastewater disposal at the Masterton land-based sewerage effluent disposal scheme*. A report for Beca Carter Hollings and Ferner Ltd. HortResearch, Palmerston North.

- NIWA (2003). Hickey, C.W. *Ruamahanga River: Nutrient and Algal Periphyton Monitoring in Relation to the Masterton Wastewater Discharge. No. BCH03207; HAM2003-154*. NIWA report for Beca Carter Hollings & Ferner Ltd, Wellington, Hamilton.

- NIWA (2004a). Hickey, C.W.; Norton, N.; Broekhuizen, N. *Proposed dissolved reactive phosphorus guidelines for the Ruamahanga River. No. BCH03207; HAM2004-082*. NIWA report for Beca Carter Hollings & Ferner Ltd.

- NIWA (2006a). Hickey, C.W. Bacterial indicator (*E. coli*) effects of Masterton wastewater pond discharge on Ruamahanga River above median flow: Predictions after pond upgrades. No. BCH06201. March 2006. NIWA memorandum to Beca Carter Hollings & Ferner Ltd, Wellington. pp. 4.

- NIWA (2007). Oldman, J.; Nagels, J.; Rutherford, K.; Hickey, C.W. *Mixing and dilution studies in the Ruamahanga River below the Masterton Wastewater Treatment Plant.* No. BCH07201; HAM2007-038. NIWA report for Beca Carter Hollings & Ferner Ltd (Beca), Wellington.

- PDP (2008). *Masterton Wastewater Upgrade: Revised Groundwater Modelling*. A report prepared for Beca Carter Hollings and Ferner Ltd. Pattle Delamore Partners Ltd, Wellington.

20. In general, the background and technical reports were reasonably sound in their approach, content and conclusions. However, the following aspects were considered inappropriate/problematic:

    (a) The discharge proposals have changed since some of the reports were prepared, meaning that the conclusions reached in these reports may not necessarily apply to the new proposals. One example, raised with the applicant in June 2008 prior to the revised consent application being submitted, is the HortResearch (2007) modelling report which does not take into account some of the proposed new land irrigation area.

(b) No assessment was provided of the effects of the proposed interim WWTP discharge to the Ruamahanga River arising as a consequence of recent changes to the area and construction of the land irrigation system.

(c) The periphyton assessment focused largely on filamentous algae in the summer months when it is known that cyanobacterial mats capable of producing toxins harmful to animals and humans are present in the Ruamahanga River.

(d) We believe that errors have been made in the calculation of the periphyton accrual period used to derive a site-specific dissolved reactive phosphorus target for the Ruamahanga River in accordance with the national periphyton guidelines (Biggs 2000). Consequently, we recommend that the Hearing Panel dismiss the applicant's proposed dissolved reactive phosphorus receiving water target of 0.030 g/m^3.

(e) Limited data sets were presented in places for wastewater and receiving water quality (e.g., existing water quality in the Ruamahanga River was assessed (p.83 of AEE) using data collected from May 2004 to May 2005), leading us to use larger data sets in Sections D and E of this report. There was also some variation in summary statistics (mean vs median, 95^{th} percentile vs max) and reporting periods which created confusion as to exactly which data were used in some modelling calculations.

D The receiving environment

21. The existing receiving environment for the Masterton WWTP discharge is the Makoura Stream and, indirectly, via both the Makoura Stream and seepage through groundwater from underneath the base of the existing oxidation ponds, the Ruamahanga River.

22. Under the applicant's proposed new discharge regime, the Ruamahanga River will become the primary receiving environment for any direct wastewater discharges to water. However, the Makoura Stream (and the river) will receive stormwater discharges from the land irrigation area and is also expected to receive groundwater seepage from the land irrigation area and new oxidation ponds.

23. Both the Makoura Stream and the Ruamahanga River have a strong hydraulic connection with the shallow groundwater aquifer, gaining groundwater adjacent to the Homebush site during average river flows and possibly losing water to groundwater during floods. According to the applicant, the depth of

the groundwater table is typically less than 2 m at but varies seasonally between 1 and 4 m. The direction of groundwater flow also varies, from a southeasterly to southerly direction.

Makoura Stream

24. The Makoura Stream is a small stream rising from spring seepage along the Masterton fault scarp. Several springs combine to form the stream, which flows through the urban area of Masterton and then through farmland to join the Ruamahanga River approximately 4.5 km southeast of Masterton. Although the flow in the stream is predominantly sourced from the spring seepage, the stream receives some urban stormwater from Masterton and runoff from rural areas following rainfall. The Masterton WWTP discharge enters the Makoura Stream approximately 800 m upstream of its confluence with the Ruamahanga River.

25. There are limited hydrological records for the Makoura Stream. Spot flow measurements indicate that the typical low flow is around 0.12-0.15 m^3/s immediately upstream of the Masterton WWTP discharge.

26. Water quality in the Makoura Stream is considered degraded, owing to a combination of stock access, urban and rural runoff, and, in the lower reaches, the Masterton WWTP discharge. Below the point of discharge water quality is severely degraded, with the discharge often contributing the majority of the stream’s flow.

27. The lower reaches of the Makoura Stream flow relatively slowly and consist of deep but gently meandering channels. Some pools are also present. Monitoring by the applicant has shown that the benthic invertebrate community is severely degraded below the WWTP discharge. This is discussed further in Section E.

28. There are limited fishing records for the Makoura Stream. Electric fishing undertaken on two occasions in 2005 identified both long and short-fin eel, koura and brown trout. *Fissidens berteroi*, a nationally threatened aquatic moss, is also found in the Makoura Stream.

29. The Makoura Stream is recognised in the RFP as requiring enhancement for aquatic ecosystem purposes and has recently become the subject of intensive restoration efforts driven by Sustainable Wairarapa and supported by both Greater Wellington and Masterton District Council. Schools, iwi and other community groups have been involved with the Makoura Stream Restoration Project to date.

Ruamahanga River

30. The Ruamahanga River’s headwaters rise in the northern part of the Tararua Range and the river flows approximately 130 km through the Wairarapa valley before entering Lake Onoke (Figure 1). Major tributaries of the river include the Kopuaranga, Waipoua, Whangaehu, Waingawa, Taueru, Waiohine and Huangarua rivers.

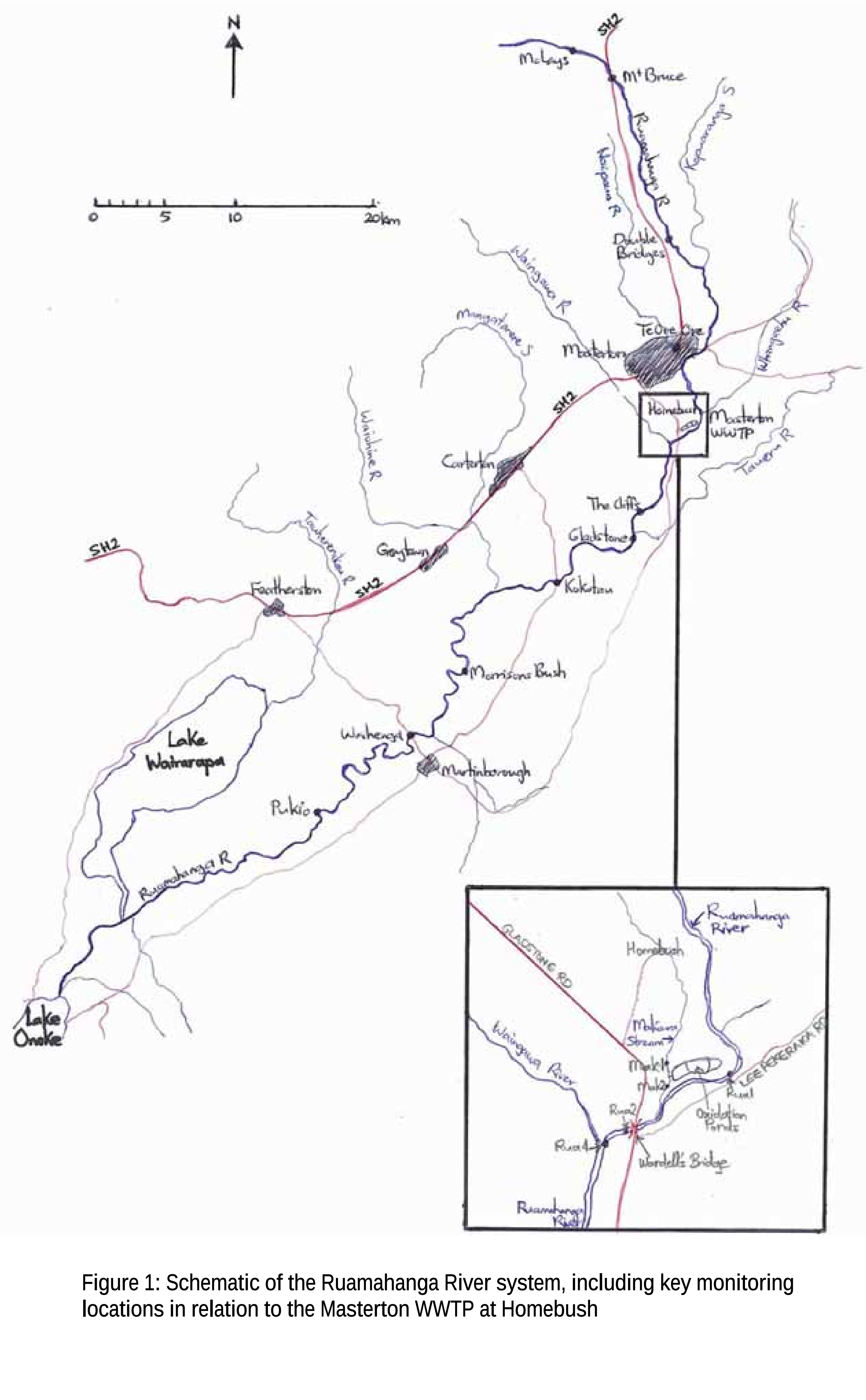

Figure 1: Schematic of the Ruamahanga River system, including key monitoring locations in relation to the Masterton WWTP at Homebush

31. The Ruamahanga River at Homebush drains an upstream catchment of approximately 63,346 ha. Downstream of Double Bridges, the dominant land cover changes from bush and scrub to high production pasture. As well as non-point source contaminant inputs from the upstream catchment, the Ruamahanga River also receives, either directly or indirectly, at least five significant wastewater discharges. These include treated wastewater from Rathkeale College (upstream of Te Ore Ore), the Masterton WWTP (Homebush, approximately 7 km downstream of Te Ore Ore), Carterton WWTP (via the Mangatarere and Waiohine rivers), Greytown WWTP (via Papawai Stream) and Martinborough (at Waihenga). The Masterton WWTP is the most significant of these discharges, in terms of both volume and contaminant loadings.

32. Flows in the upper reach of the Ruamahanga River are monitored by Greater Wellington at Mt Bruce (where the river emerges from the Tararua Range) and at Wardell's Bridge (approximately 200 m downstream of the Makoura Stream confluence). Flow monitoring data from the Wardell's Bridge site will be used throughout this report. This site was installed in 1954 and is one of the earliest rated water level recorders in the Wairarapa. Only data from 1977 onward are used in this report because the earlier data have not been audited.

33. The record from the Ruamahanga River at Wardell's Bridge monitoring site shows an average flow of 23.3 m^3/s and a median flow of 12.3 m^3/s. The highest average monthly flows occur from June to October, and these are the months when the most floods and 'freshes' occur, as indicated by the monthly distribution of flows greater than three times median flow in Figure 2. Due to the Ruamahanga River having its headwaters in the Tararua Range, the river is relatively 'flashy', having a relatively high number of hydrological disturbances (i.e., floods or freshes).

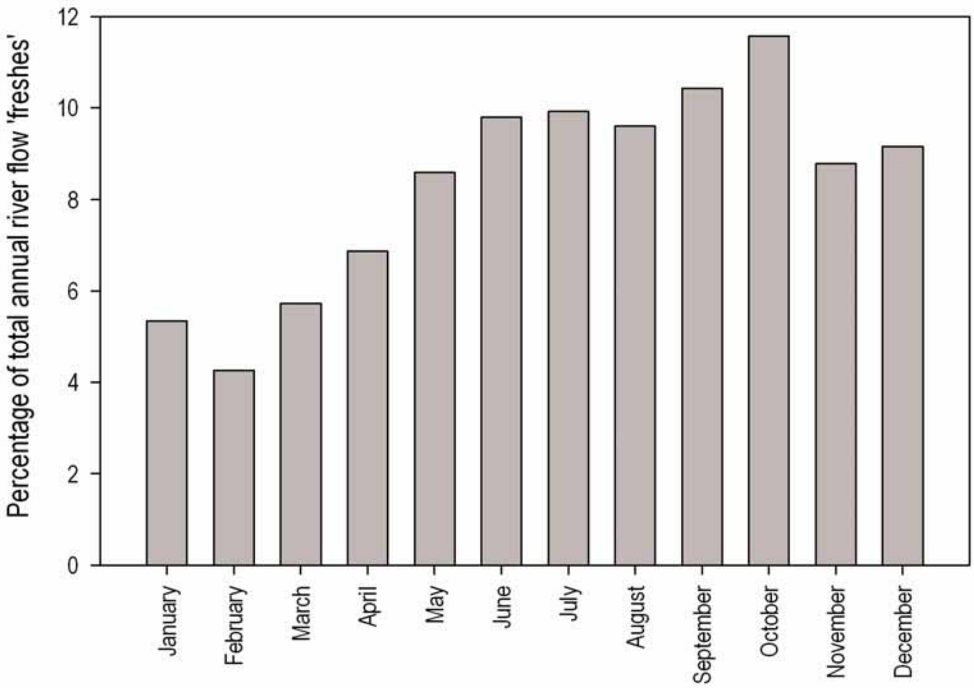

Figure 2: Intra-annual distribution of 'freshes' in the Ruamahanga River at Wardell's Bridge

34. The mean annual low flow (7-day duration) is 3.1 m^3/s, and the river is of a 'high baseflow' nature according to Ministry for the Environment draft ecological flow assessment guidelines (Beca 2008). However, the Ruamahanga River can also be subject to sustained periods of low flow, particularly during January to April. On average each year, the longest duration between significant freshes is 39.5 days[2]. The longest low flow period in recent years was over January to March 2008, when there were 53 days between significant freshes.

35. Water quality in the Ruamahanga River is excellent in its bush-clad headwaters. However, once the dominant landuse shifts to pasture north of Te Ore Ore, water clarity reduces and nutrient concentrations increase. Greater Wellington monitoring shows that the deterioration in water quality is particularly marked downstream of Te Ore Ore. Compared with Te Ore Ore, dissolved nutrient concentrations at Gladstone, in particular dissolved phosphorus and ammoniacal nitrogen, are significantly higher and frequently exceed ANZECC (2000) guidelines[3]. Further downstream near Martinborough, the median concentrations of these nutrients are lower (than at Gladstone) but water clarity is poorer.

36. Overall, water quality in the Ruamahanga River at Homebush (between Te Ore Ore and Gladstone) is generally fit for its intended management purpose (i.e., contact recreation and trout angling). The key exceptions are immediately following rainfall and, at times during low river flows, when dilution of the Masterton WWTP discharge is reduced, resulting in a reduction in water clarity, increased nutrient and indicator bacteria concentrations and an increase in benthic periphyton biomass downstream of the Makoura Stream confluence.

37. The Ruamahanga River has a largely cobble channel, with pool-run-riffle sequences common. These habitat characteristics provide for a diverse range of benthic invertebrates, including sensitive mayfly, stonefly and caddisfly (commonly referred to as Ephemeroptera, Plecoptera and Trichoptera, or 'EPT') taxa that are indicative of good water quality. The mayfly *Deleatidium* is especially common. Greater Wellington macroinvertebrate records show a decrease in the proportion of EPT species with distance downstream between Mount Bruce (SH 2) and Waihenga, reflecting the decline in water quality noted in paragraph 35.

38. A wide range of native and introduced fish species are found within the Ruamahanga River catchment. The native species include several classified as nationally threatened; long-fin eel, giant kokopu, shortjaw kokopu, dwarf galaxias and brown mudfish. Other less sensitive native species found in the catchment include upland bully, common bully, smelt and short-fin eel. Introduced species include sportsfish such as brown trout and perch, and pest species such as rudd.

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[2] Based on a fresh size of 37 m^3/s (equivalent to 3x median flow) and using the most recent 10 years of river flow data (1999-2008).

[3] Milne & Perrie (2005) and Perrie (2007) demonstrated over two different reporting periods that the median dissolved reactive phosphorus concentration at Te Ore Ore complies with the ANZECC (2000) trigger value for lowland ecosystems (0.010 g/m^3), while median concentrations at Gladstone and sites in the lower river reaches (Waihenga and Pukio) exceed the trigger value by a significant margin. Of all the sites monitored along the river, the highest concentrations have been recorded at Gladstone. Based on monthly monitoring over September 2003-August 2008 (n=63), the median dissolved reactive phosphorus concentrations for McLays (headwaters near Mt Bruce), Te Ore Ore, Gladstone and Pukio were 0.002 g/m^3, 0.008 g/m^3, 0.025 g/m^3 and 0.017 g/m^3 respectively.

39. The majority of the native fish species found in the Ruamahanga River catchment are diadromous, meaning that they need to migrate between freshwater and the sea to complete stages of their life cycle. The distribution of some of the more sensitive diadromous species (e.g., shortjaw kokopu) appears to be somewhat restricted within the catchment despite good habitat being available in the headwaters and tributaries running out of the Tararua and Rimutaka ranges. This may indicate that some type of physical (e.g., blocked Lake Onoke opening) or chemical (e.g., poor water quality) “barrier” is obstructing fish passage within the Ruamahanga River system.

40. The Ruamahanga River is the principal waterway in the Wairarapa and, as such, is highly valued for both contact recreation – including swimming, and kayaking – and trout angling. There are three swimming locations in the vicinity of the Makoura Stream (and Masterton WWTP) outflow; a private family swimming hole just upstream, Wardell’s Bridge, approximately 200 m downstream, and ‘The Cliffs’, approximately 8 km downstream. Wardell’s Bridge is the nearest recognised angling location.

Lake Onoke

41. Lake Onoke is a 630 ha highly modified shallow coastal lake/estuary and the ultimate receiving environment for the Masterton WWTP and other discharges entering the Ruamahanga River. Lake Onoke drains to the sea at Palliser Bay through an opening at the southeastern end of the lake. The lake outlet regularly blocks and is opened artificially.

42. An ecological vulnerability assessment undertaken in September 2007 (Robertson & Stevens 2007) rated Lake Onoke’s existing condition as poor for sedimentation, nutrients, saltmarsh and aquatic macrophytes. This poor rating reflects significant modifications to the lake environment including the loss of a large proportion of saltmarsh habitat, likely loss of submerged aquatic macrophyte beds, and reduced water and sediment quality. Most of these modifications can be attributed to the extensive drainage, river training and realignment, reclamation and artificial lake outlet actions which were undertaken to develop pastureland and minimise flooding, and to past and present catchment landuse intensification.

43. Despite these modifications, Lake Onoke still has considerable human uses and values, particularly fishing, boating and natural character. Ecologically it is valued for its remaining saltmarsh habitat (particularly Pounui Lagoon which drains into the northwestern end of the lake), adjoining duneland on Onoke Spit, and its bird and fish life (Wellington Regional Council 2008).

44. High nutrient, sediment and pathogen inputs from terrestrial catchment intensification are considered to be one of the major threats to the existing values of Lake Onoke. This is because the lake’s outlet has a tendency to block, creating a high natural susceptibility to issues such as eutrophication (excessive nutrients) and sedimentation.

E Assessment of environmental effects

Existing effects on the Makoura Stream

45. We concur with the applicant that the existing wastewater discharge is having significant adverse effects on the Makoura Stream. These adverse effects, which are clearly documented in the applicant's AEE, reflect the significant volume of wastewater discharged relative to stream flow (i.e., very little dilution) and include:

(a) A conspicuous change in water clarity (from a median of 1.46 m upstream to a median of 0.33 m downstream[4]) and colour;

(b) Significant increases in contaminant concentrations (55-fold and 119-fold for dissolved reactive phosphorus and ammoniacal nitrogen respectively[4]), with ammoniacal nitrogen concentrations often exceeding the ANZECC (2000) *toxicity* guideline for aquatic ecosystems downstream of the discharge;

(c) Reduced dissolved oxygen concentrations (median saturation downstream 72.8% compared with 92.8% upstream[3]); and

(d) A severely degraded macroinvertebrate community, evidenced by a marked reduction in the number of taxa downstream – including a near absence of sensitive EPT taxa – and a large increase in the abundance of pollution-tolerant *Chironomus* midges.

Existing effects on the Ruamahanga River

46. The applicant acknowledges that the existing wastewater discharges to the Ruamahanga River via the Makoura Stream and leakage from the oxidation ponds are affecting the Ruamahanga River but concludes that the effects are "*generally minor and principally a result of incomplete mixing*" (p.85 of AEE). In addition to adverse cultural effects, the applicant cites:

(a) Aesthetic effects from a conspicuous change in downstream water clarity and colour, as measured at Wardell's Bridge (i.e., within the existing mixing zone);

(b) A minor contribution to an increased human health risk from contact recreation downstream of the discharge as a result of more frequent exceedances of the Ministry for the Environment/Ministry of Health (2003) microbiological water quality guidelines, especially during dry weather and low river flows;

(c) Increased dissolved nutrient concentrations downstream, contributing to increased periphyton growth (though not reaching nuisance levels) on the river bed during periods of sustained low flow; and

[4] Based on monthly monitoring by the applicant over March 2003 to September 2008 (*n*=84-95).

(d) A lower quality (yet generally healthy) macroinvertebrate community downstream indicative of organic enrichment of the river below the discharge.

47. In contrast to the applicant's view, we consider that the existing effects are both significant and adverse because:

(a) The decreased clarity and elevated dissolved nutrient concentrations extend down to just above the confluence of the Ruamahanga and Waingawa rivers, some 700 m downstream of the Makoura Stream outflow (Tables 1 & 2).

(b) Dissolved reactive phosphorus concentrations, a key determinant of periphyton growth, consistently exceed the ANZECC (2000) trigger value for lowland aquatic ecosystems at both Wardell's Bridge (100% of sampling occasions over 2003-2008) and above the Waingawa River confluence (58% of sampling occasions). Exceedences are less frequent upstream of the discharge (29% of upstream sampling occasions).

(c) The applicant's assessment of the effects of the discharge on periphyton growth focused primarily on periphyton *coverage* across the river bed. Periphyton surveys have consistently reported greater algal *biomass* downstream of the discharge. An investigation undertaken by NIWA (2003) in summer 2003 showed an average two-fold increase in periphyton biomass downstream of the discharge, with algal growth estimated to be up to 27.5 times higher than upstream[5]. Similarly, routine annual periphton assessments undertaken for the applicant in both February 2007 and March 2008 found downstream algal biomass exceeded national guidelines (Biggs 2000) for the protection of benthic biodiversity (50 mg/m^2) and aesthetics/trout angling (120 mg/m^2). In the 2008 survey, chlorophyll *a* concentrations (an indicator of algal biomass) upstream of the discharge and downstream at Wardell's Bridge and the Waingawa confluence were 105, 267 and 99 mg/m^2 respectively.

(d) Macroinvertebrate surveys undertaken for the applicant have reported a lower quality invertebrate community downstream of the discharge. This was shown in the 2007 survey by a greater abundance of pollution-tolerant orthoclad and tanytarsus midges at both downstream sites compared with upstream, and in the 2008 survey by a lower abundance of pollution sensitive *Deleatidium* and *Nesameletus* mayflies downstream of the discharge.

[5] These increases occurred despite lower than average nutrient concentrations and a greater number of freshes over the 2003 summer (NIWA 2003).

Table 1: Median[1] water quality results for the Ruamahanga River upstream and downstream of the Makoura Stream confluence, based on monthly sampling by the applicant over March 2003 to September 2008. Note that there are some key differences from the limited data presented by the applicant (p.83 of AEE), in particular, visual clarity is higher and conductivity, ammoniacal nitrogen and dissolved reactive phosphorus concentrations lower upstream of the discharge, while nitrate nitrogen is higher upstream and lower downstream

Parameter	Rua1 (upstream of Makoura S)	Rua2 (downstream of Makoura S) [2]	Rua4 (upstream of Waingawa R) [3]	Rua1 to Rua2 change
Clarity (m)	1.9	1.2	1.6	-37%
pH	7.3	7.2	7.4	-1.4%
Conductivity (µS/cm)	97.9	112.8	107.7	15%
Turbidity (NTU)	2.64	4.22	2.61	60%
E. coli (cfu/100 mL)	60	170	82	183%
Ammoniacal-N (g/m^3) [4]	0.005	0.135	0.02	2600%
Nitrate-N (g/m^3) [4]	0.679	0.816	0.667	20%
Nitrite-N (g/m^3) [4]	0.002	0.004	0.003	100%
DIN (g/m^3) – by addition	0.698	1.056	0.688	51%
TKN (g/m^3) [4]	0.2	0.5	0.2	150%
DRP (g/m^3) [4]	0.007	0.092	0.012	1200%
Total Organic Carbon (g/m^3) [4]	2.9	4.0	3.4	38%

Notes:
[1] Median results for occasions when all three sites were sampled. The number of samples is 139 for *E. coli*, 74 for pH and conductivity, 70 for clarity, and 66 for all other parameters.
[2] At Wardell's Bridge, 200 m downstream of the Makoura Stream confluence
[3] Above the Waingawa River confluence, approximately 500 m downstream of Wardell's Bridge
[4] Measurements below detection limit taken to be half the detection limit

Table 2: Median[1] water quality results for the Ruamahanga River upstream and downstream of the Makoura Stream confluence during flows less than 12.3 m^3/s, based on monthly sampling by the applicant over March 2003 to September 2008

Parameter	Rua1 (upstream of Makoura S)	Rua2 (downstream of Makoura S) [2]	Rua4 (upstream of Waingawa R) [3]	Rua1 to Rua2 change
Clarity (m)	3.5	1.54	2.32	-56%
pH	7.4	7.3	7.6	-1%
Conductivity (µS/cm)	115.1	127.8	121.2	11%
Turbidity (NTU)	1.1	2.91	1.44	165%
E. coli (cfu/100 mL)	33	129	60	291%
Ammoniacal-N (g/m^3) [4]	0.005	0.090	0.020	1700%
Nitrate-N (g/m^3) [4]	0.549	0.806	0.578	47%
Nitrite-N (g/m^3) [4]	0.001	0.023	0.004	2200%
DIN (g/m^3) – by addition	0.555	1.161	0.683	109%
TKN (g/m^3) [4]	0.1	0.5	0.2	400%
DRP (g/m^3) [4]	0.002	0.138	0.012	6800%
Total Organic Carbon (g/m^3) [4]	2.7	4.0	3.3	48%

Notes:
[1] Median results for occasions when all three sites were sampled. The number of samples is 85 for *E. coli*, 37 for pH and conductivity, 35 for clarity, and 33 for all other parameters.
[2] At Wardell's Bridge, 200 m downstream of the Makoura Stream confluence
[3] Above the Waingawa River confluence, approximately 500 m downstream of Wardell's Bridge
[4] Measurements below detection limit taken to be half the detection limit

48. It is important to point out that the applicant's assessment of periphyton cover (percentage filamentous algae cover and percentage mat cover) is primarily based on Greater Wellington's monthly Rivers State of the Environment (RSoE) monitoring data. The assessment methods used in the RSoE programme are currently under review as they are limited to a single transect in "run" habitat. In addition, transects are often restricted to only a third or half of the river's width if the river is deep or turbid (turbidity "hides" periphyton at the time of assessment). Recent closer observations made in response to benthic cyanobacterial growths in Wellington's recreational rivers have highlighted that cyanobacterial mats establish and proliferate in riffles. Hence the presence of mat cover is likely to have been significantly under reported[6] and it is likely that the national guideline of 60% mat cover (for the protection of aesthetics/trout angling) has been exceeded in sections of the river.

49. The significance of benthic cyanobacterial mats in relation to potential effects on animal and human health was completely overlooked by the applicant. Benthic cyanobacterial mats are common in many recreational rivers in the Wellington region, including the Ruamahanga River. The 2008 periphyton assessment undertaken for the applicant reported the cyanobacterium *Phormidium* as dominating the biomass upstream and downstream of the Masterton WWTP. This cyanobacterium produces cyanotoxins that have been linked with dog deaths and illness in the Hutt River over the last few years (Ryan & Warr 2008, Watts & Milne 2007, Wood et al. 2007). There have also been anecdotal reports of stock deaths, and skin rashes and vomiting by people following bathing in other rivers with *Phormidium* proliferations. While there may be some correlation between mat coverage/biomass and toxicity, current scientific understanding of toxicity triggers is limited and the existing mat cover and biomass guidelines for protecting aesthetics/trout angling can not be transferred to protection of human and animal health (Dr Susie Wood, Cawthron Institute, pers. comm.).

Effects of the proposed upgrade on wastewater quality and the Ruamahanga River

50. The proposal will differ in its effects from those of the existing wastewater discharge, due to planned upgrades to the WWTP and changes to the discharge regime (refer Section C). It is important to note that as the upgrade will be staged over a period of up to five years, the existing effects are expected to continue in their present form – or a reduced form – during this period.

Wastewater (effluent) quality and quantity

51. The construction of new oxidation ponds with additional maturation cells operating in series will reduce *E. coli* counts in the final effluent discharged to land and water. The proposed *E. coli* targets in the effluent following the upgrade are 200 cfu/100 mL during summer and 1,000 cfu/100 mL during

[6] Field notes made under Greater Wellington's RSoE and recreational water quality monitoring programmes over the last 12 months provide some examples. Observations from the Ruamahanga River at Te Ore Ore in April 2008 were 22.5% filamentous cover and 0% mat cover in the sampling transect but *"a lot more algae growth (both types) in riffles downstream"*. Similarly, on 5 January 2009, no mat cover was recorded across a transect in the Waipoua River at Colombo Road (Masterton), yet the field notes stated *"Blue green algae abundant in upstream riffle (100% cover in some places) becoming exposed on edges and dry on bank."*

winter. This is a 60% reduction in *E. coli* during summer, but a 54% increase during winter, compared to the existing summer and winter geometric means of 485 cfu/100 mL and 651 cfu/100 mL respectively (Table 25, p.125 of AEE). The proposed upgrades are not predicted to improve any other aspect of existing effluent quality (Table 3).

52. The total quantity of wastewater flows entering the Masterton WWTP is expected to increase slightly, from the current average of 15,750 m^3/day to 16,300 m^3/day by 2015.

53. As effluent quality and quantity will largely remain similar to the current situation, the mass load of contaminants discharged will also remain similar (Table 3). Effluent monitoring and discharge standards are recommended to ensure this is the case. The key difference will be that only a portion of the total contaminant load will be discharged directly to the Ruamahanga River.

Table 3: Current and expected (2015) organic and nutrient contaminant loads in the final treated effluent to be discharged to land and water, based on median concentrations from monthly sampling by the applicant over March 2003 to September 2008 (*n*= 67-144) and current and predicted average daily flows

Parameter	Concentration (g/m^3)	Existing Load		Future (2015) Load	
		Kg/day	Tonnes/year	Kg/day	Tonnes/year
BOD_5	11.0	173	63.2	179	65.4
Soluble BOD_5	4.00	63	23.0	65	23.8
Suspended Solids	19.0	299	109	310	113
Ammoniacal-N	6.56	103	37.7	107	39.0
Nitrate-N	0.84	13	4.83	14	5.00
Nitrite-N	0.08	1.3	0.46	1.3	0.48
DIN	7.48	118	43.0	122	44.5
Total Nitrogen	11.0	173	63.2	179	65.4
DRP	2.50	39	14.4	41	14.9
Total Phosphorus	3.00	47	17.2	49	17.8

54. According to the applicant (Tables 26 and 27, p.113 of AEE), the volume of treated effluent discharged directly to the receiving waters will reduce, on average, from as little as 7% (May) to as much as 67% (January) of that discharged currently, with an overall reduction for the summer months (November to April inclusive) of 58%. This equates to an average discharge of 5,818 m^3/day in summer.

55. Tables 26 and 27 of the AEE indicate that there will be a discharge to the river at least 30% of the time during the summer months and, except during the months of January to April, more effluent will be discharged to the river than to land.

56. The maximum instantaneous rate of discharge to the Ruamahanga River of 1,200 L/s sought by the applicant is considerably higher than the current maximum rate of 700 L/s authorised by existing Discharge Permit WAR020074. The rationale for this increase has not been explained but presumably relates to a need to discharge significant volumes of stored effluent

to the river when irrigation to land is not possible or preferred. This means that when a discharge to the river does occur, a potentially greater effluent volume and contaminant load will be able to be discharged (or, at least a greater volume and contaminant load in a given amount of time) than is currently the case. We therefore recommend that the contaminant loads be controlled through the establishment of maximum daily discharge volume and/or nutrient loading limits (see paragraphs 85-87).

57. The use of a 400 mm thick clay liner in the new ponds will reduce the amount of effluent seepage through the base of the ponds to groundwater (and ultimately the Ruamahanga River). The applicant has estimated seepage from the existing ponds as being as high as 2,400 m^3/day and predicts seepage from the new ponds will not exceed 750 m^3/day initially and, approximately 150 m^3/day once sludge builds up on the pond base.

Receiving water quality

Mixing

58. The relocation of the existing discharge from the Makoura Stream directly into the Ruamahanga River and installation of a diffuser outfall on the riverbed will assist with effluent mixing resulting in a significantly shorter mixing zone than is presently the case. Mixing will also be improved by the proposed discharge regime which will mean:

(a) No discharge of effluent to the river below half-median flow (6.1 m^3/s) during summer for the first five to six years and then no discharge below median flow (12.3 m^3/s) during summer once the land irrigation has commenced;

(b) No discharge of effluent to the river during below half-median flow (6.1 m^3/s) during winter; and

(c) A river/effluent dilution ratio of at least 30:1 at all times.

59. Modelling by the applicant indicates effluent will be reasonably (66-70%) mixed 200-400 m downstream of the outfall and fully mixed by 800 m downstream (450 m upstream of Wardell's Bridge).

60. Taking into account the applicant's modelling results and mixing zones specified on other wastewater discharges, we consider that a mixing zone of 200 m is appropriate for the direct discharge from the Masterton WWTP. While this would normally mean that water quality guidelines need to be met after 200 m, we suggest the application of the mixing zone is restricted largely to those effects listed under s107 of the RMA. This places emphasis on ensuring there are no toxic effects and no significant nuisance periphyton growths on the riverbed after reasonable mixing. We consider this approach is appropriate because effluent is being discharged to the river above median river flow in summer (half median initially and during winter) when upstream water clarity, nutrients and faecal bacteria are likely to be approaching or outside of guideline values.

61. A "mixing zone" is also recommended at times of no direct discharge to the Ruamahanga River, to safeguard against unacceptable effects of nutrients leaching into the river via groundwater seepage underneath the land irrigation area and the base of the oxidation ponds. Taking into account the predicted direction of groundwater flow, we recommend that the boundary of the zone ends at Wardell's Bridge. Dissolved nutrient and periphyton standards should be imposed at this location with monitoring undertaken at this site and several locations upstream during the summer months when there is no direct river discharge. This is discussed further in paragraphs 73, and 80 to 84. Note that while we are willing to accept higher dissolved nutrient concentrations in the river upstream of Wardell's Bridge adjacent to the land irrigation area and oxidation ponds, we recommend a requirement that periphyton streambed cover guidelines for aesthetics/recreation be met in this reach.

62. Whilst we concur with the idea of having a minimum dilution factor, the rationale for the proposed dilution factor of 30 requires more explanation by the applicant as it will not necessarily result in an improvement from the existing situation. For example, analysis of instantaneous effluent discharge data for the 2007/08 year indicates that a dilution ratio of more than 30:1 has always been maintained when river flows are above median, with the dilution ratio considerably larger at higher flows (Figure 3). Moreover, based on existing median effluent quality data (Table 3), a 30-fold dilution may be insufficient to reduce dissolved reactive phosphorus concentrations to below recommended guideline values (see paragraph 74).

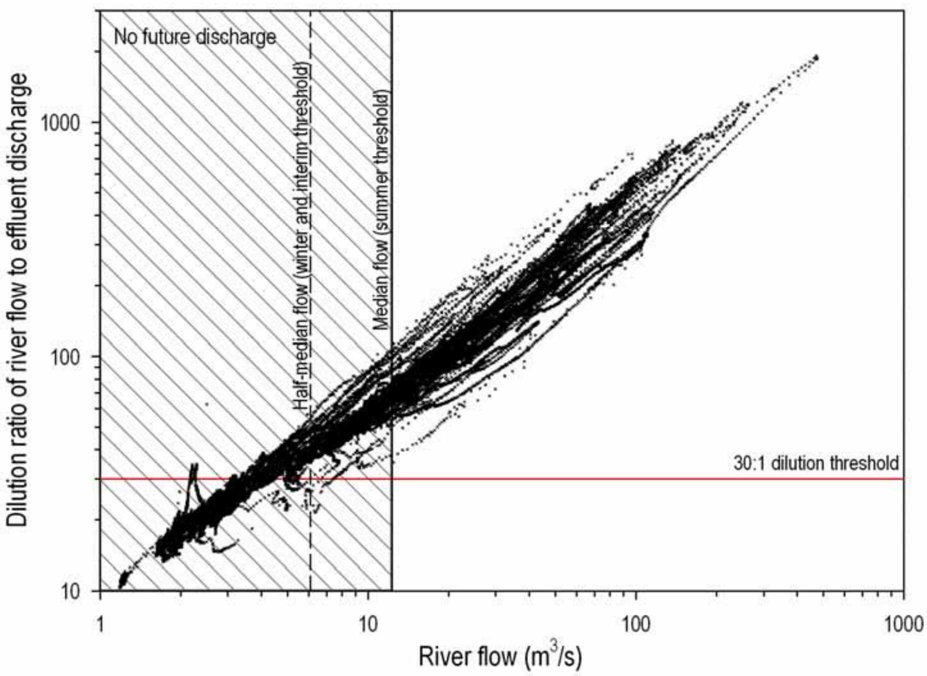

Figure 3: Relationship between river flow and effluent dilution ratios in the Ruamahanga River over 2007/08, based on instantaneous (15-minute) effluent and river flow data from Wardell's Bridge. The hatched area represents the proposed flow range when direct effluent discharge will not occur. The average and median dilution ratios currently being achieved at the proposed onset of a direct discharge are 68.5:1 and 67:1 respectively[7].

[7] Based on 100 data points between river flows of 12.3 and 12.4 m^3/s during 2007/08.

Colour and clarity

63. The proposed discharge regime will eliminate colour and clarity effects at river flows below median in summer and half-median in winter. As a result, the river is expected to comply with the recommended contact recreation clarity standard of 1.6 m (Ministry for the Environment 1994) both upstream and downstream of the WWTP.

64. Improved mixing in the Ruamahanga River will reduce existing colour and clarity effects at all other river flows when a discharge is occurring. However, the applicant's modelling suggests some reduction in clarity (up to 50%) is still expected after reasonable mixing in summer, particularly during "the threshold flow range" of 12.3-14.0 m^3/s (i.e., river flows just above the median, triggering the onset of a discharge). Although we note these flows are predicted to occur for only a short period of time, the clarity effects at such flows could be reduced if the dilution ratio is increased above 30:1. At higher flows, the river is likely to already be quite turbid from upstream diffuse source inputs.

Pathogens

65. The proposed discharge regime will eliminate existing pathogen effects at river flows below median in summer and half-median in winter. As a result, the river is expected to more frequently comply with the MfE/MoH (2003) microbiological water quality guidelines downstream of the WWTP.

66. The additional maturation cells are expected to reduce pathogen levels in the final discharge, which, when combined with improved dilution and mixing in the river, will reduce existing pathogen effects at all other river flows. This may improve compliance with the MfE/MoH (2003) microbiological water quality guidelines downstream of the WWTP at just above median flows in summer but, more often than not when river flows are high, indicator bacteria counts in the river are likely to already be elevated as a result of upstream diffuse source inputs. In any case, regular monitoring upstream and downstream when effluent is being discharged to the river will provide a check on downstream pathogen levels.

67. We concur with the applicant that the contribution of pathogens to the river from seepage through the base of the oxidation ponds and groundwater underneath the land irrigation area is expected to be negligible. We note that the technical review of the discharges to land prepared by Hamish Lowe has recommended groundwater monitoring to ensure that this is the case. We support this monitoring.

68. While there will be no discharge of pathogens to the river at times when river flows are most conducive to contact recreation, the proposed location of the diffuser means that the effluent will enter the river upstream of an existing family swimming hole that was not previously affected by the discharge. The effects on pathogen levels (and general water quality) at the location of the swimming hole have not been assessed and it should be kept in mind that until the land irrigation system is developed the discharge will actually be occurring above half-median river flow during summer when recreational use may occur.

Nutrients

69. The proposed discharge regime will eliminate direct inputs of nutrients at river flows below median in summer and half-median in winter. However, there will be indirect nutrient inputs at these times, resulting from seepage through the base of the oxidation ponds and groundwater underneath the land irrigation area. Nitrate, in particular, is highly mobile in groundwater.

70. It is difficult to determine what the indirect nutrient inputs at river flows below median in summer and half-median in winter will be. The applicant has stated conservative modelling results suggest inputs of dissolved reactive phosphorus (the principal limiting nutrient for periphyton growth) will be negligible, ranging from 0.003 g/m^3 at river flows just below median to 0.012 g/m^3 at very low river flows. When the median background (upstream) concentration at these flows is taken into account (Table 2), this equates to a total downstream concentration (after full mixing) in the order of 0.014 g/m^3 during low river flows.

71. The applicant has not provided any modelling results for combined dissolved inorganic nitrogen inputs from pond and groundwater seepage but, based on pond seepage alone and the median background (upstream) concentration from Table 2[8], the median dissolved inorganic nitrogen concentration at Wardell's Bridge (1.25 km downstream) at flows just above median is expected to be around 0.564-0.571 g/m^3. Dissolved nutrient concentrations are discussed further in relation to periphyton growths in paragraph 79.

72. We are concerned that nutrient inputs to the river from pond and groundwater seepage may be higher than modelling predicts. Our reasons are largely based on multiple concerns raised in the land irrigation technical review report for Greater Wellington prepared by land treatment expert Hamish Lowe. In essence:

   (a) Models are only tools and are based on a large number of assumptions (e.g., effluent is evenly applied over the entire land area);

   (b) Not all of the inputs to the model were conservative (e.g., use of average rather than 90th percentile or maximum nutrient concentrations in the effluent);

   (c) An expert soil assessment has raised questions about the suitability of the soils for border strip irrigation and the soils are considered to have a low phosphorus retention capacity (8-19%);

   (d) In places the soils are highly permeable and the depth to groundwater is shallow (around 2 m), suggesting that nutrients, particularly nitrate, are likely to move rapidly through the soils into the groundwater and, subsequently, the river;

8 Note the applicant's calculations (Table 33, p.136 of AEE) were based on an upstream background concentration of 0.50 g/m^3, which is lower than the median concentration provided in Table 2.

(e) From a hydraulic perspective, the land application rates appear to be very high (in excess of plant requirements) and nutrient leaching rates on the sandy soils may be higher than predicted, or nutrient attenuation in the groundwater lower than expected due to groundwater mounding under the site;

(f) Effluent is being applied to land using a method that can easily result in uneven distribution – the described operation of the proposed "wipe-off" drainage system provides one example of the potential for uneven effluent application and therefore leaching rates that differ from modelled outputs;

(g) The proposed infiltration areas and "wipe-off" drainage system in the land application area incorporate permeable sandy gravel "trenches" in places alongside the river (and Makoura Stream) designed to rapidly drain – rather than adequately treat – excess effluent from the land surface[9];

(h) The applicant intends to vary effluent application rates based on the ability of the soil to receive water, introducing potential nutrient leaching scenarios that differ from those modelled; and

(i) There is a heavy reliance on the skills of the WWTP operator to adequately manage all aspects of the land irrigation system, including the high variability in soil properties across the site that will require special attention to detail.

73. Owing to the significant uncertainty around nutrient leaching from the land irrigation area and oxidation ponds to the Ruamahanga River, nutrient monitoring is recommended in the river upstream and downstream of the likely groundwater inputs during summer when there is no direct effluent discharge to the river. Receiving water limits for dissolved nutrients are also recommended to safeguard against the stimulation of periphyton growths. These limits are discussed further in paragraphs 79 to 84.

74. Modelling by the applicant shows that when there is a direct effluent discharge to the river, dissolved reactive phosphorus concentrations will significantly exceed the ANZECC (2000) trigger value for lowland aquatic ecosystems (0.010 g/m^3) after both reasonable and full mixing (the applicant's derived site specific guideline value of 0.030 g/m^3 will also be exceeded). Moreover, Table 43 of the AEE (p.142) shows that the concentration at Wardell's Bridge (for flows above 12.3 m^3/s) is expected to increase 41%, from an existing summer median of 0.071 g/m^3 to 0.100 g/m^3. We presume the increase reflects the greater instantaneous rate of effluent discharge sought for discharges to the river when flows are above 12.3 m^3/s (refer paragraph 56).

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9 The significance of this is evident in the fact that efficient operation of the border-strip irrigation system requires "wipe-off" flow (to ensure even application of effluent along the length of the irrigation strips), meaning that a significant amount of this "excess flow" could enter shallow groundwater via rapid land drainage.

75. The applicant assessed dissolved inorganic nitrogen (DIN, the sum of nitrite-nitrate nitrogen and ammoniacal nitrogen) concentrations against ANZECC (2000) toxicity guidelines rather than guidelines relevant to protection against undesirable periphyton growths. The need to consider DIN inputs in relation to periphyton growths is discussed in paragraphs 79 and 80.

Toxicants

76. The high groundwater infiltration rate to the Masterton WWTP, combined with a relatively low industrial input, means that concentrations of toxicants in the effluent, such as ammonia and heavy metals, are relatively low compared with other municipal oxidation ponds. Given this, and the elimination of a direct effluent discharge to the river at low flows (when dilution is reduced), the discharge is not expected to result in the ANZECC (2000) guidelines for toxicants being exceeded after reasonable mixing. One possible exception is ammoniacal nitrogen if effluent is discharged at just above half median river flows under the proposed minimum dilution ratio and the river pH is elevated[10]. The establishment of maximum ammoniacal nitrogen standards for both the discharge and receiving water is therefore recommended.

Aquatic life

Periphyton – filaments & mats

77. The removal of direct nutrient inputs to the river during low flows is expected to significantly reduce the effects of the existing discharge on river bed periphyton cover and biomass. However, there is considerable uncertainty as to what the indirect nutrient inputs resulting from seepage through the base of the oxidation ponds and groundwater underneath the land irrigation area will be and, therefore, the impacts this may have on instream periphyton biomass.

78. The effects of the discharge on periphyton growth and biomass during times of direct river discharge are also unclear. While such discharges will only occur at flows above 12.3 m^3/s in summer, we do not agree with the applicant that the river conditions at these times will always prevent the stimulation of periphyton growths on the riverbed. For example, in last summer's hydrological record there were several small freshes below the commonly accepted flushing/scouring flow (3x median) that would have triggered a direct effluent discharge to the river (Figure 4). We note the very high periphyton biomass reported on the riverbed in a survey on 26 March (refer paragraph 47c) followed several small freshes on 5, 10 and 12 March. Cyanobacterial mats dominated the biomass, supporting our observations that such mats tend to be more resistant to scouring from high river flows compared with green filamentous algae. As a result, it is not unusual to find cyanobacterial mats on the river bed year-round.

[10] The applicant's ammoniacal nitrogen receiving water target of 1.61 g/m^3 is based on an *average* river pH of 7.5 and so, in our view, is not conservative. Greater Wellington's RSoE monitoring records indicate that pH in the Ruamahanga River can on occasions exceed 8.0. A pH of 8.2 (90th percentile recorded at Te Ore Ore over February 1997 to December 2008) equates to a toxicity trigger value of 0.66 g/m^3, using Table 8.3.7 of the ANZECC (2000) guidelines.

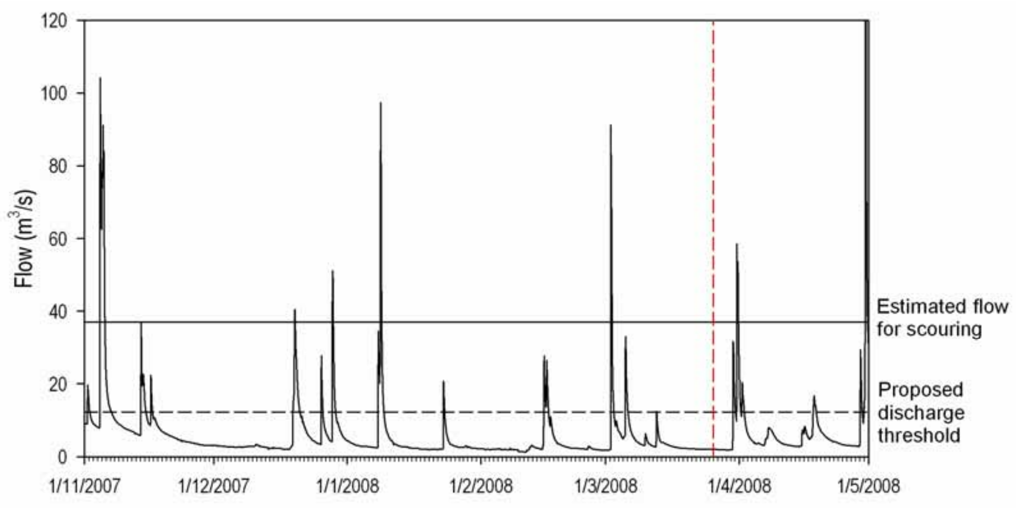

Figure 4: Average hourly flows in the Ruamahanga River at Wardell's Bridge over 1 November 2007 to 30 April 2008 inclusive. Both the threshold for a direct effluent discharge to the river in summer (>12.3 m^3/s) and the assumed river flow to flush periphyton from the riverbed (3 x median river flow) are indicated. The vertical red dashed line indicates the date of the 2008 periphyton survey (26 March, see paragraph 78).

79. In order to protect against the potential for nuisance instream periphyton growths, we recommend:

(a) The setting of receiving water standards for both dissolved (soluble) nutrients associated with the promotion of periphyton growth (i.e., dissolved reactive phosphorus (DRP) and dissolved inorganic nitrogen, DIN) that would apply over November to April at Wardell's Bridge at times when effluent is not being directly discharged into the river; and

(b) The setting of maximum daily loads for DRP and DIN in the effluent that would apply year-round when effluent is being discharged into the river.

80. Our rationale for year-round controls on both dissolved nutrients is that:

(a) Analysis of DIN and DRP ratios calculated from data collected under both Greater Wellington's RSoE monitoring programme and NIWA's National Rivers Water Quality Monitoring Network indicate that while the limiting nutrient is typically DRP, there is clear evidence that suggests at times the river may be nitrogen-limited[11];

(b) There is evidence of significant periphyton coverage in the Ruamahanga River on occasions outside of the November to April "summer period", including an exceedance of cyanobacterial mat

[11] For example, monthly monitoring at RSoE sites over the period September 2003 to November 2008 (*n*=62-63) indicates dissolved inorganic nitrogen was the limiting nutrient at McLays on 21 (34%) occasions, predominantly – but not exclusively – in the summer months. RSoE data for Te Ore Ore, Gladstone and Pukio also indicate occasional nitrogen limiting conditions.

cover guidelines for aesthetics/trout angling at Wardell's Bridge on 13 September 2005[12]; and

(c) Our recommendation is consistent with recent expert opinion (Wilcock et al. 2007) that highlights the interconnectivity of waterways, the influence of antecedent water quality on periphyton growth and rigour[13], and the need to protect downstream lake or estuarine receiving environments (in this case Lake Onoke).

81. The proposed in-river DRP standard of 0.012 g/m^3 (Table 4) was derived in strict accordance with the periphyton biomass model in the national periphyton guidelines (Biggs 2000), focusing on the protection of aesthetics/trout angling and taking into account the average number of days for periphyton accrual over the course of a year (19 days based on the full data record dating back to 1977, with a "filter" period of 5 days). We consider our standard to be more appropriate than the guideline proposed by NIWA (0.030 g/m^3) which was based on a 13-day accrual period calculated from summer data only and a "filter" period of just one day. A standard of 0.012 g/m^3 also relatively closely aligns with standards in other regional plans (e.g., Horizons and Hawke's Bay both have a standard of 0.015 g/m^3 for some catchments) and the applicant's own predictions of the downstream concentration after full mixing (refer paragraph 70).

Table 4: Recommended dissolved nutrient standards for the Ruamahanga River at Wardell's Bridge over November to April when there is no direct effluent discharge to the river

	Dissolved Reactive Phosphorus (DRP)	Dissolved Inorganic Nitrogen (DIN)
Standard (g/m^3)	0.012 or up to 20% greater than the upstream concentration	0.580 or up to 20% greater than the upstream concentration

82. The proposed in-river DIN standard of 0.580 g/m^3 (Table 4) was determined by taking into account both the existing median upstream concentration for river flows less than median and predictions by the applicant that downstream increases as a result of groundwater seepage will be negligible (taken here as <5%). The "up to 20% increase" component of the standard provides for those occasions when upstream concentrations are elevated. A similar magnitude increase has been built into the DRP standard for the same reason, although we note that, based on the last five years of monitoring, the 95th percentile DRP concentration upstream at river flows below median is only marginally above 0.012 g/m^3.

83. To assess compliance with the in-river nutrient standards, we recommend monthly monitoring of dissolved nutrients over November to April inclusive at a new site upstream of the land irrigation area (in the vicinity of the upstream boundary of irrigation plot 1), the existing upstream sampling site that will be subjected to groundwater seepage under the proposal (Rua1), at the boundary

12 Source: NIWA's NRWQN records – average mat cover was recorded as being 64.2%.

13 Lengthy exposure to elevated nutrient concentrations preceding a major flood event is likely to give rise to vigorous periphyton growth that will respond more quickly than if it had grown in low-nutrient waters (Wilcock et al. 2007).

of the mixing zone for the river discharge (200 m downstream of the diffuser outfall), and Wardell's Bridge (Rua2).

84. Semi-quantitative assessments of periphyton cover across the riverbed should be undertaken at the same time as in-river nutrient monitoring. In particular, we consider there is a need to closely examine the coverage of toxic benthic cyanobacterial mats to manage potential human health risks. No guideline exists for the protection of animal or human health, but in response to growing reports and concerns of toxic benthic mats in recreational rivers across New Zealand, the Ministry for the Environment is currently in the process of developing a draft guideline. The draft guideline is expected to recommend an "alert level" warning be issued where mat coverage exceeds 20-50% of the riverbed (Wood, pers. comm.). This closely aligns with Greater Wellington's recently revised benthic toxic cyanobacteria response protocol and we recommend that it be observed at Wardell's Bridge during November to April.

85. Our rationale for controlling the daily dissolved nutrient loads in the direct WWTP discharge to the river is:

(a) Discharges to the river will occur at times when background (upstream) nutrient concentrations may already be elevated, reducing the applicability of in-river concentration standards;

(b) Loading-based standards take into account both contaminant concentration and effluent volume, and are therefore more appropriate from a receiving environment effects-based point of view; and

(c) The applicant has proposed a very high maximum instantaneous discharge rate that at times could result in a significant increase in mass nutrient loads currently discharged to the river (Table 5), with potential for flow-on effects in downstream waters such as Lake Onoke.

86. Effluent nutrient loading standards could be derived from background (upstream) nutrient loads and back-calculation of these to an effluent load that allows for a nominal (20%) increase in-river loads after full mixing. An example of such an approach is provided in Table 5. We note that under this scenario – which is based on median upstream and effluent nutrient concentrations at the onset of a river discharge (i.e., 12.31 m^3/s), the DRP loading standard is unlikely to be met if the applicant's proposed minimum dilution ratio is observed. Moreover, the phosphorus loading will be higher than the current median load (which is discharged at a higher dilution rate). The easiest way for the applicant to reduce the loading rate would be to restrict the volume of effluent discharged to the river (i.e., increase the minimum 30:1 dilution ratio, preferably so that it aligns with the minimum and median dilution ratios that are currently being achieved). This matter will need to be discussed at the hearing as increasing the dilution ratio would require an increased discharge to land and/or additional pond storage.

Table 5: Possible derivation of dissolved nutrient loading standards for the Masterton WWTP effluent discharge to the Ruamahanga River

	DRP	DIN
Median upstream nutrient load (kg/day) during river flows above median (>12.3 m^3/s)	23.9	1,409
Proposed effluent standard: median upstream load with nominal 20% increase (kg/day)	28.7	1,691
Median effluent concentration (g/m^3)	2.50	7.48
Expected effluent flow at just above median river flow (m^3/s) and 30:1 dilution	0.410	0.410
Expected effluent nutrient load (kg/day) at just above median river flow (12.31 m^3/s) and 30:1 dilution	89.2	267
Current effluent nutrient load (kg/day) at just above median river flow and median dilution (67:1)	*39.5*	*118*
Expected total downstream nutrient load (kg/day) at just above median river flow and 30:1 dilution	113.1	1,676
% difference (expected effluent load and upstream load) from proposed standard	294% greater	0.9% less

87. If effluent nutrient loading – as opposed to effluent volume – standards are established, we recommend that compliance is assessed using nutrient concentration data obtained from regular (at least monthly) receiving water and effluent quality sampling and the average daily discharge volume for the day of sampling.

Invertebrates and fish

88. No toxic effects on invertebrates or fish are expected, owing to the relatively low toxin concentrations in the effluent and the removal of a direct discharge to the river during low river flows (when dilution is reduced). Maximum toxicant discharge standards are recommended to ensure that this is the case.

89. The removal of the direct discharge at low river flows may result in an improved downstream macroinvertebrate community, through an increase in taxa sensitive to organic enrichment. However, macroinvertebrate community health is also adversely affected by excessive periphyton growth and, as discussed above, it is unclear what effects seepage from the oxidation ponds and land irrigation area will have on periphyton biomass. We therefore recommend macroinvertebrate samples are collected at sites upstream and downstream of the Masterton WWTP in conjunction with a detailed annual periphyton survey that assesses species composition and biomass measures.

Cumulative effects

90. In our view, the Masterton WWTP discharge to the Ruamahanga River can not be considered in isolation from the larger receiving water system. Even with an average reduction in direct contaminant load inputs of up to 60% in summer, this discharge remains the most significant point source discharge to the Ruamahanga River system. Lake Onoke, some 68 km downstream of Homebush[14], is the ultimate receiving environment and is showing signs of

[14] We estimate an approximate travel time of 32 hours for inputs from Homebush to reach Lake Onoke during median flow conditions and in the order of 8-10 hours during flood events.

eutrophication, a key reason why we recommend restrictions on the mass nutrient loads discharged from the Masterton WWTP. While we do not dispute that significantly greater nutrient inputs are derived from diffuse sources during wet weather (e.g., farm run-off), the Masterton WWTP is a significant point-source discharge that needs to be managed. We think the applicant needs to focus on making land application (or effluent re-use) more viable year-round. This would be assisted greatly if the very high incoming flows to the Masterton WWTP could be reduced.

Effects of the proposed upgrade on the Makoura Stream

91. The removal of the direct discharge to the Makoura Stream under the applicant's proposal means that the significant adverse effects described in paragraph 45 will cease. However, the Makoura Stream has a strong hydraulic connection with shallow groundwater (refer paragraph 23) and so water quality in the lower stream reaches is still likely to be degraded to some degree as a result of nutrient-rich and potentially pathogen-enriched groundwater seepage from the land irrigation area.

92. The applicant's proposal includes the construction of a new drainage system within the land irrigation area that will discharge to the Makoura Stream at the southwest corner of proposed pond six. As the drain will penetrate permeable gravels below the surface silts it is expected to provide rapid drainage of nutrient-rich groundwater directly to the stream with little or no treatment.

93. Stormwater is also to be discharged from the land irrigation area into the Makoura Stream. Under the applicant's proposal, excess effluent run-off from the bottom of the border strips will be collected by "wipe-off" drains and either discharged to groundwater via designated rapid infiltration areas or pumped back to the oxidation ponds for discharge at a later time. We understand the recycle pump station is to operate during irrigation and for a two-hour period after irrigation has ceased. Any runoff after this period is classified as "stormwater" and is *"suitable for direct discharge to a surface waterbody"* (p.102 of AEE) as it is expected to carry low contaminant concentrations.

94. It is difficult to determine the likely extent of water quality degradation in the Makoura Stream as a result of groundwater infiltration and drainage but in a modelling report prepared for the applicant, PDP (2008) predicted:

    (a) Groundwater nutrient concentrations adjacent to the Makoura Stream ranging from 0.48 to 2.97 g/m^3 for nitrate nitrogen and from 0.012 to 0.372 g/m^3 for dissolved reactive phosphorus; and

    (b) increases in base stream flow of 0.15 m^3/s (resulting in a total flow of 0.32 m^3/s), nitrate nitrogen of 7% (from 3.5 to 3.75 g/m^3 after mixing) and dissolved reactive phosphorus of 50% (from 0.02 to 0.03 g/m^3 after mixing[15]) during summer low flows (for indictor bacteria the increase was predicted to be negligible).

[15] Based on monthly monitoring over March 2003 to September 2008 (*n*=82), the median upstream nitrate nitrogen concentration is actually lower (2.66 g/m^3).

95. For the reasons outlined in paragraph 72, we consider that nutrient seepage into the Makoura Stream may be higher than the applicant predicts. Water quality and flow monitoring is therefore recommended. This should be undertaken at sites upstream of the land irrigation area, within the land irrigation area (water quality only – adjacent to the boundary of plot 11 and the existing Mak1 monitoring site) and in the lower reaches (at the existing Mak2 monitoring site). Monitoring at the latter site will provide a check on the effects of groundwater drainage on the stream before it enters the Ruamahanga River.

96. In order to ensure that the seepage discharges are not adversely affecting aquatic life, we also recommend an annual ecological assessment is undertaken at each monitoring site following a period of stable stream flows in late summer or early autumn. Because the Makoura Stream has a predominantly silty substrate, this assessment can be limited to macroinvertebrate health.

Synthesis

97. The proposed upgrades to the Masterton WWTP and changes to the discharge regime mean that the adverse effects associated with the existing discharges will be reduced significantly, with the Ruamahanga River at Wardell's Bridge expected to be suitable for contact recreation as a result. While this is a clear step in the right direction by the applicant, it may take up to five or six years for the site works to be completed, meaning the discharge of treated wastewater will continue at river flows less than median in summer. The effects of such discharges were not assessed by the applicant.

98. The Ruamahanga River will remain the principal receiving environment for the majority of the year, with more treated wastewater discharged to the river than irrigated to land. We also note that the proposed treatment upgrades are only predicted to improve the quality of the discharge by reducing bacteria counts (and possibly ammonia concentrations) during summer, and may result in higher bacteria counts during winter;

99. Our main concerns with the proposal relate to:

(a) The proposed minimum river flow to effluent dilution ratio of 30:1 will provide less dilution in the river than at present;

(b) The proposed maximum instantaneous discharge rate of 1,200 L/s is significantly higher than the existing 700 L/s and will enable a greater contaminant load to be discharged to the river; and

(c) The significant potential for greater than anticipated nutrient inputs (and associated effects on instream periphyton biomass and macroinvertebrate communities) into both the Makoura Stream and the Ruamahanga River via seepage through groundwater underneath the proposed land irrigation area and the base of the new oxidation ponds.

F Recommendations

100. Despite serious concerns with some aspects of the applicant's proposal, we believe from a surface water quality perspective, resource consents 27160-27163 of application WAR090066 can be granted subject to strict conditions that:

(a) Require removal of the direct discharge to the Makoura Stream as soon as possible;

(b) Restrict the maximum daily wastewater volume (or nutrient load) discharged to land and the Ruamahanga River;

(c) Control the quality of wastewater discharged to both land and the Ruamahanga River;

(d) Require comprehensive monitoring of water quality in both the Ruamahanga River and Makoura Stream, including at times where there is no direct wastewater discharge into the Ruamahanga River;

(e) Require regular reporting of monitoring results, together with a comprehensive annual monitoring report summarising compliance with resource consent conditions; and

(f) Establish clear receiving water targets which, if breached, trigger a review of the applicant's operation of the Masterton WWTP and/or the relevant consent(s).

101. We have recommended consent conditions along these lines. In terms of setting restrictions on the maximum daily wastewater volume and/or nutrient loads for the discharge to the river, our approach has been to limit the average daily dry weather discharge volume based on current and predicted (2015) wastewater flows, along with the maximum instantaneous discharge rate, based on the existing peak wet weather flow (i.e., 700 L/s). We recognise that such restrictions may have implications for the viability of the proposed WWTP operation as additional discharge to land and/or storage is likely to be needed. This will need to be discussed at the hearing. In particular, we require clarification from the applicant on the rationale for and intended application of the minimum dilution ratio and maximum instantaneous discharge rate.

102. Discharge quality standards may also need to be discussed at the hearing. Some of the standards proposed by the applicant represent a significant increase in existing contaminant concentrations (Table 6) and, in most cases, these standards are able to be exceeded on three out of 12 proposed sampling occasions each year (p.211 of AEE). We recommend that the discharge standards be based on median and 95th percentile values from recent (last five years) monitoring results (Table 6), as well as proposed bacteriological improvements (nominal increases can be built in, which would allow for any changes in wastewater quality that might result from reduced I & I). Similarly, compliance with the standards should be based on an assessment of the most

recent monitoring results – we recommend rolling assessments based on the last 12 consecutive results from monthly sampling.

Table 6: Masterton WWTP effluent quality (median, geomean and 90th percentile values), based on monthly sampling by the applicant over March 2003 to September 2008 (*n*=67-144), together with the applicant's proposed geomean discharge and 90th percentile standards

Parameter	Median	Geomean	Applicant's Geomean	95th Percentile	Applicant's 90th Percentile
BOD_5 (g/m^3)	11.0	11.8	21	30.4	42
Soluble BOD_5 (g/m^3)	4.00	4.13	10	16.0	28
Suspended Solids (g/m^3)	19.0	17.7	32	61.9	91
E. coli (cfu/100 mL)	620 (all data)	-	300 (summer) 1,000 (winter)	3,310 (all data)	1,800 (95th percentile)
Ammoniacal-N (g/m^3)	6.56 (all data)	2.18 (all data)	2.0 (summer) 6.0 (winter)	13.0 (all data)	11.0 (summer) 11.0 (winter)
Nitrate-N (g/m^3)	0.84	0.42	1.0	4.26	7.5
Nitrite-N (g/m^3)	0.08	0.08	0.5	1.51	2.0
DIN (g/m^3)	7.48	2.68	-	18.8	-
Total Nitrogen (g/m^3)	11.0	10.7	13	16.3	20
DRP (g/m^3)	2.50	2.25	3.0	3.19	4.0
Total Phosphorus (g/m^3)	3.00	2.78	-	3.90	-

Suggested consent conditions

We recommend that resource consent conditions are based around the following:

General conditions

1. The discharge shall only be treated municipal wastewater from the township of Masterton, as described in the application dated 15 August 2008.

2. All sampling techniques employed in respect of the conditions of this permit shall be acceptable to the Wellington Regional Council. Unless specifically approved otherwise in writing by the Manager Environmental Regulation, Wellington Regional Council, all analytical testing undertaken in connection with this consent shall be performed by a laboratory that is IANZ registered for the analytical tests.

3. Monitoring results shall be submitted to the Wellington Regional Council in electronic and written format by no later than the last day of each calendar month incorporating the results of all monitoring undertaken in the preceding calendar month. The monthly report shall include reasons for any non-compliance and subsequent actions undertaken to remedy the non-compliance.

4. A comprehensive annual monitoring report shall be prepared summarising compliance with all resource consent conditions. This report shall include as a minimum:

(a) A summary of all monitoring undertaken and a critical analysis of the information in terms of compliance and adverse environmental effects; and

(b) A comparison of data with previously collected data in order to identify any emerging trends; and

(c) Detailed comment on any groundwater inflow and stormwater infiltration reduction measures implemented in the preceding 12 months, including their effectiveness and planned measures for the coming 12 months; and

(d) Comment on compliance with consent conditions; and

(e) Any reasons for non-compliance or difficulties in achieving compliance with any consent conditions; and

(f) Any measures that have been undertaken, or are proposed to be undertaken in the upcoming 12 months, to improve the environmental performance of the wastewater treatment and disposal system; and

(g) Copies of the laboratory analytical results monitoring results; and

(h) Any other issues considered important by the permit holder.

Interim wastewater discharge to Makoura Stream and Ruamahanga River

1. The maximum instantaneous discharge rate shall not exceed 700 L/s.

2. The average dry weather discharge volume shall not exceed 15,750 m^3/day.

3. The discharge of treated wastewater to the Makoura Stream shall be removed within six months of the granting of resource consent.

4. Treated wastewater shall only be discharged to the Ruamahanga River when the mean hourly river flow at Wardell’s Bridge gauge station is greater than 6.15 m^3/s.

5. Effluent quality shall meet the standards specified under existing resource consent WAR020074, except that the standards shall be based on a rolling-12 month geomean or median.

6. Effluent and receiving water quality monitoring shall be undertaken in accordance with the relevant conditions of existing resource consent WAR020074. The exception is that the existing upstream monitoring site on the Ruamahanga River shall be moved upstream of the land irrigation area (at or about Map Reference NZMS 260 T26:358-218) upon commencement of wastewater irrigation to land.

Long-term wastewater discharge to Ruamahanga River

1. From the commencement of full-scale irrigation of wastewater to land, or by no later than 1 July 2015, treated wastewater shall only be discharged to the Ruamahanga River:

   (a) During 1 November to 30 April inclusive, when the mean hourly river flow at Wardell’s Bridge gauge station is greater than 12.3 m^3/s and less than 300 m^3/s; or

   (b) During 1 May to 31 October inclusive, when the mean hourly river flow at Wardell’s Bridge gauge station is greater than 6.15 m^3/s and less than 300 m^3/s; and

   (c) When the instantaneous flow in the river at Wardell’s Bridge gauge station is at least **XX** times more than the instantaneous discharge rate; and

   (d) Up to a maximum instantaneous discharge rate of 700 L/s; and

   (e) Up to an average dry weather discharge volume of 16,300 m^3/day.

2. All reasonable efforts shall be undertaken to reduce the influence of groundwater inflows and stormwater infiltration on wastewater flows entering the treatment plant. This shall include preparation and implementation of a 10-year Inflows and Infiltration Reduction Plan within six months of the granting of resource consent.

3. Wastewater flows entering the Masterton Wastewater Treatment Plant and the volume of the treated wastewater discharged to the Ruamahanga River shall be measured continuously. The flow measuring devices shall be capable of continuously measuring wastewater flows of magnitudes up to and beyond the peak instantaneous flow rate, and shall be maintained to ensure that the measurement error is no more than ± 5%.

4. Within six months of the granting of resource consent, an Operations and Management Manual shall be prepared that provides for the effective and efficient operation of the wastewater treatment and disposal system. The system shall be managed and operated in accordance with this manual, which shall be updated within six months of the commissioning of the upgraded wastewater treatment system and at other times as appropriate. The manual shall be to the satisfaction of the Wellington Regional Council and include as a minimum:

   (a) A brief description of the treatment and disposal system, including a site map indicating the locations of all wastestreams entering the treatment system, treatment device(s), point of discharge, and monitoring sites; and

   (b) How the wastewater outfall will be maintained to ensure it remains intact, positioned correctly and achieves the necessary dilution required to ensure compliance with conditions 9 and 10; and

(c) Key operational matters, including daily, weekly and monthly maintenance checks; and

(d) Monitoring procedures; and

(e) Contingency plans in the event of system malfunctions or breakdowns; and

(f) The means of receiving and dealing with any complaints.

Records of maintenance, complaints, malfunctions and breakdowns shall be kept in a log and a copy of the log shall be made available to an officer of the Wellington Regional Council on request.

5. Treated wastewater discharged to the Ruamahanga River shall comply with the following criteria:

Parameter	Standard Type	Standard
pH	Acceptable range	6-9 pH units
Total BOD_5	Rolling 12-month median Rolling 12-month 95th percentile	15 g/m^3 35 g/m^3
Soluble BOD_5	Rolling 12-month median Rolling 12-month 95th percentile	6.0 g/m^3 20 g/m^3
Total Suspended Solids	Rolling 12-month median Rolling 6-month 95th percentile	20 g/m^3 70 g/m^3
Escherichia coli	Rolling 6-month median Rolling 12-month 95th percentile	300 cfu/100 mL (summer) 1,000 cfu/100 mL (winter) 1,800 cfu/100 mL
Ammoniacal Nitrogen	6-month median Maximum	Summer: 2.0 g/m^3 Winter: 6.5 g/m^3 Summer: 12 g/m^3 Winter: 12 g/m^3
Dissolved Inorganic Nitrogen	6-month median Maximum	Summer: 2.75 g/m^3 Winter: 7.0 g/m^3 Summer: 14 g/m^3 Winter: 14 g/m^3
Total Nitrogen	Rolling 12-month median Rolling 12-month 95th percentile	14 g/m^3 18 g/m^3
Dissolved Reactive Phosphorus	Rolling 12-month median Rolling 12-month 95th percentile Maximum	3.0 g/m^3 4.0 g/m^3 XX kg/day
Total Phosphorus	Rolling 12-month median Rolling 12-month 95th percentile	3.5 g/m^3 4.5 g/m^3
Total recoverable arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver and zinc	Maximum	20 times the relevant freshwater toxicity trigger values (for the 95% level of species protection) in Table 3.4.1 of the Australian and New Zealand Environmental and Conservation Council (ANZECC, 2000) Water Quality Guidelines

Compliance with the wastewater quality standards set out in the table above shall be determined from the results of any 12 consecutive sampling events undertaken in accordance with condition 7 (six consecutive sampling events for *Escherichia coli* and ammoniacal nitrogen).

6. At weekly intervals representative measurements shall be made of the treated wastewater immediately prior to discharge to the Ruamahanga River for the following:

Parameter	Measurement unit and detection limit
Temperature	0.1 °C
Dissolved oxygen	0.1 g/m^3
pH	0.1 pH
Electrical conductivity	10 uS/cm
Colour	Visual observation
Foam and Scum	Visual observation

7. At monthly intervals representative grab samples of the treated wastewater immediately prior to discharge to the Ruamahanga River shall be collected and analysed for:

Parameter	Measurement unit and detection limit
Total Carbonaceous BOD_5	1 g/m^3
Soluble BOD_5	1 g/m^3
Total suspended solids	1 g/m^3
Escherichia coli	10 cfu/100 mL
Ammoniacal nitrogen	0.1 g/m^3
Nitrite nitrogen	0.1 g/m^3
Nitrate nitrogen	0.1 g/m^3
Total kjeldahl nitrogen	0.1 g/m^3
Total nitrogen (by calculation)	0.1 g/m^3
Dissolved reactive phosphorus	0.1 g/m^3
Total phosphorus	0.1 g/m^3

8. In February or March each year, representative grab samples of the treated wastewater prior to discharge to the Ruamahanga River shall be collected and analysed for:

Parameter	Measurement unit and detection limit
Total recoverable arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver and zinc	0.001 g/m^3
Alkalinity & hardness	0.1 g/m^3
Total petroleum hydrocarbons	0.001 g/m^3
Polycyclic aromatic hydrocarbons	0.001 g/m^3
Semi-volatile organic hydrocarbons	0.001 g/m^3
Volatile organic hydrocarbons	0.001 g/m^3

9. The wastewater discharge and the outfall diffuser shall be managed and maintained to ensure that the discharge is reasonably mixed 200 m downstream of the outfall and fully mixed 800 m downstream of the outfall.

10. The treated wastewater discharge shall not, after reasonable mixing, give rise to any of the following effects in the Ruamahanga River:

    (a) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials; or

    (b) Any conspicuous change in the colour of the river; or

    (c) A reduction in horizontal visibility greater than 30% (black disc measurement) compared with upstream of the discharge; or

    (d) Any emission of objectionable odour; or

    (e) The rendering of fresh water unsuitable for consumption by farm animals; or

    (f) Any significant adverse effects on aquatic life; or

    (g) The ammoniacal nitrogen concentration to exceed 0.8 g/m^3; or

    (h) Any heterotrophic or nuisance periphyton growths.

11. (a) At monthly intervals to coincide with wastewater sampling undertaken in accordance with condition 7, representative water samples shall be collected from the Ruamahanga River at each of the following locations when treated wastewater is being discharged to the river:

    (i) Upstream of the discharge and the influence of the land irrigation area (at or about Map Reference NZMS 260 T26:358-218);

    (ii) 200 m downstream of the discharge to the river (at or about Map Reference NZMS 260 T26:354-197); and

    (iii) Approximately 1,250 m downstream of the discharge to the river at Wardell's Bridge (at or about Map Reference NZMS 260 T26:346-190).

    The samples shall be analysed for:

Parameter	Measurement unit and detection limit
Soluble BOD_5	1 g/m^3
Total organic carbon	0.5 g/m^3
Total suspended solids	1 g/m^3
Turbidity	0.05 NTU
Escherichia coli	1 cfu/100 mL
Ammoniacal nitrogen	0.01 g/m^3
Nitrite nitrogen	0.002 g/m^3
Nitrate nitrogen	0.002 g/m^3
Total kjeldahl nitrogen	0.1 g/m^3
Total nitrogen (by calculation)	0.1 g/m^3
Dissolved reactive phosphorus	0.004 g/m^3
Total phosphorus	0.004 g/m^3

(b) At monthly intervals to coincide with the monitoring undertaken in accordance with condition 11(a), the following *in-situ* measurements shall be made using field equipment calibrated in accordance with the manufacturer's instructions:

Parameter	Measurement unit and detection limit
Water temperature	0.1 ˚C
Dissolved Oxygen	0.1 g/m^3 and 1 % saturation
pH	0.1 pH
Electrical conductivity	0.1 µS/cm
Black disc (visual clarity)	0.1 m
Colour	Munsell scale

12. Once per year during the period 31 January to 30 April inclusive and following at least a two week period without a significant flood event (defined as the instantaneous river flow at Wardell's Bridge exceeding 37 m^3/s), an appropriately experienced and qualified freshwater ecologist shall carry out a quantitative ecological survey of the Ruamahanga River upstream and downstream of the point of discharge for the purpose of determining the effect of the discharge on the aquatic ecosystem of the river. The survey shall comprise as a minimum:

(a) An inspection of the riverbed within the entire mixing zone (0-200 m downstream of the discharge) for the presence of any nuisance heterotrophic or periphyton growths; and

(b) Two upstream and two downstream periphyton and macroinvertebrate sampling sites in the general locations outlined below that, where possible, share similar habitat features in terms of substrate, flow, depth and width:

(i) Upstream of the land irrigation area, at or about Map Reference NZMS 260 T26:358-218;

(ii) Approximately 1,000 m upstream of the discharge, at or about Map Reference NZMS 260 T26:364-202;

(iii) Approximately 200 m downstream of the discharge, at or about Map Reference NZMS 260 T26:354-197; and

(iv) Approximately 1,250 m downstream of the discharge at Wardell's Bridge, at or about Map Reference NZMS 260 T26:346-190.

The periphyton survey shall include:

- An assessment of the percentage cover of both filamentous algae and algal mats (to nearest 5%) at 10 points across each of four transects encompassing both riffle and run habitat and extending across the width of the river at each sampling site;

- Collection of a composite periphyton sample from riffle and run habitat (a composite of scrapings from 10 rocks, 5 from a riffle and 5 from a run) across each sampling site using method QM-1a from the Stream Periphyton Monitoring Manual (Biggs & Kilroy 2000); and
- Analysis of periphyton samples for community composition and abundance using the Biggs & Kilroy (2000) relative abundance method, ash free dry weight and chlorophyll *a*.

The macroinvertebrate survey shall follow Protocols C3 and P3 from the Ministry for the Environment's report on protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001). This shall involve:

- Collection of 5 replicate 0.1 m^2 Surber samples at random within a 20 m section of riffle habitat at each sampling site;
- Full count of the macroinvertebrate taxa within each replicate sample to the taxonomic resolution level specified for use of the Macroinvertebrate Community Index (MCI); and
- Enumeration of the results as taxa richness, MCI, QMCI, %EPT taxa and %EPT individuals.

The results of the ecological survey shall be reported in writing to Manager Environmental Regulation, Wellington Regional Council by 31 May each year.

13. Appropriate signage shall be erected and maintained on the true left and true right river banks in the immediate vicinity of the wastewater outfall and Wardell's Bridge to the satisfaction of the Manager Environmental Regulation, Wellington Regional Council. The signage shall:

(a) Provide clear identification of the location and nature of the discharge; and

(b) State the width and downstream distance of the mixing zone authorised by this permit; and

(c) Provide a 24-hour contact phone number; and

(d) Be visible to the public visiting the area and legible from a distance of 50 metres without unnecessarily detracting from the visual amenity of the area.

Written confirmation of the signage placement accompanied by photographs of the signage shall be provided to the Manager Environmental Regulation, Wellington Regional Council within three months after installation of the diffuser outfall.

Note: The permit holder shall consult with Wairarapa Public Health regarding the wording of the signs prior to be submitting them for approval to Wellington Regional Council.

Wastewater discharges to land and groundwater via irrigation and pond seepage

From a surface water quality perspective (i.e., in addition to the recommended conditions in Hamish Lowe's technical report), we recommend:

1. The combined discharges of wastewater to land via irrigation and groundwater via seepage through the base of the oxidation ponds shall not cause:

   (a) The dissolved reactive phosphorus concentration in the Ruamahanga River as measured at Wardell's Bridge to exceed 0.012 g/m^3 or to be more than 20% greater than the upstream concentration; or

   (b) The dissolved inorganic nitrogen concentration in the Ruamahanga River as measured at Wardell's Bridge to exceed 0.580 g/m^3 or to be more than 20% greater than the upstream concentration; or

   (c) The percentage cover of filamentous algae on the riverbed to exceed 30%; or

   (d) The percentage cover of algal mats on the riverbed to exceed 60%.

   Compliance with the receiving water standards set out above shall be determined on a monthly basis from the results of upstream and downstream sampling undertaken in accordance with conditions 4 and 5. The upstream sampling results will be taken into account when assessing compliance with this condition.

2. Flow in the Makoura Stream upstream and downstream of the land irrigation area shall be measured continuously. The flow measuring devices shall be maintained to ensure that the measurement error is no more than ± 10%.

3. (a) At regular monthly intervals, representative water samples shall be collected from the Makoura Stream at each of the following locations:

   (i) Upstream of the land irrigation area, at or about Map Reference NZMS 260 T26:353-217;

   (ii) Within the land irrigation area at or about Map Reference NZMS 260 T26:354-210;

   (iii) Within the land irrigation area at or about Map Reference NZMS 260 T26:352-202; and

   (iv) Downstream of the land irrigation area prior to discharge to the Ruamahanga River (at or about Map Reference NZMS 260 T26:353-197).

The samples shall be analysed for:

Parameter	Measurement unit and detection limit
Escherichia coli	1 cfu/100 mL
Total organic carbon	0.5 g/m^3
Ammoniacal nitrogen	0.01 g/m^3
Nitrite nitrogen	0.002 g/m^3
Nitrate nitrogen	0.002 g/m^3
Total nitrogen (at site iii only)	0.01 g/m^3
Dissolved reactive phosphorus	0.004 g/m^3
Total phosphorus (at site iii only)	0.004 g/m^3

(b) At monthly intervals to coincide with the monitoring undertaken in accordance with condition 3(a), the following *in-situ* measurements shall be made using a field meter calibrated in accordance with the manufacturer's instructions:

Parameter	Measurement unit and detection limit
Water temperature	0.1 ˚C
Dissolved Oxygen	0.1 g/m^3 and 1 % saturation
pH	0.1 pH
Electrical conductivity	0.1 µS/cm

4. At monthly intervals during November to April inclusive when there is no direct discharge of wastewater to the Ruamahanga River, representative water samples shall be collected from the river at each of the following locations:

   (a) Upstream of the land irrigation area and diffuser outfall, at or about Map Reference NZMS 260 T26:358-218;

   (b) Approximately 1000 m upstream of the diffuser outfall, at or about Map Reference NZMS 260 T26:364-202;

   (c) Approximately 200 m downstream of the diffuser outfall, at or about Map Reference NZMS 260 T26:354-197; and

   (d) Approximately 1,250 m downstream of the diffuser outfall at Wardell's Bridge, at or about Map Reference NZMS 260 T26:346-190.

The samples shall be analysed for:

Parameter	Measurement unit and detection limit
Ammoniacal nitrogen	0.01 g/m^3
Nitrite nitrogen	0.002 g/m^3
Nitrate nitrogen	0.002 g/m^3
Dissolved reactive phosphorus	0.004 g/m^3

5. To coincide with the monthly water sampling during November to April inclusive under condition 4, the percentage cover of both filamentous algae and algal mats (to the nearest 5%) shall be assessed at 10 points across each of four transects encompassing both riffle and run habitat and extending across the width of the river at each sampling site listed in condition 4. The average value for each site shall be used to determine compliance with the periphyton cover guidelines specified in condition 1.

6. The Manager Environmental Regulation, Wellington Regional Council, shall be notified within 24 hours of any monitoring under condition 5 if the average cover of cyanobacterial mats at the Wardell's Bridge sampling site exceeds 20%.

7. Wellington Regional Council shall require a review of the operation of the Masterton WWTP or initiate a review of the conditions of consent if receiving water standards (c) or (d) under condition 1 above are exceeded on more than one occasion in any year and the exceedances can be attributed with reasonable certainty to discharges from the Masterton WWTP.

Stormwater discharges and runoff from the land irrigation area

We recommend routine monitoring of water quality in the Makoura Stream and the Ruamahanga River undertaken in accordance with the suggested receiving water monitoring conditions for the wastewater discharges to land and water.

G About the authors – qualifications and experience

Juliet Rosalind Milne is employed as Team Leader Environmental Science within the Environmental Monitoring and Investigations department of the Wellington Regional Council. Juliet has held this position since March 2007. Prior to that she was in the role of Surface Water Quality Scientist at Wellington Regional Council. She holds a Bachelor of Resource Studies in Ecology and Environmental Monitoring and a Master of Applied Science in Resource Management (first class honours) both from Lincoln University, and has over ten years work experience in environmental management, encompassing both scientific (surface water quality and ecology) and regulatory roles (resource consents and compliance) across three regional councils. Juliet's regulatory roles have primarily focused on discharges, including municipal and industrial wastewater discharges to land and water.

Laura Fleur Watts is employed as a Senior Environmental Scientist within the Environmental Monitoring and Investigations department of the Wellington Regional Council. She has held that position since September 2008. From July 2003 to September 2008 she was in the same team in the role of Environmental Scientist – Hydrology. She holds a Bachelor of Science with First Class Honours in Physical Geography and a Master of Science in Physical Geography (with distinction) from Victoria University. Laura has been employed by Greater Wellington for more than eight years, during which time she has also undertaken regulatory (resource consents and compliance) and technician (water quality and hydrology) roles. She has considerable experience in low flow analysis, instream habitat assessment and investigation of linkages between hydrology and water quality, particularly in the Ruamahanga catchment.

Summer Rata Warr is employed as an Environmental Scientist within the Environmental Monitoring and Investigations Department of Greater Wellington Regional Council. She holds a Bachelor of Science and a Master of Science in Aquatic Ecology (first class honours) from Waikato University. Summer has eight years experience as an environmental scientist, working in both regulatory agencies and consultancy. Her responsibilities in her current position are to investigate and report on surface water quality and ecology in the Wellington region. Her previous roles include working as an environmental consultant for the Water Research Centre in the United Kingdom and as a freshwater ecologist for the Scottish Environment Protection Agency. Summer has significant experience in assessing the effects of discharges of contaminants on water quality and aquatic ecosystems.

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I Acknowledgements

Monitoring data from NIWA's National Rivers Water Quality Network were used in places in this report.