Masterton Wastewater Treatment Plant and Disposal System Long-Term Upgrade

Notice of Requirement
Resource Consent Applications
Assessment of Effects on the Environment

SUMMARY REPORT

Masterton District Council

May 2007

Table of Contents

List of Figures

List of Tables

1 Introduction

1.1 Purpose and Structure of Report

The purpose of this report is to provide a non-technical summary of the information contained within the main AEE (Assessment of Effects) report that supports the Notice of Requirement and resource consent applications for the proposed upgrade of the Masterton Wastewater Treatment Plant (MWTP). Readers should refer to the main report for more detail where required (and to the background reports for additional technical detail).

This summary is structured as follows:

- A description of the existing situation and the reasons for the proposed upgrade
- An outline of the proposed upgrade including the quality of effluent discharge
- A summary of the assessment of effects on the environment
- A review of the alternatives methods and schemes that were investigated leading to the selection of the current proposed upgrade
- An overview of the consultation process
- The mitigation measures proposed to address any potential effects on the environment.

1.2 Background

Masterton District Council (MDC) has a responsibility under the Local Government Act 2002 and the Health Act 1956 to provide a municipal wastewater treatment plant for Masterton.

The Homebush site has been the location of a municipal wastewater facility since 1900 when the first municipal septic tanks were constructed. The present Masterton Wastewater Treatment Plant (MWTP) includes an oxidation pond system originally comprising two primary ponds and one secondary pond, and was constructed and commissioned in 1970-71. The effluent (treated wastewater) is currently discharged via the Makoura Stream into the Ruamahanga River.

Since then the MWTP has had a number of upgrades, including the latest in 2003, which involved construction of an additional treatment pond (called a maturation cell) that further reduced the bacterial levels in the effluent (treated wastewater).

The location and key components of the existing MWTP is shown in Figure 1 and Figure 2 below.

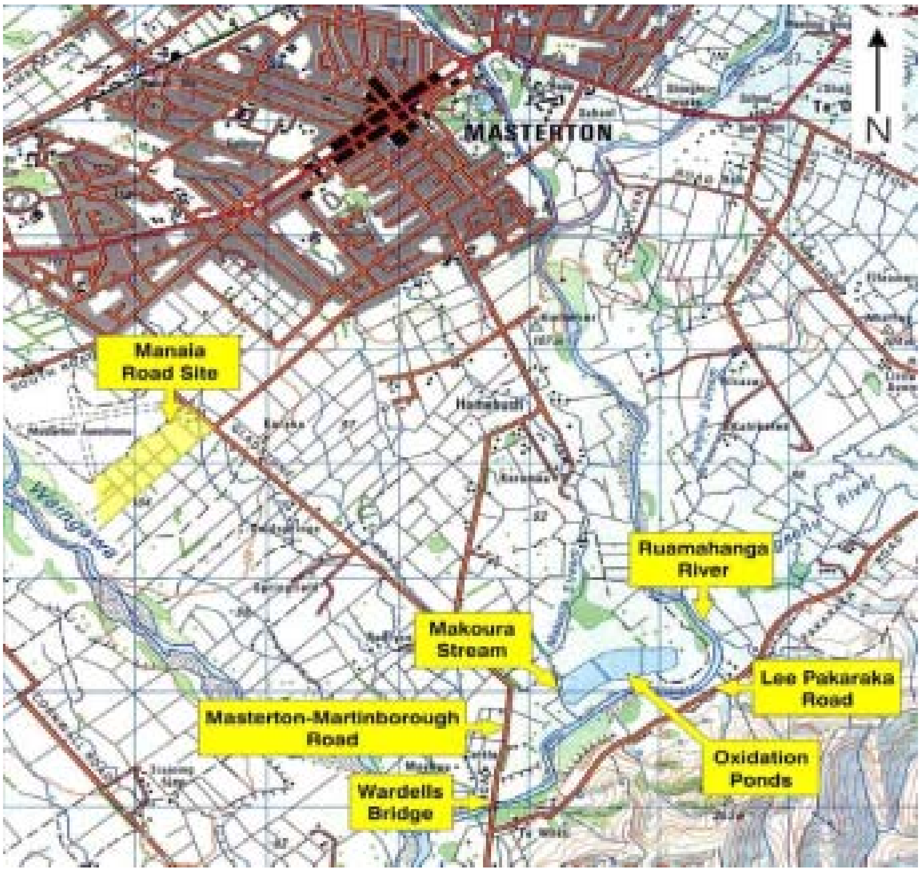

Figure 1 Location of Homebush Oxidation Ponds

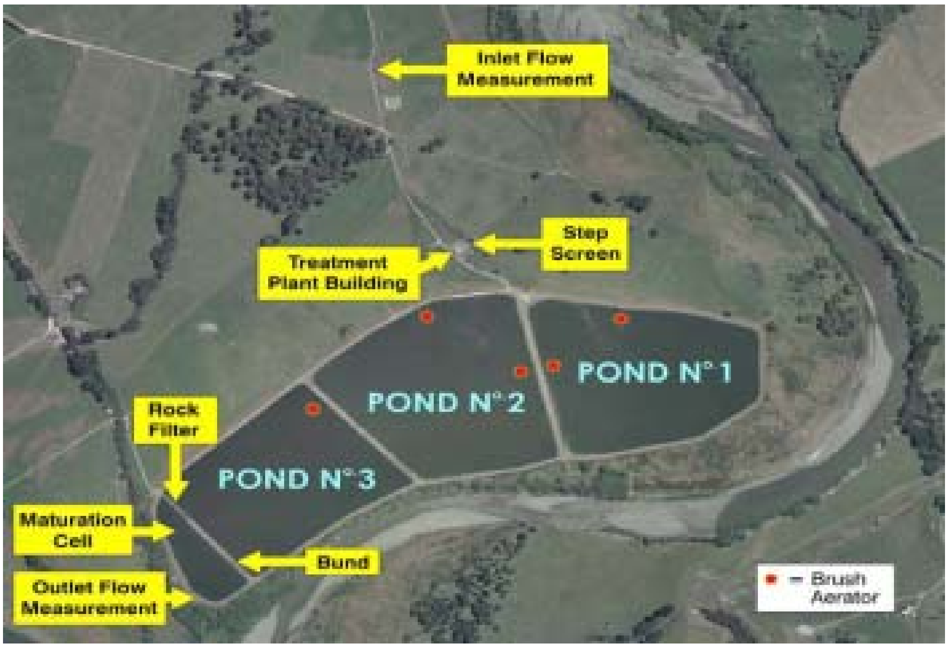

Figure 2 Key Components of Existing Treatment Plant

2 Existing Situation

2.1 Existing Wastewater Treatment Plant

The existing MWTP at Homebush is situated on approximately 42ha of flat land located in the rural area 5 km southeast of Masterton Town. The total area of the site for the proposed upgraded treatment plant and irrigation area that is owned by MDC is 131 ha. It is located off the Martinborough-Masterton Road adjacent to the Ruamahanga River, approximately 1 km upstream of Wardells Bridge (refer Figure 1).

On average, the Masterton MWTP currently receives 15,500m^3/day, an inflow that is noticeably higher than the 5000m^3/day wastewater flow that could normally be expected from a town with a population of almost 18000 people. The high influent flows are due to groundwater infiltration and stormwater inflows into the sewerage reticulation system. Accordingly, during wet weather, the influent flows can be very high because of this infiltration/inflow.

The raw sewage is collected through a reticulation system of 127 km of pipes, and delivered to the MWTP where it first passes through a screen to remove non-organic matter. The screenings are collected in a sealed trailer and regularly disposed at the landfill. Following screening, the flow is evenly split into each of the two primary ponds (Ponds Nº1 and Nº2). The two primary ponds feed into the secondary pond (Pond Nº3). The wastewater passes from Pond Nº3 through a rock filter into a maturation cell. Figure 2 above identifies the location of key components of the existing MWTP.

There are two brush aerators in each of the primary ponds and one aerator in the secondary pond to enhance the circular flow within the ponds. Effluent from the maturation cell is discharged to the Makoura Stream over a rectangular weir, which controls the discharge volume (up to a maximum of 35,000m^3/day).

The ponds were constructed over a filled alluvial meander of the Ruamahanga River and have no “engineered lining”, and as a consequence, the bases of the ponds leak. However, due to the inherent sealing characteristic of wastewater sludge, the rate of leakage is not as high as might be expected.

2.1.1 Effects of Existing Discharge

The effluent from the MWTP is currently discharged to the Makoura Stream, which is a tributary of the Ruamahanga River. The confluence of the Ruamahanga River and Makoura Stream is approximately 200m upstream of Wardells Bridge, at which point the effluent is not fully mixed with the river flow. There are therefore more effects from the discharge at Wardells Bridge compared with the situation further downstream once the effluent is fully mixed with the river flow.

Annual Monitoring by MDC

The ‘Interim Consent’ conditions imposed in 2003 required the compiling and supply of an annual monitoring report to GW. These reports have confirmed that the discharge complies with the requirements of the relevant consents. GW has also confirmed this in its annual compliance reports.

The effects of the existing discharge on the water quality of the Makoura Stream and the Ruamahanga River are reported in the annual monitoring reports to the Regional Council.

Key conclusions from the 2005/2006 Annual Monitoring Report regarding the impact of the effluent discharge on the Makoura Stream and Ruamahanga River are summarised below:

Makoura Stream

- The discharge causes a conspicuous change in water clarity at the downstream monitoring point
- The effluent discharge appears to cause significant increases in the concentrations of ammonia-nitrogen, and the ANZECC (2000) toxicity guideline for aquatic ecosystems is often exceeded downstream of the discharge
- Water quality both upstream and downstream of the discharge meets the ANZECC (2000) guideline for nutrients in livestock drinking water
- The stream complies with the ANZECC (2000) nitrate-nitrogen guideline for the aquatic ecosystems both upstream and downstream of the discharge
- The discharge has a negligible effect on pH, *E.coli*, nitrate-nitrogen and temperature
- Dissolved oxygen was typically lower than 80% saturation downstream of the discharge approximately half of the time

Ruamahanga River

- The discharge causes a conspicuous change in water clarity in the mixing zone (as measured at 'Rua2'[1] just downstream of Wardells Bridge). However, further downstream at 'Rua4' (measured just upstream of the Waingawa confluence), the water clarity is similar to that upstream of the discharge.
- There is an increase in ammonia-nitrogen, nitrite-nitrogen and nitrate-nitrogen downstream of the WWTP discharge. However, the river complies with the ANZECC (2000) aquatic ecosystem toxicity guidelines for all the parameters on all monitoring occasions.
- The discharge has a negligible effect on temperature, pH and dissolved oxygen.
- The Ruamahanga River has been sampled upstream and downstream of the discharge for *E.coli* concentrations on more than 130 occasions since December 1999. The MfE/MoH (2003) microbiological bathing water quality guidelines 'alert' level (130 cfu/100 mL) was exceeded upstream (Rua 1) on 20 occasions and downstream of the MWTP (Rua 2) on 34 occasions. The median downstream increase in *E.coli* concentration was 2-fold for these occasions. The upstream contamination is attributable to rainfall runoff with 95% of the 'alert' samples occurring when the average river flow is greater than 2.9 times median flow
- The downstream periphyton levels were below nuisance levels in the 2005 and 2006 annual samplings.
- Pond Leakage does not appear to have a significant effect on surface water quality, but may be making a minor contribution to *E.coli* levels in the Ruamahanga River

Table 1 below shows the effect of the existing discharge on the Ruamahanga River. In summary, the existing discharge, after reasonable mixing, does not have significant adverse effects on the receiving water quality in the Ruamahanga River, and generally complies with the relevant guidelines in the Wellington Regional Freshwater Plan.

[1] Rua1, Rua2, Rua3 and Rua4 are the river monitoring sites.

Table 1 Water Quality of Ruamahanga River Upstream and Downstream of Makoura Stream Confluence

Parameter	Rua 1 (Upstream of Makoura Stream) Median	Rua 2 (Downstream from Makoura Stream) Median	Rua 4 (upstream from Waingawa River) Median	Rua 1 to Rua 2 Increase
PH	7.31	7.14	7.26	-2%
Conductivity (›S/cm)	124	113	110	-9%
Dissolved Oxygen (g/m^3)	9.5	10.3	11.1	9%
Dissolved Oxygen % saturation (%)	96	92	98	-4%
Black Disc (m)	1.4	1.17	1.15	-16%
Colour - Hue (Munsell points)	37.5	35	37.5	2.5 points change
E.coli (cfu/100mL)	56	130	50	2.5 fold
Ammonia-N (g/m^3)	0.02	0.17	0.02	9 fold
Nitrate-N (g/m^3)	0.549	0.95	0.693	73%
Nitrite-N (g/m^3)	0.003	0.019	0.004	6 fold
Total Kjeldahl Nitrogen (g/m^3)	0.2	0.45	0.15	2 fold
Total Nitrogen (g/m^3)	0.7	1.45	0.9	2 fold
Total Phosphorus (g/m^3)	0.012	0.121	0.025	10 fold
Dissolved Reactive Phosphorus (g/m^3)	0.010	0.099	0.012	10 fold
Turbidity (NTU)	0.72	5.19	3.56	7 fold
Total Organic Carbon (g/m^3)	2.65	3.8	3.65	38%

(1) Data from Beca (2005) for period 4 May 2004–16 May 2005. Sites upstream (Rua 1), downstream of Makoura Stream Confluence at Wardells Bridge (Rua 2), and above Waingawa River Confluence (Rua 4) approximately 0.5 km downstream and fully mixed. Rua2 is within the mixing area of the Makoura Stream (includes the WWTP discharge).

In summary, although the adverse effects of the current discharge are minor, there are nevertheless effects which can be addressed and to which this upgrade is directed. In particular:

4 **Significant Contribution to Degraded Water Quality of the Makoura Stream**

Although already in a degraded state before reaching the discharge point, the MWTP makes a significant contribution to the poor condition of the Makoura Stream, with the effluent appearing to cause significant increases in the concentrations of ammonia-nitrogen, with the ANZECC (2000) toxicity guideline for aquatic ecosystems often being exceeded downstream of the discharge

4 **Minor Contribution to Health Risk**

The discharge to the river increases the levels of pathogens downstream and contributes, albeit at a minor level, to an increased health risk, particularly at times of low flow when the river is used for primary contact recreation and when the upstream concentrations of pathogens are at their lowest. This increase in health risk is highest at Wardells bridge where the discharge is not fully mixed and decreases downstream to become very low at "The Cliffs". At higher flows, upstream non-point source contamination poses the greatest risk to health.

4 **Build-up of Undesirable Biological Growth in Waterways**

The level of nutrients in the discharge in combination with nutrient inputs from upstream can contribute to a build-up of algal growth (periphyton) on the bed of the Ruamahanga River during periods of sustained low flow in the summer. Although this build up is not at nuisance levels, it does have some minor impacts on the recreational and aesthetic values of this section of the River.

- **Effect of organic enrichment on some Biological Communities**

  While the River ecosystem is generally in a healthy condition in of terms of the presence and abundance of aquatic biological species, the abundance of some community groups indicates the organic enrichment of the River downstream of the MWTP.

- **Recreational Amenity**

  The existing discharge does have some adverse impacts on the recreational values of the river, especially for that section of the Ruamahanga River downstream of the discharge until full mixing is achieved, particularly during periods of low flows (usually in summer). The impacts derive from the slightly elevated health risk, and the aesthetic considerations discussed below. These impacts are most apparent at times when the river is most valued for recreational use (at times of lower flows in warm summer periods).

- **Aesthetic Amenity**

  During summer low river flows in summer, the algae in the treatment process result in a discernible bright green plume from the discharge while mixing with the river water. There is also a reduction in clarity for some distance downstream of the discharge. The visual effect of the discharge plume before it becomes fully mixed has a negative impact on the aesthetic and amenity values of the Ruamahanga. The effect of the added nutrients on the creation of periphyton (algae) on the river bed also has a minor effect on the aesthetic value of the river, particularly at times of sustained low flow.

- **Tangata Whenua Values : Effects of the Discharge on the mauri of the River**

  The Ruamahanga River has traditional significance to Ngati Kahungunu and Rangitaane and is regarded as a taonga (treasure). While the existing discharge does not appear to be degrading the state of mahinga kai, the discharge of effluent directly into the river affects the mauri of the river. The tangata whenua, as the kaitiaki of the Ruamahanga, would prefer that there be no discharge to water except via land.

Conclusion

It is clear that the existing discharge is a major contributor to the degraded water quality in the Makoura Stream into which it discharges. However, the effects of the discharge on the Ruamahanga River are generally minor and are principally the result of incomplete mixing in the reach between the confluence with the Makoura Stream and Rua2 (the point for compliance monitoring). The effects of concern are primarily with respect to water clarity and *E coli* levels, particularly at summer low flows when the river is used for contact recreation. Minor effects on periphyton growths (though not reaching nuisance levels) have also been recorded. The leakage from the ponds is not having any more than minor effect on surface or groundwater quality.

2.2 Reasons for the Proposed Upgrade

The existing consent for discharge to the Makoura stream was granted on an interim basis in 2003 and expires in 2010. It was applied for and granted on that basis to allow MDC time to carry out a full review of upgrade options, including options for alternative treatment, disposal and plant location.

There are community expectations that the discharge will be upgraded, significantly reduced or removed from the river. The current applications for long-term consent will allow the community, via Greater Wellington Regional Council (GWRC) to assess the merits (sustainability) of the proposal. The upgrade will significantly reduce discharge to the river and will eliminate direct discharge at times of lower river flow, thereby minimising adverse effects. The upgrade will also meet the objective of discharging to land so far as is reasonably practicable.

In 2004, the MDC and the Consultation Task Group (CTG) developed the objectives for the project set out below - the Proposal will achieve these objectives.

Project Objectives

Overall Objective

- *To provide a sustainable long-term solution to the treatment and disposal of Masterton's wastewater*

Social and Cultural Objectives

- *To construct and operate a wastewater treatment plant that is robust and reliable*
- *To recognise Maori cultural values associated with the Ruamahanga River and other water bodies*
- *To recognise the use and amenity value of the Ruamahanga River for recreation*
- *That the treated wastewater, after mixing, meets nationally recognised standards for bacteria to minimise the risk to public health in relation in recreation in and food gathering from, the Ruamahanga River*
- *To have input and support from the Masterton and affected communities (including tangata whenua) for the selected upgrade option*

Environmental Objectives

- *That the wastewater is treated to a standard, particularly in terms of suspended solids, colour, clarity and nutrients that protects surface water for current and future users and recognises the objectives of the Regional Freshwater Plan for the Wellington Region*
- *That the wastewater is treated to a standard, particularly in terms of suspended solids, colour, clarity and nutrients that protect groundwater for current and future users*
- *That the wastewater upgrade project promotes sustainability, particularly in resource consumption (for example non-renewable chemical use, energy use and gas emission)*
- *That the wastewater treatment plant upgrade does not result in any significant odour beyond the site boundary*
- *To reduce over time the inflow and infiltration of stormwater and groundwater into the reticulation system and/or manage the peak flow in the treatment process*

Economic Objectives

- *That the proposed upgrade is cost effective and affordable for the Masterton Community*

2.3 Consents and Designations Sought

Resource consents are being sought from Greater Wellington Regional Council (GW) and a designation is proposed to be introduced into the operative Masterton and Proposed Combined Wairarapa District Plans.

MDC Designation

MDC has lodged a Notice of Requirement (NoR) to:

- Modify the existing designation (42 ha) for the MWTP so that it covers all land use activities associated with the operation of the upgraded MWTP
- Designate 91 ha of land owned by the Council adjacent to the existing MWTP designation for the irrigation of treated wastewater to land
- Designate a further 107 ha of land (which is about to be purchased by the Council) for the future irrigation of treated wastewater to land

The NoR for the designations covers the following land use activities associated with the upgrade works:

- The construction and operation of the upgraded MWTP
- The construction and operation of a land irrigation scheme to dispose of treated wastewater (effluent)
- Pump stations for the irrigation scheme

4 The construction of the outfall diffuser
4 Pond desludging (Pond 1)
4 Sludge storage and dewatering area
4 Erosion protection measures, comprising in-river works
4 Raising the existing stop bank immediately upstream of the oxidation ponds
4 General ongoing operation, management and maintenance of the MWTP
4 All other activities ancillary to the operation and maintenance of the MWTP

The extended designation will be limited to land owned MDC, with the exception of that part of the outfall diffuser within the bed of the Ruamahanga River.

Resource Consents

The resource consents being sought are as follows:

1. Water Permit to dam or divert water (Ruamahanga River during floods) by upgrading a stopbank, pursuant to section 14
2. Land Use Consent (regional) to place and use a structure (diffuser) in the river bed, and any associated disturbance, pursuant to s 13
3. Discharge Permit to discharge contaminants to water pursuant to section 15 from the base of the oxidation ponds to ground water or surface water
4. Discharge Permit to discharge contaminants to land (irrigation of effluent, and leakage from the base of the oxidation ponds), pursuant to section 15
5. Discharge Permit to discharge contaminants to air (from oxidation ponds and irrigation area), pursuant to section 15

The regional consents are sought for a term of 35 years to reflect the considerable investment involved in this upgrade and low level of environmental effects anticipated.

3 Proposed Upgrade

3.1 Summary Description of the Proposed Upgrade

The methods and technology proposed are well proven. The oxidation pond treatment (with maturation cells), will yield a high quality of effluent. The scheme is innovative in that it combines land disposal at times when that is most beneficial, with a river discharge at times when that will have the least impact. Land disposal will be maximised so that discharge to the river and associated effects on its mauri and amenity values can be minimised.

The layout of the upgraded treatment and disposal scheme is shown in Figure 3 on the following page.

The upgrade is described in detail in section 6 of the AEE. The upgrade comprises the following key elements:

- The construction and operation of two additional maturation cells in series in the secondary oxidation pond (currently there are two)
- A pump station to deliver effluent to the irrigation area
- Construction of a land disposal/irrigation scheme at Homebush to irrigate effluent to land whenever soil conditions allow (the majority of effluent will be irrigated in summer)
- Desludging of Pond 1 (Pond 2 to be desludged within ten years as part of the Council's Asset Management programme)
- New outfall diffuser located within the Ruamahanga River erosion protection wall
- Establishment of a sludge dewatering area (dewatered sludge to be used as landfill cover)
- Raising the level of the Pond 1 and upstream stopbank to provide protection for a 100-year return period flood
- Erosion protection works on the right bank adjacent to Ponds 2 and 3 and on the left bank at the bend upstream of the ponds and immediately downstream
- Change in discharge regime, from a continuous effluent discharge to the river, to a regime that has land disposal as the first preference.

A key component of the proposed upgrade is the new discharge regime. It involves a balance between the influent (incoming volume of raw wastewater), storage in the ponds (calculated maximum of 275,000 m^3), volumes of effluent irrigated to land and the residual volumes that have to be discharged to the river. To identify the most effective discharge regime, a water balance model was constructed to determine the volumes irrigated to land, stored in the ponds and discharged to the river. From this model, the operating philosophy for the proposed disposal of treated wastewater was established, based on the following criteria:

- Irrigation of treated wastewater will occur whenever soil conditions allow (summer and winter)
- In summer (1 November to 30 April) there will be no discharge to the river when the flow in the river is less than 12.3 m^3/s (median river flow)
- In winter (1 May to 31 October) there will be no discharge to the river when the flow in the river is less than 6.1 m^3/s (half median river flow)
- Whenever there is a discharge to the river, the river flow will be at least 30 times greater than the discharge rate of effluent (i.e., a minimum dilution of 30X)
- If irrigation and disposal to the river are prevented, or are limited to less than the inflows, then the expanded pond system will be used for storage.

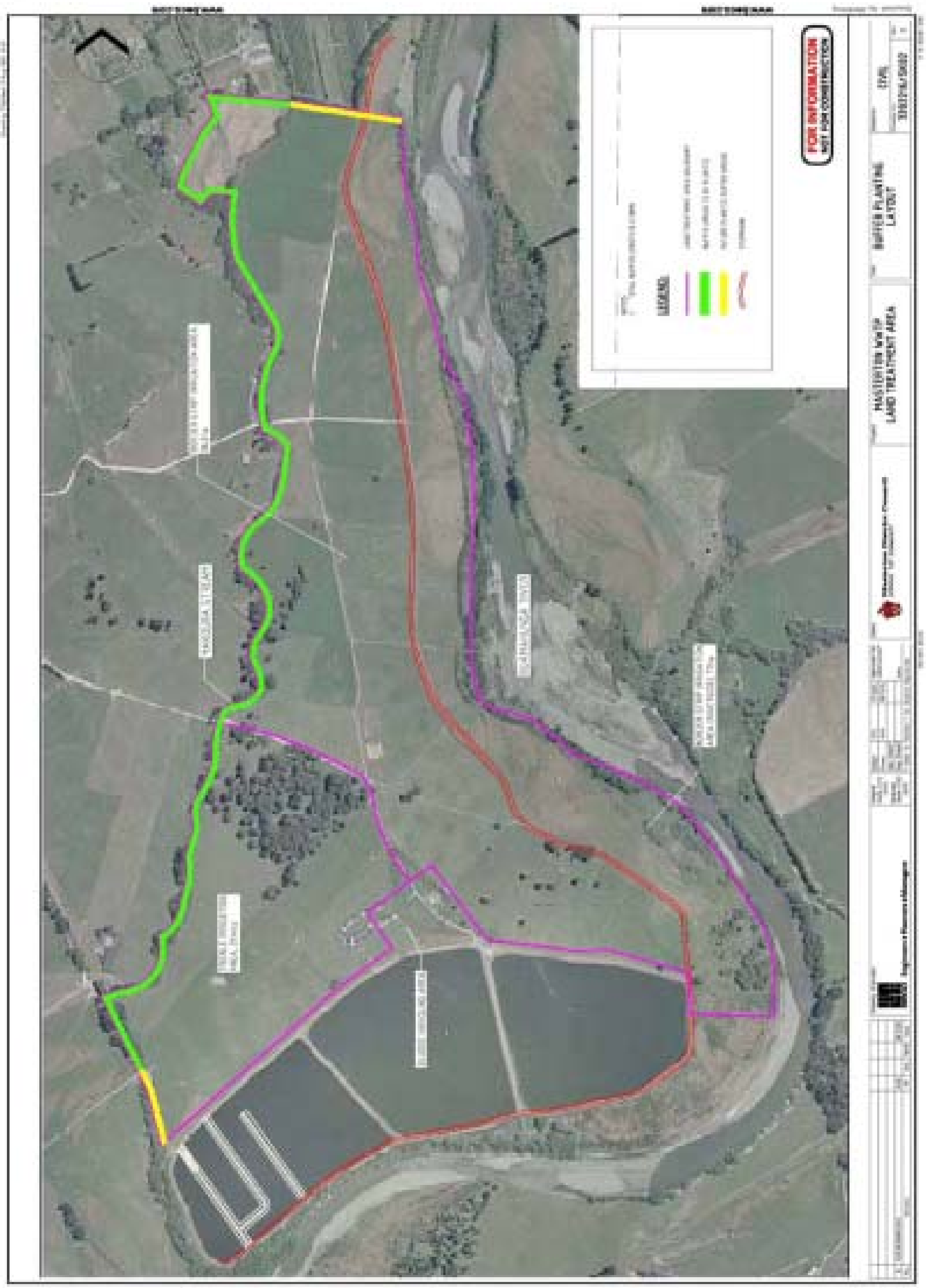

Figure 3 Layout of the Proposed Upgrade

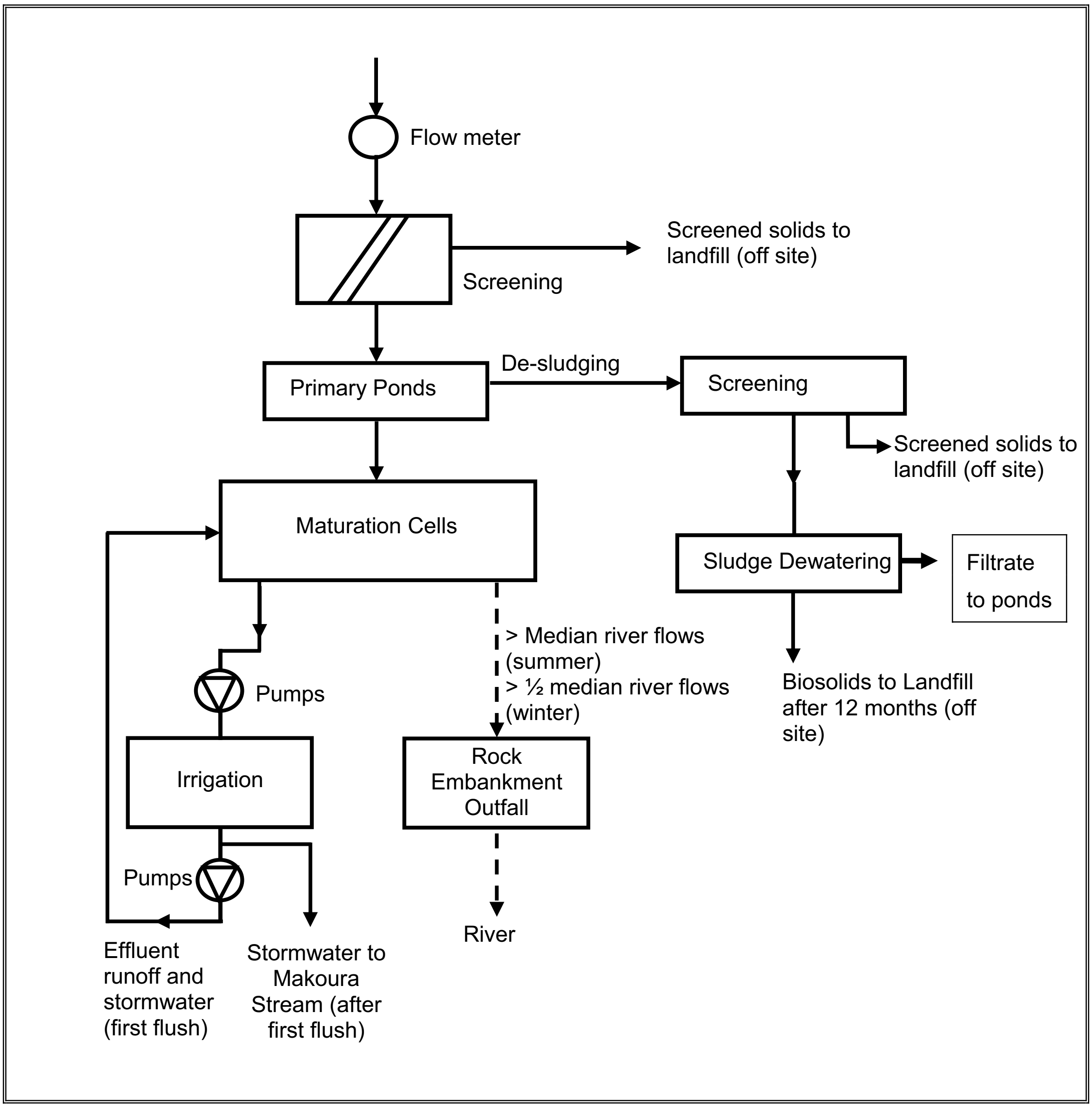

Figure 4 Proposed Masterton WWTP Upgrade Schematic

3.2 Physical Improvements

The proposed layout of the upgraded MWTP is shown in Figure 3, while the proposed modifications to the treatment and disposal scheme are detailed schematically in Figure 4 above.

3.2.1 Reasons for Continuing with Oxidation Ponds as Primary Treatment Mechanism

Oxidation ponds are a well-proven method for the treatment of domestic wastewater and are used extensively in New Zealand and overseas. There are approximately 200 oxidation pond systems in New Zealand.

Oxidation ponds are a robust, natural wastewater treatment process. They can buffer peak flows and loads and provide storage for higher inflows during wet weather. They provide excellent reductions of waterborne pathogenic (disease-causing) bacteria due to the long retention time and natural disinfection provided by sunlight.

The proposed maturation cells will provide further significant reductions in bacteriological concentrations.

In summary, oxidation ponds are an appropriate treatment technology for Masterton because:

- They already exist and are performing well and meeting the requirements of the existing resource consents
- They require a low level of operator supervision
- They have low operating costs and energy requirements, and they have the ability to effectively treat Masterton's wastewater influent
- The treatment processes in oxidation ponds are not adversely affected by peak flows, and oxidation ponds also provide good hydraulic buffering of stormwater inflows
- A pond system can also be upgraded, or added to, for improved performance if required in the future, and.
- There is a significant level of investment by Council (and hence the community) in the existing ponds.

3.2.2 The Physical Improvements to the Ponds

Maturation Cells

The upgrade involves retaining the existing ponds and dividing the secondary pond with two additional maturation cells-in-series. The use of multiple cells-in-series reduces the potential for hydraulic short-circuiting to occur, thereby increasing the overall treatment efficiency of the pond system. It will provide significant reduction in bacteria levels in the wastewater.

Storage In Ponds

When irrigation and/or river discharge is not possible, wastewater will be stored in the ponds. The ponds have a live storage capacity of 363,000 m^3. This is more than adequate to accommodate the predicted maximum storage volume of 275,000 m^3 that is required for the proposed upgrade.

Pond Leakage/Volumes/Lining

The existing ponds do not have an "engineered" lining and treated wastewater 'leaks' through their bases into the ground and to the groundwater below them. The pathway from there is, via groundwater, to the Ruamahanga River.

The amount of leakage has been assessed based on field trials. The adopted leakage rates are:

- At normal pond operating levels - average of 800m^3/d.
- At elevated pond levels[2] - average of 1200 m^3/d
- At median river flow, pond leakage for elevated pond levels is approximately 0.1% of the river flow. At half median river flow, pond leakage is approximately 0.2% of the river flow. Accordingly, the pond discharge on its own is diluted to a very significant degree by river flows.

It is not proposed to line the ponds as part of this upgrade. This is because the leakage at normal operating levels in the ponds is:

- Not significantly greater than leakage from ponds with engineered linings;
- Is significantly diluted by river flows, and
- Is not causing (and will not cause) any significant adverse effect on the receiving environment.

Furthermore, lining the ponds would be prohibitively expensive to undertake and would be practically very difficult.

[2] As the scheme involves storing effluent during times of low river flow the water levels in the ponds will increase (potentially by 0.5 m-0.7 m to a top level of approximately RL88).

Pond Desludging

Pond desludging, while an infrequent event (every 20 to 30 years depending on the loading), is a normal part of the maintenance requirements. The upgrade includes desludging Pond 1 prior to the operation of the upgraded scheme. The sludge from the pond will be dredged while the ponds are full, and then dewatered.

The dredged sludge will be screened prior to dewatering to remove litter and other debris that has accumulated in the sludge (for approximately the first 20 years the ponds were operated without an inlet screen).

One option for dewatering the sludge is to use geotubes. Geotubes consist of bags made from a geotextile material that allows the liquid in the sludge to pass through but prevent rainwater from entering. It is estimated that 13 bags will be needed, which will require a total land area of approx 1 ha. Other equivalent technologies will be considered at the time that the desludging proceeds.

3.2.3 Land Irrigation (Treatment and Disposal)

The key part of the upgrade is the shift from a full time discharge to the river to a system of part time discharge to land (land disposal to be maximised and river disposal to be minimised). The proposed **initial** MWTP irrigation area (for which resource consent is currently being sought) occupies a gross area of approximately 91 ha of land. It is bounded on the southern and eastern sides by the Ruamahanga River, on the western side by the Makoura Stream and on the northern boundary by an apple and pear orchard and farmland.

Generally, there are two different soil types at the site (i.e. sandy and silty loam soils that are free draining and silty clay soils that are poorly drained). The effluent will be applied as border strip irrigation over the whole site.

The initial net area available for irrigation is approximately 75 ha. The intention of the scheme is to maximise the amount of land used for irrigation.

The proposed land use for the border strip area is a cut and carry system; i.e. baleage or silage. The proposed quality of the effluent from the upgraded oxidation ponds would exclude the silage or baleage being fed to dairy cows.

The Council has recently purchased an additional 107 ha of land adjoining the MWTP. This area is also being designated for future land disposal – the Council will apply for discharge permits for this land at a later date once investigations are complete. This additional land will allow for a further significant increase in land disposal volumes, and will result in a further decrease in the volume of effluent disposed of to the river and consequent further mitigation of residual adverse effects (which will be minimal in any event).

3.2.4 Influent (Raw Sewage)

Domestic wastewater flows and loads to the Masterton MWTP are expected to remain unchanged over the next 20 years. This is due to the projected static population. Trade waste flows are expected to rise slightly in relation to the projected increase in GDP. Total flows and loads are made up of the contribution of domestic and trade waste loads and are shown in Table 2 below.

Table 2 Current and Projected MWTP Flows and Loads, 2005 to 2015

	Current (2005)				**Future (2015)**			
	Av. flow (m^3/d)	**Peak Flow (litres/sec)**	**BOD (kg/d)**	**SS (kg/d)**	**Av. flow (m^3/d)**	**Peak Flow (litres/sec)**	**BOD (kg/d)**	**SS (kg/d)**
Domestic	14,830	692	1,316	1,530	14,830	692	1,316	1,530
Trade	670	8	516	292	1,220	14	710	429
TOTAL	15,500	700[1]	1,832	1,822	16,050	706	2,026	1,959

Note: Peak flow recorded during 5-7 July 2006 storm event.

3.2.5 Infiltration and Inflow

The average flow into the MWTP is significantly higher than would be expected from a township with a population of almost 18,000 people. This is attributed to infiltration and inflow (I/I) into the sewer system from high groundwater levels and rainfall runoff (due to illegal connections and network leaks).

MDC has a commitment as part of its ongoing asset management strategy to progressively upgrade areas of the reticulation system that are significantly under performing. Approximately $3.7 million has been allocated for I/I investigations and capital works over the next 10 years, with additional capital expenditure able to be added for specific projects.

3.2.6 Key Improvements Resulting from Proposed Upgrade

The following is a summary of the key improvements that are central to the proposal:

4 Improved effluent quality with regard to bacteria and pathogens as a result of the installation of maturation cells in the secondary pond

4 Maximisation of land based disposal and minimisation of direct discharge to the river

4 No discharge of treated wastewater to the Ruamahanga River when river flow is below median flow (Ω12.3 m^3/s) in summer (1 November-30 April) or below ½ median flow (Ω6.2 m^3/s) in winter (1 May-31 October)

4 The new discharge location will result in improved mixing which, combined with the intermittent nature of the discharge, will result in full mixing well upstream of Wardells Bridge and a significant improvement in aesthetic impacts and reduction in health risk

4 Raising an area of stop bank to the north of the ponds will improve flood protection to the ponds and irrigation area

4 There will be no discharge of effluent directly to the Makoura Stream, with a subsequently significant improvement of water quality in the lower reaches of that stream

In addition to these improvements to the treatment and disposal system, the Council has committed funding of an ongoing asset management programme to repair/replace the worst sections of the reticulation network (in terms of inflow and infiltration), which would further improve the operation of the MWTP.

4 **The key improvements during low flows when there is no direct discharge to the river will be:**

∉ No green colouring in the water from pond algae

∉ No change to river water clarity

∉ No adverse effects on the aesthetic amenity of the river at these flows

∉ No nutrients discharge to the river that would encourage undesirable biological growths (periphyton/slime) on bed of river

∉ No discharge of effluent to the river when the river is more attractive for swimming and other forms of contact recreation (greatly reduced bacterial and pathogen loads in the river at these times)

∉ Minimal risk to human health at these flows/times

∉ No metals or chemicals discharged directly to the river

∉ Residual discharge via pond leakage will have negligible effects on the water quality in the river

4 **The key improvements at higher flows, when there is a direct discharge to the river will be:**

- Improved water quality in the Ruamahanga River and, in particular, at Wardells Bridge
- Reduced mixing zone due to improved mixing;
- Moving of the mixing zone upstream as a result of the diffuser and new upstream the discharge point, so that full mixing will occur upstream of Wardells Bridge (currently full mixing occurs downstream of Wardells Bridge)
- The discharges into the Ruamahanga River will generally occur when the river water quality is already of a lower quality due to upstream sources
- Discharge will occur at times when little if any primary contact recreation occurs and levels of secondary contact recreation are low
- The discharge will not cause any more than very minor risk to health at these flows
- The discharge will not cause any more than minor increase in periphyton growth at these flows
- Changes to colour and clarity will not be conspicuous after reasonable mixing and, at most times, will not be noticeable

3.3 Discharge Regime (Operating Rules)

3.3.1 Operating Philosophy

The operating philosophy is to:

4 Maximise application of effluent to land when the soil conditions allow for irrigation;

4 Cease direct discharge of effluent to the river when the river is the most used for primary contact recreation (particularly swimming); and to

4 Ensure adequate mixing and dilution at times when discharge does occur

3.3.2 Trigger Conditions for Discharge to River

The ½ median flow in the river was identified as the threshold flow below which the discharge of nutrients in the direct discharge would encourage the proliferation of periphyton in the river.

The proposed upgrade adopts the more conservative "trigger value" of the median river flow during the summer to provide additional benefit in reducing adverse effects on the river water quality during periods when the river is most attractive to recreational users. Adopting median flow as the summer trigger has additional benefits in terms of pathogens (health risk), colour and clarity.

A trigger flow of half median in winter is considered appropriate because at these times little contact recreation occurs and periphyton growth is not an issue at this time of the year.

3.4 Existing Environment

3.4.1 Sensitivity of Existing Environment

The sensitivity of the existing environment is a key consideration in assessing the effects on the environment. The key characteristics of the sensitivity of the receiving waters, as well as the land and air resources, are set out below.

Surface and Ground Water

- The Ruamahanga River is of high value to the community and tangata whenua
- The existing discharge has adverse effects on the amenity value of the river and its mauri, and also results in elevated health risks particularly at times of lower flows in summer.
- There are significant periods when the Ruamahanga River water quality upstream of the discharge does not meet the recreational water quality guidelines
- The Ruamahanga River is a “flashy” river where frequent ‘freshes’ cause the river level to rise and fall quickly. This has two implications:
  - In ‘fresh’ conditions, the water quality in the river quickly declines; and
  - Any algal growths are ‘sloughed’ off the stony riverbed.
- The Wellington Regional Freshwater Plan seeks to manage this reach of the Ruamahanga River for Contact Recreation
- The groundwater is generally close to the surface and affected by percolation of stock effluent and fertiliser from agricultural activity
- The direction of the groundwater flow is generally towards the Ruamahanga River

Land

- The soils in the locality range from poor to free draining
- The Homebush site soils can generally accept water (as rain or effluent) at average rates of between 5-10mm/d as a total water balance for the poor and free draining soils respectively
- The closest house at 350 m to the northwest of the ponds. The southeastern edge of the Masterton Urban area is approximately 1 km to the north of the irrigation land
- The surrounding land use is generally agricultural, with dairying the predominant farming activity

Community

- The river is highly valued by tangata whenua/kaitiaki and the wider community.
- The closest of the acknowledged public swimming areas downstream of the existing MWTP discharge is ‘The Cliffs’ (7.5 km) which is a popular well used area. At the present time there is minimal recreational use at Wardells Bridge, partly due to the presence of signs warning of the proximity of the effluent discharge. These warning signs actively discourage recreational use of the river at Wardells Bridge for swimming and food gathering. Access to the site is across private property, and although it is publicised as an access point for fishing, there is no formed public access to the site.
- There are no known sites of significance or for mahinga kai to tangata whenua in the immediate vicinity of the MWTP
- The ability of the Masterton Community to afford an expensive high technology MWTP is less than the average community in New Zealand
- Kayakers occasionally pass through the area and a small number of fishers use the river immediately upstream and downstream of the MWTP.

3.5 Quality of the Wastewater

Table 3 below compares the raw wastewater quality with the existing treated effluent quality and predicted effluent quality. This demonstrates:

4 Good removal of BOD

4 Good removal of suspended solids

4 Moderate removals of nutrients (nitrogen and phosphorus)

4 Good removal of *E.coli* (existing)

4 Improved removal of *E.coli* (proposed)

Table 3 Comparison of Raw Wastewater and Effluent Quality (Pre and Post upgrade)

Parameter	Raw Wastewater Quality	Existing Effluent Quality (geometric mean)	Proposed Target Effluent Quality
BOD_5 (g/m^3)	158	17.7	No change from existing quality
Filtered BOD (g/m^3)		5.2	No change from existing quality
Suspended solids (g/m^3)	133	22.5	No change from existing quality
Total Nitrogen (g/m^3)	19.1	10.1	No change from existing quality
Ammonia-Nitrogen (g/m^3)	11.5	0.7 3.0	No change from existing quality
E.coli (cfu/100 mL)	1,440,000	485 651	200 (summer) No change from existing quality (winter)
Dissolved reactive phosphorus (g/m^3)	2.4	2.4	No change from existing quality

Notes: Existing effluent quality data is based on results of testing since July 1994 (n = 180), and following the interim upgrade of the oxidation ponds in 2003 for E. coli *(n = 65 summer, 43 winter), to April 2006 (NIWA 2006b).*

3.5.1 Comparison of Pre and Post Upgrade Receiving Water Quality

Table 4 below illustrates the improvement in receiving water quality following the proposed upgrade. The assessment takes the median upstream concentration of each parameter and combines it with the 95 percentile of the effluent. Leakage based on elevated pond levels is also included in the calculations. This represents the situation when a discharge of effluent has just commenced. *E.coli* and clarity are not shown on Table 4.

Table 4 Predicted Concentrations of Key Parameters for Effluent Discharge at Just Above Median River Flow

	Concentrations (g/m^3)					Distance downstream of outfall (m)					
Parameter	Median Upstream	95%ile Effluent	Median Leakage	RWT		200	300	300 % RW	400	800 & Wardells Bridge	800% RW
fBOD	0.3	6.1	3.7	2.00		0.66	0.60	30%	0.56	0.51	26%
NH4-N(S)	0.01	11.3	1.1	1.61		0.65	0.55	34%	0.47	0.39	24%
NH4-N(W)	0.01	11.1	6.7	1.61		0.66	0.56	35%	0.47	0.40	25%
NO2-N	0.002	2.01	0.14	9.00		0.12	0.10	1%	0.08	0.07	1%
NO3-N	0.5	4.29	0.84	7.20		0.75	0.71	10%	0.67	0.64	9%

Notes: Table from NIWA (2007). Uses upstream background concentrations with leakage (2400 m^3/d; 443x dilution). RWT = receiving water target

Table 5 Predicted Concentrations of Key Parameters for River Flow at Just Below Median Flow (no direct discharge in summer)

	Concentrations (g/m^3)					Distance downstream of outfall (m)					
Parameter	**Median Upstream**	**95%ile Effluent**	**Median Leakage**	**RWT**		**200**	**300**	**300% RW**	**400**	**800 & Wardells Bridge**	**800% RW**
FBOD	0.30	0	3.7	2.00		0.33	0.32	16%	0.32	0.32	16%
NH4-N(S)	0.01	0	1.1	1.61		0.02	0.02	1%	0.02	0.01	1%
NH4-N(W)	0.01	0	6.7	1.61		0.061	0.053	3%	0.047	0.040	3%
NO2-N	0.002	0	0.14	9.00		0.003	0.003	<0.1%	0.003	0.003	<0.1%
NO3-N	0.5	0	0.84	7.20		0.51	0.51	7%	0.50	0.50	7%
E.coli (S)	103	0	200	130		105	104	80%	104	104	80%
E.coli (W)	49	0	260	130		51	51	39%	50	50	38%
DRP	0.010	0	2.7	0.030		0.031	0.027	92%	0.025	0.022	74%

Notes: Table from NIWA (2007); Upstream Background with Leakage (2400 m^3/d; 221x dilution) to Half- Median River Flow, with (s) = summer; (w) = winter.
RWT = receiving water target

Table 5 above illustrates the improvement in receiving water quality following the upgrade. The assessment takes the median upstream concentration of each parameter and combines it with the leakage based on elevated pond levels. This therefore represents the situation when there is no discharge of effluent to the river, and pond storage is high.

Table 5 shows that there is negligible impact as a result of leakage from the base of the ponds, with the receiving water quality at Wardells Bridge well within applicable receiving water guideline standards.

Table 6 Summer *E.coli* and Clarity in Ruamahanga River Upstream of Discharge, in Relation to River Flow

	E.coli **(cfu/100 mL)**	**Clarity (visibility of Black Disc in metres)**
Flow category [1]	**Median (5 – 95%ile)**	**Median (5 – 95%ile)**
< Half-median	29 (7 – 87)	3.4 (1.1 – 5.8)
Half-median to Median	40 (4 – 219)	2.0 (0.22 – 4.3)
Threshold flow range [2]	83 (13 – 1058)	1.0 (0.17 – 4.6)
High flow	207 (16 – 2909)	0.34 (0.09 – 1.92)

Notes: [1] Flow ranges are: <Half-median = < 6.15 m^3/s; Half-median to Median = 6.15 – 12.3 m^3/s; Threshold flow range = 12.3 – 14.0 m^3/s; High flow = >14 m^3/s. [2] The analysis uses actual data (between 21 and 36 data points) for each flow range except for the threshold flow range, which is based on modelled values derived from the Monte-Carlo simulation (this is discussed below). [3] "Threshold flow range" is the flow region where the discharge is initiated and prior to higher flows where upstream quality is poorer.

Table 7 Predicted Summer *E.coli* and Clarity at Wardells Bridge in Relation to River Flow

	E.coli **(cfu/100 mL)**	**Clarity (visibility of Black Disc in metres)**
Flow category [1]	**Median (5 – 95%ile)**	**Median (5 – 95%ile)**
< Half-median	No change	No change
Half-median to Median	No change	No change
Threshold flow range [2]	87 (14 – 1014)	0.89 (0.17 – 2.67)
High flow	Negligible change	Negligible change

Notes: 'No change' refers to distribution values upstream as given in Table 32. 'Negligible change' indicating that the magnitude of change would be very small. [2] Model predicted values for E.coli is based on a median effluent concentration of 330 /100mL added to upstream distribution.

Tables 6 and 7 (above) show the impact for *E.coli* and clarity in summer, and Tables 8 and 9 (below) show the impact for *E.coli* and clarity in winter

The analysis in Table 6 and Table 7 has been carried out for the following ranges of summer river flows:

4 Less than half median – a discharge to river will not take place in this flow range

4 Half median to median – a discharge to river will not take place in this flow range

4 A ‘threshold’ condition (12.3 m^3/s - $14 m^3/s$) when a discharge is first initiated – this is the river’s flow range that is most sensitive to the effects of the discharge because upstream quality is relatively high. This threshold flow range only occurs for approximately 4% of time. Typically the river flow rises rapidly to flows well in excess of median flow

4 High flow – a discharge to the river takes place. Typically, the receiving water quality upstream of the MWTP deteriorates rapidly at higher river flows

Table 8 Winter *E.coli* and Clarity in Upstream Ruamahanga River in Relation to River Flow

Flow category [1]	*E.coli* (cfu/100 mL)	Clarity (visibility of Black Disc in metres)
	Median (5 – 95%ile)	Median (5 – 95%ile)
< Half-median	6 (2 – 10)	3.6 (0.3 – 7.1)
Threshold flow range [2]	ND	3.0 (0.7 – 5.2)
High flow [3]	50 (5 – 291)	0.6 (0.084 – 3.6)

Notes: ND = No Data available. [1] Clarity data for <Half-median flows comprises 8 data points; E.coli *data for <Half-median flows comprises 2 data points. [2] A ‘threshold flow range’ of 5 to 8 m^3/s was used to summarise data in the range where the effluent discharge commences; 9 data points available for clarity; [3] Clarity data for high flows (>6.15 m^3/s) comprises 16 data points; 32 data points for E. coli (range 3 – 493 cfu/100 mL).*

Table 9 Predicted Winter *E.coli* and Clarity at Wardells Bridge in Relation to River Flows

Flow category [1]	*E.coli* (cfu/100 mL)	Clarity (visibility of Black Disc in metres)
	Median (5 – 95%ile)	Median-
< Half-median	No change	No change
Threshold flow range	Negligible change	2.6 [a]
High flow	Negligible change	Negligible change

Notes; [a] Estimated value based on a 13% reduction predicted for Monte-Carlo modelling of summer discharge. ‘Negligible change’ indicating that the magnitude of change would be very small

The analysis in Tables 8 and 9 has been carried out for the following ranges of winter river flows:

4 Less than half median – a discharge to river will not take place in this flow range

4 A threshold flow range, which for winter has been taken as $5 m^3/s$ to $8 m^3/s$ – this is the flow range when a discharge is first initiated in winter

4 High flow – a discharge to river takes place

In summary, Tables 6 to 9 show that the effluent discharge will have negligible impact on the receiving water quality.

4 Assessment of Effects on the Environment

4.1 Water Quality of the Ruamahanga River

4.1.1 Expected Improvement in Water Quality

The following is a summary of the key improvements to water quality that will result from the proposed upgrade:

- There will be no discharge of effluent to the Makoura Stream
- There will be improved microbiological quality as a result of improved pond performance, the elimination of discharge below median flow in summer (half-median flow in winter), and relocation and enhanced mixing from the discharge diffuser
- A significant improvement in the water quality of the Ruamahanga River during summer low to median flows downstream of the MWTP because there will be no effluent discharged directly to the river at these river flows, when the river is most attractive for contact recreation (especially swimming)
- No coloured plume in the Ruamahanga River downstream from the Makoura Stream to Wardells Bridge, along with enhanced clarity
- No conspicuous change to colour and clarity after reasonable mixing
- Elimination of the presence of settled algae from the pond in the partially mixed region downstream of the Makoura confluence and upstream of Wardells Bridge
- An improvement in microbiological water quality of the Ruamahanga River downstream of the MWTP when effluent is discharged above median flow (summer)
- Zone to achieve full mixing reduces from well below Wardells Bridge to approximately **450m** upstream of Wardells Bridge
- Compliance with water quality targets after reasonable mixing and at Wardells Bridge
- Minimal risk to human health
- Minimal effects on colour and clarity
- Minimal effect on the build up of periphyton

4.1.2 Summary of Predicted Effects of the Discharge

Effects of the Discharge on Health Risk

Recreational health risk will be mitigated by eliminating the discharge of treated effluent to the river during low flow periods. At these times, the river is often clear and warm, attracting peak numbers of swimmers. In the future, treated effluent will only be discharged to the river during the summer when freshes occur and the flow exceeds the median value of 12.3m^3/s.

During freshes, water quality deteriorates (colour, turbidity and microbiological), the water temperature drops and the current becomes swifter. These factors all discourage swimming, which markedly reduces numbers of swimmers and consequent exposure to health risk. In addition, the water quality upstream of the MWTP deteriorates to such an extent that the addition of treated effluent has a negligible negative effect on health risk. The threshold flow range where the river is most sensitive to the discharge (just above median flow) only occurs for a short duration.

Effects of the Direct Discharge on Periphyton Growth

The potential for undesirable biological growths is relevant to both the intermittent effluent discharge and the leakage from the ponds. The Ruamahanga River was found to have a limited presence of phosphorus and the peak periphyton growths limited by frequent flood flows (NIWA 2003). Presently, although there is currently a detectable impact in terms of increased biological growth downstream of the existing discharge, the extent of the biological growth does not reach nuisance (*undesirable*) levels.

In summary, in the future following the upgrade, there will be a marked improvement in nutrient status, with there being no direct effluent discharge at less than median river flow in summer (the time when biological growth is most prolific). At flows above median, the additional nutrients from the plant will not cause any undesirable growths because the frequency of high flow periods (river freshes) is sufficient to scour the river bed and in doing so will limit undesirable growths.

Effects of the direct discharge on aquatic life

The existing discharge does not cause significant adverse effects on macroinvertebrate communities at Wardells Bridge, nor on fish populations in the Ruamahanga River or catchment area.

The proposed upgrade to an intermittent discharge, with improved downstream mixing of effluent and limitation of discharge to flows greater than median in summer (>half-median in winter) will not result in exceedance of ammonia toxicity guidelines and will improve water quality both immediately downstream of the discharge and at the Wardells Bridge site (as a result of improved mixing). An increase in sensitive invertebrate species, such as mayflies, will be expected in the previously poorly mixed region at Wardells Bridge which is downstream of the Makoura Stream inflow. Additionally, the removal of the discharge from the Makoura Stream will result in a significant improvement in water quality in that stream which will have beneficial effects on resident macroinvertebrate and fish communities.

Effects of direct discharge on colour and clarity

The Ruamahanga River at Wardells Bridge will show a marked improvement in clarity as a result of the elimination of the summer discharge at flows below median. Initiation of the discharge at median flow will not result in a conspicuous reduction in clarity after reasonable mixing during the threshold flow period when the discharge is initiated. At higher flows, river clarity naturally declines and the discharge will be inconspicuous at or shortly downstream of the discharge point. The shifting of the discharge point upstream and the use of a mixing diffuser will eliminate the highly visual partial mixing zone which currently exists below the Makoura Stream inflow. The combined result will be a significant improvement in river clarity, particularly, during high use recreational periods.

The impact of the discharge on perceived colour will be markedly reduced following the proposed upgrade for four main reasons:

- There will be no algae settling on the bed below median flows (summer) because there will be no discharge;
- There will be markedly reduced settling of pond algae on the bed when the flows are median and above because higher river velocities will keep algae entrained in the water column;
- Moving the discharge point from the Makoura Stream to the main stem of the Ruamahanga River and discharging via a diffuser will result in better mixing and less visual impact; and
- The discharge occurs only during flows above median, when the river is naturally discoloured, this will result in a lesser ability to perceive any colour changes.

After the proposed upgrade, the effects of discharge on the colour of the receiving water will therefore be minor and significantly less than the existing situation.

4.1.3 Standards and Guidelines

The proposed discharge, will readily achieve the minimum water quality standards in section 107.

The discharge will achieve all relevant water quality guidelines and targets. In particular, the contact recreation guidelines will be met.

The predicted impact on receiving water quality, assessed against relevant water quality guidelines and targets is shown in Table 10 below.

Table 10 Predicted Values of Water Quality Parameters after Reasonable Mixing (i.e. 20x dilution at 300m downstream) and at Wardells Bridge in Summer for Threshold Flow Region

Parameter	Receiving Water Target	Measured values (just below median flow) [b]	Predicted value: after reasonable mixing	Predicted value: Wardells Bridge
Filtered BOD (g/m3)	2.0	0.31	0.60	0.51
Visual Clarity - Black disc (m)	1.6	1.0	0.85	0.89
Visual Clarity change (%)	33-<50% change	Nil	17%	13%
Colour –Hue (Munsell points)	10 points change	10GY(40)8/2	c. 7.5 GY(37.5) (2.5 points change)	7.5 GY(37.5)7/6 (2.5 points change)
Ammonia-Nitrogen (g/m3)	1.61	0.01	0.55	0.39
Nitrate–Nitrogen (g/m3)	7.25	0.50	0.71	0.64
Nitrite–Nitrogen (g/m3)	9	0.001	0.10	0.07
E.coli (cfu/100 mL) – human [livestock]	130 [100]	83	89	87
E.coli change (%)			6.5%	4.3%
Dissolved Reactive Phosphorus (g/m3)	0.03	0.015	NR	0.020 [c]

[a] Threshold flow range = 12.3 – 14.0 m3/s. "Threshold flow range" is the flow region where the discharge is initiated. This occurs approximate 4% of the time and 13% of the time when potentially discharging. [b] Measured upstream medians except model predicted median values for E. coli and clarity. [c] leachate contribution at less than median flow. NR = Not relevant to target guideline.

4.1.4 Residual Effects of Indirect Discharge to the River via Pond Leakage

The indirect discharge to the river via pond leakage will not have any more than very minor adverse effects on the environment for the following reasons:

- Pond leakage volumes and therefore contaminant loads are minimal as compared to river flows and accordingly there is significant dilution (for leakage at the elevated pond level, dilution at half median flow is estimated at around 450 times and at median flow around 900 times)
- The indirect discharge is treated as a result of passage through the base of the ponds and the underlying gravels.
- Site-specific assessment has shown that pond leakage has little effect on periphyton growth
- Assessment suggests that health risks from the pond leakage are insignificant (a conservative estimate is an infection rate of 1 per 1000 swimmers at Wardells Bridge).
- Microbiological quality downstream of the ponds will be little different from upstream quality after mixing.

4.1.5 Effects of In-River Works

Work will be required in the river channel for erosion protection and construction of the embankment outfall.

Construction activities will adopt recognised practices for in-river works. There will be a temporary minor effect on river water quality due to the impact of machinery working on the river's edge and in the river, which will cause discolouration.

Noise levels and working hours of machinery will be restricted.

Any in-river works will be planned to avoid fish spawning periods.

A number of bird species (eg banded dotterel, black-fronted dotterel and pied stilt) breed locally on the large rivers of the Wairarapa Plains (including the Ruamahanga River). However, the area immediately around the ponds has not been identified as a nesting site.

Any adverse effects of the erosion works and embankment construction will be no more than minor and will be temporary

4.2 Groundwater

4.2.1 Pond Leakage

Testing of groundwater shows there is little effect on the groundwater from the pond leakage. This is as expected, given the passage of leakage through the base of the ponds and then through the underlying gravels. The groundwater flow in the vicinity of the ponds is to the south and hence the leakage flow path is from the ponds directly to the Ruamahanga River.

Sampling from monitoring bores located between the ponds and the Ruamahanga River (located so as to sample the leakage/groundwater flow) shows that there is negligible impact on groundwater quality.

There are a number of shallow bores on farms and small holdings close to the Masterton-Martinborough Road, to the southwest of the ponds. The possibility of groundwater contamination of these bores has been considered, and has been assessed as being negligible.

There is also one bore on the left bank of the Ruamahanga River opposite the downstream end of the ponds. It is unlikely that that there would be any adverse effects from contaminated groundwater travelling under the river to the far bank, due to the geology of the river. The groundwater would be in hydraulic contact with the river, and thus any pond leakage would discharge to the river.

In conclusion, the environmental effects of pond leakage are minimal, and will largely be confined to effects on the river, which have been shown to be negligible.

4.2.2 Irrigation of Effluent

When the effluent is irrigated to the soil surface it will infiltrate vertically down through the soil profile.

Mounding

When the effluent percolates through the soil profile and reaches the underlying aquifer, a small additional head will be created in the aquifer (mounding), creating the driving force to transmit the additional recharge away.

The mounding expected from irrigation is small compared with the natural seasonal fluctuations, and is of a similar order of magnitude to the groundwater fluctuations caused by passing floods in the Ruamahanga River. Such small changes are not expected to significantly change groundwater flow directions, with the predominant direction continuing towards the south and the Ruamahanga River. In other words, the groundwater flow direction under irrigated conditions does not deviate from its pre-irrigation state.

In summary, the groundwater analysis shows that the proposed land treatment system design and disposal rates should not cause excessive mounding in the underlying aquifer.

Flow in the Makoura Stream

The irrigation scheme may slightly increase flows in the Makoura Stream by groundwater transmittal (while the removal of the discharge from the Makoura Stream would reduce its existing average flow by approximately 50%).

Groundwater quality

The proposed irrigation scheme will result in the aquifer receiving effluent that has higher levels of some contaminants than those found in natural rainfall derived recharge. Treatment during the infiltration process through the surficial soil column substantially reduces the contaminant concentrations reaching the aquifer. The residual concentrations will then be further reduced within the aquifer through dilution with groundwater, and through the subsequent dispersion, advection and, in the case of microbiological contaminants, die-off and filtration in the aquifer.

The estimated concentrations of nitrate and phosphorus will be low compared with background concentrations in groundwater at the site. The average background nitrate level up-gradient of the ponds is 1.3 mg/L (which is nearly ten times lower than the drinking water standard for nitrate) and average background DRP concentrations are 0.02 mg/L. Analysis has shown that predicted nitrate and DRP concentrations at the irrigation area boundary are at most approaching the background concentration for the average rate application, and are generally less than half the background concentrations.

The *E.coli* concentrations will be slightly higher than the background levels. The average *E. coli* level up gradient of the ponds is 1.2cfu/100 mL. The most significant change is expected to occur under high rate irrigation on the free draining soils along the Ruamahanga River, where it forms the eastern site boundary. At high irrigation rates the predicted *E. coli* concentrations at the boundary of the site are the highest for the scheme. However, even these highest *E.coli* concentrations are such as to have a minimal impact.

There have been no adenovirus measurements at the site therefore no direct comparisons can be made. There is also no guideline value set in the Drinking Water Standards for viruses “due to a lack of reliable evidence” for these concentrations to be compared to. The analysis and results are considered to be conservative, as no filtration effects of attenuation in the unsaturated zone have been incorporated in the groundwater model.

The predicted concentrations of *E.coli*, nitrate-N and phosphorus in groundwater at the boundary of the irrigation site are also small compared with concentrations within the Makoura Stream and Ruamahanga River. In all cases, the modelled concentrations in the groundwater are small compared with receiving water concentrations before dilution is considered.

In summary, analysis has shown that the concentrations of bacteria, viruses, nitrates and phosphorus will be largely contained within the site boundaries. There should be no effects from the irrigation on any groundwater abstractions beyond the site boundaries (for example, the private bores to the southwest) and only minimal effects on receiving waters.

4.3 Long Term Sustainability of Soils

The key issues in relation to long term sustainability of the soils for effluent disposal by irrigation is that excessive irrigation has the potential to lead to leaching of nutrients to groundwater, excessive salt build up and excessive phosphorus build up. Such effects could potentially reduce crop growth, or lead to a failure of the land-based disposal system. These potential impacts have been investigated and the assessment concluded that the long-term sustainability of the irrigation soils will not be compromised, as the current data demonstrates there is at least 28 years life (and more likely longer) in the soils capacity to accept the effluent under the operation proposed.

4.3.1 Water Balance and Nutrient Leaching

The potential effects of discharge will be greatest under the more free-draining soils that receive the highest nutrient and contaminant loads.

Nitrate leaching should not pose a risk to ground water quality since the average concentrations in drainage water will be at least three times lower than the NZ Drinking Water standards for nitrate. Similarly, the risk of phosphate leaching would be small as most of the applied phosphorus is removed by the cut and carry process, or would remain in the soil profile.

The risk of bacteria leaching to groundwater is likely to be negligible at poorer draining sites that receive lower amount of wastewater irrigation. However, elevated levels of bacteria in drainage water in the soil will occur under the more free-draining sites. Additional die-off and dilution in the groundwater could act to reduce microbial concentrations.

4.3.2 Effects on Soil Structure

Soil structure can be affected by the application of salts, for example in irrigation water. Excessive salt accumulation in soil can reduce crop production and sodium accumulation can degrade soil structure thereby reducing the permeability for water.

Generally, the risk of salt or sodium problems for New Zealand soils irrigated with domestic wastewater is considered to be low. In this case, winter rainfall and flushing of salts would generally limit any damage.

4.3.3 Potential Toxicity from Phosphorus Build-up

Phosphorus is an essential nutrient important for plant growth. Effluent adds more phosphorus to the soil than can be used by the pasture. As a result, soil phosphorous will slowly accumulate in the top layer of the soil.

There are generally no adverse effects of high soil P concentrations on plant growth and soil function.

The accumulation of phosphorus in the topsoil is unlikely to cause any long term problems with pasture production or soil function at Homebush.

4.4 Risks from Natural Hazards

4.4.1 Earthquake

Potential risks to the embankments at this site from earthquakes are ground shaking (including liquefaction) and fault rupture.

Ground shaking (in a 100-year return event) may result in displacements of the embankments up to 500mm, and this could result in a breach. Fault rupture is considered unlikely. However, if it did cause a breach, as a worst case scenario a substantial amount of sediment (but small in quantity relative to annual yield) could be discharged and be deposited on the bed of the river. Recovery of ecological communities would be expected to be relatively rapid and hence the effect will be short-lived.

It is considered that the 100-year return event is an appropriate design standard for the ponds.

4.4.2 Erosion

MDC has previously carried out an intensive erosion protection programme along the banks of the river that has included riprap and rock groynes. Further works are proposed as part of this upgrade to reduce the erosion hazard at the treatment plant and for adjacent landowners.

4.4.3 Flooding

Upgrading the stop bank on the true right side of the river in the vicinity of the treatment ponds is to provide protection against the 1 in 100 year return event. This is considered to be appropriate for the asset being protected. Otherwise flooding in the area is unaffected by the upgrade proposals.

4.5 Social and Cultural

4.5.1 Use of the River

The Ruamahanga River is of significant recreational value to the community. The summer period is when most forms of contact recreation, particularly swimming occur. The main public swimming areas are Te Ore Ore (upstream) and The Cliffs (downstream). Wardells Bridge has been acknowledged as a historical 'public' swimming area, but access does require crossing private land and thus the permission of the owner. 'The Cliffs' is so far downstream as not to be affected by the discharge (due to dilution and bacteria and pathogen "die-off").

At flows above median the river becomes less attractive for contact recreation, particularly swimming, as the current strengthens and the river becomes turbid (dirty). By removing discharge to the river at flows below median in summer, the health risk to contact recreation users of the river at Wardells Bridge will be significantly reduced. The upstream water quality of the Ruamahanga River at flows less than median is very good.

The recreational and aesthetic amenity of the river between Makoura Stream and Wardells Bridge will be significantly improved as a result of the absence of discharge at times when it would be most intrusive (in terms of colour clarity and perceived health risk) At flows when discharge does occur the river will normally be discoloured upstream and the discharge will have little impact. When it is visible there will be a much smaller mixing zone, located further upstream and away from Wardells Bridge (full mixing by a minimum of 450m upstream of the bridge).

4.5.2 Maori Values

MDC has consulted Rangitaane O Wairarapa and Ngati Kahungunu Ki Wairarapa over a substantial period of time. The key concern of tangata whenua is that effluent discharge to waterways is offensive to its cultural values and adversely affects the mauri of the river. The proposed land disposal scheme addresses tangata whenua concerns in part. While the discharge will not be totally removed from the river, it will be removed when the river is most sensitive and most used. The upgrade will maximise land disposal within land the available to the Council including the additional 107ha recently purchased. In addition, the quality of the effluent will be improved. Accordingly, the relationship of Maori with the river and Makoura Stream has been recognised and will be provided for as far as is practicable.

4.5.3 Affordability to the Community

One of the issues MDC considered in selecting a preferred upgrade was affordability, which was a principal established at the start of the project by the Working Party.

MDC commissioned a study on this issue, which found that the residents of Masterton have relatively low incomes compared to similar districts and have a relatively high index of deprivation. Rates in Masterton are currently relatively low compared to the other regions represented, and sewerage rates are also very low by these standards.

Given that all of the alternative schemes (refer to following discussion) were considered to deliver similar benefits to that proposed, but would be higher cost schemes that would increase the urban rates above those of comparative councils, the analysis of affordability supported the selection of the lowest cost scheme (based on using the existing ponds).

5 Alternatives Considered

5.1 Overview of Alternatives

A large number of treatment and disposal options have been considered throughout the duration of the wastewater upgrade project.

At the commencement of the investigations into the long term upgrading options in 1994, fifteen treatment and disposal options involving a wide range of technologies were evaluated.

In May 2000, the Wastewater Working Party considered treatment and disposal options ranging from upgrading the existing oxidation ponds to a new mechanical plant, with disposal options including land and river discharges. The Working Party shortlisted these options focusing on:

Treatment	Disposal
Existing ponds	Land irrigation/Rapid Infiltration;
New ponds	River discharge

In 2005, MDC considered 14 scheme options (based on the above shortlisted options). These schemes can be grouped into four categories as follows:

- **Retention of existing oxidation ponds –** four schemes including the following components: upgrade of maturation cells, land treatment/disposal, wetland discharge, DAF, DRP, microfiltration with chemical dosing.
- **New oxidation ponds –** three schemes including the following components: new maturation cells, land treatment/disposal, wetland discharge, DAF to remove DRP.
- **Dual power lagoons** – three schemes including the following components: land treatment/disposal, UV disinfection, Clarifier with chemical dosing to remove DRP and wetland discharge.
- **Mechanical treatment plants** – four schemes including the following components: land treatment/disposal, UV disinfection, chemical dosing for DRP removal, wetland discharge, membrane bioreactor.

All of the schemes assumed that effluent disposal would be either full time to the river, or to land at times when river flows are below half median.

5.2 Reasons for Choosing Preferred Option

In June 2005, MDC selected Scheme 1a, which was based on the retention of the existing oxidation ponds, because

- It met MDC's objectives (set out in Section 1 of this report) for the upgrade project
- It is consistent with the Regional Policy Statement and the Freshwater Plan
- It will meet national receiving water quality guidelines
- It is consistent with Part II of the RMA, in particular:
    - It will adequately avoid remedy and mitigate adverse effects
    - Will provide for the wellbeing and health and safety of the community
    - Is an efficient use of natural and physical resources (including the physical resource in the existing infrastructure).

4 There are a number of distinct advantages relating to the existing plant and its location, including:

- Its relatively short distance from the Masterton urban area
- Gravity flow from the urban area to the site
- The rural location of the site and sufficiently large distances to the town and to nearby dwellings
- The ability to acquire more land contiguous to the Plant
- Suitable topography, and
- The site for the existing facility is designated for wastewater purposes.

5.3 Possible Alternative Methods of Treatment and Disposal

5.3.1 Treatment

Full details of other treatment methods investigated can be found in the AEE. The main forms considered include wetlands, dissolved air floatation (DAF), and ultraviolet disinfection (UV).

The wetlands (polishing and full treatment) were not carried forward because their long-term performance was questionable. In addition, the full treatment wetland had excessive land (and cost) requirements.

The DAF and UV options were not carried forward to the proposed scheme for several reasons. They were expensive to construct and operate and the proposed land irrigation scheme (described in this report and the AEE) made them unnecessary because:

- Nutrients and algae in the treated wastewater (that the DAF plant would remove) are irrigated to land during the sensitive low river flow periods when they would be likely to encourage undesirable biological growths in the river; and
- Maturation cells in series are almost as effective as a UV plant in reducing the bacterial, pathogen and virus concentrations in the wastewater. The addition of UV disinfection at the times of discharge to the river, would result in no real benefit in terms of health risk, since at these flows little if any primary contact recreation occurs. To the extent that secondary contact recreation still occurs, the discharge will be well mixed and well diluted at these flows, and upstream microbiological quality is poorer.

5.3.2 Disposal

Several methods of disposal have been considered during the project:

- Full time discharge to land,
- Full time discharge to river, and
- Reduced discharge to the river.

Full time discharge to land

Full time discharge to land is not practical for several reasons:

- The land requirement is excessive and prohibitively expensive;
- There is insufficient land available in the immediate Homebush locality; and
- There would still be times (adverse soil conditions and rainfall) when a discharge to the river would be required.

Full time river discharge

Full time river discharge is not desired by MDC. This is because:

- It would ignore cultural concerns of tangata whenua and
- The wastewater would likely need further treatment (at greater cost) to improve water quality in the river.

Reducing the discharge to the river

- Reducing the volume of wastewater discharged to the river could occur through increased land disposal and decreased infiltration. The Council wishes to minimise the discharge to the river and accordingly now intends to increase the originally proposed land disposal area by about 145%.
- MDC has considered reduced infiltration, raising the river trigger above median and increasing the land disposal area. Infiltration and inflow is an expensive exercise with the results likely to be variable Raising the trigger (without additional land disposal area) would generate the need for more ponds or increased storage capacity in the existing ponds, both of which are expensive exercises, with marginal benefits. Notwithstanding the cost, the Council has opted for increasing the land disposal area by purchasing an additional 107ha. Subject to obtaining consent, this will result in a further significant decrease in discharge volumes to the river, which will allow a decrease in the rate of discharge at some times or an increase in trigger levels.

6 Consultation Undertaken

6.1 Introduction

MDC has undertaken an extensive public and stakeholder consultation programme on the issues and options for upgrading the wastewater system. The consultation process is outlined in the Technical Report (Beca 2005). MDC has been discussing an upgrade of the wastewater system with the public since 1995.

6.2 The Process

The last stage of the consultation (in preparation for the final assessment of options and selection of the preferred scheme) was undertaken in two phases.

- Phase 1 was on the issues and options leading to Council's December 2004 decision to shortlist the options and to request some further investigations.
- Phase 2 was on the further investigations and Council's December 2004 decision.

Both phases involved stakeholder meetings/workshops, public meetings and open days with site visits and a free telephone enquiry line.

The Consultation Task Group facilitated the process. This group included specific industry and sector group representatives, including: Rangitaane O Wairarapa; Ngati Kahungunu Ki Wairarapa; Dairy Farmers of New Zealand (Wairarapa); Industry; Recreational Users – Wellington Fish and Game Council; and Masterton District Council. There has also been consultation involved affected persons, interested parties, tangata whenua and other stakeholders such as Fish and Game and Dept of Conservation and the community in general.

MDC retained an "open door" policy of responding to members the public if they had questions on the project. MDC also maintained an ongoing liaison process with the landowners in the immediate vicinity of the MWTP to address individual concerns and effects.

6.3 Outcomes

A range of concerns has been expressed by those consulted, and these are summarised and discussed in more detail in the AEE.

While the proposed upgrade may not be accepted by everyone within the district and region, the consultation process leading up to its selection enabled the Council to take into account:

- The preferences and views of the general public and stakeholders about matters such as:
  - Alternative options;
  - Improved quality of the treated wastewater;
  - Inflow and infiltration to the reticulation system;
  - Leakage from the ponds and the risks to the MWTP from natural hazards;
  - Improved river water quality;
  - Reduced discharges to the river; and
  - Land disposal; and
- The expression and concern of ratepayers and the general public about affordability.

Overall, it is considered that the proposed upgrade option aligns well with the direction sought by those parties involved in the consultation process.

7 Mitigation of Adverse Effects

The upgrade will result in significant mitigation of existing environmental effects. In addition, the resource consents and designation will have conditions that will ensure that the scheme performs as intended. The measures proposed will ensure that any potential adverse effects of the proposed discharges and associated activities will be adequately avoided remedied or mitigated, such that the residual adverse effects are no more than minor. The overall effects of the proposal will be positive and will result in a significant improvement to water quality as compared to present.

8 Conclusions

Overall, the treatment, and disposal regime and associated upgrade:

- Is consistent with the purpose and principles of the RMA (sections 5, 6, 7 and 8)
- Will allow the Masterton community to ensure that can continue to safely dispose its wastewater into the long term
- Will result in significant environmental improvements over the existing discharge
- Removes the direct discharge from the river at the times and flows when the river is most sensitive, most valued and most used
- Will ensure that the discharges will have no more than minor adverse effects on the environment and will not compromise public health or aquatic ecosystems
- Will improve the quality of the water in the Ruamahanga River during the most sensitive periods in terms of ecological, social cultural and amenity values
- Will not adversely effect the long term sustainability of the soils

4 Will not adversely affect the quality of groundwater

4 Addresses the issues raised in consultation with the community

4 Is consistent with the objectives and policies of the relevant regional and district plans

4 Will achieve all relevant water quality standards and guidelines

4 Involves known technology and best utilises the existing infrastructure

4 Will achieve the Council's objectives for the project

4 Is a sound and affordable long term solution for Masterton

9 Glossary

BOD (Biochemical Oxygen Demand) Measure of the amount of oxygen needed to convert the unstable constituents of sewage into stable ones. It is normally measured over 5 days at 20ºC and hence designated as BOD_5

BPO (Best Pracitable Option), as defined in the RMA in relation to a discharge of a contaminant or an emission of noise, means the best method for preventing or minimising the adverse effects on the environment having regard, among other things, to—

(a) The nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects; and

(b) The financial implications, and the effects on the environment, of that option when compared with other options; and

(c) The current state of technical knowledge and the likelihood that the option can be successfully applied.

Diffuse discharges (or non-point sources) refer to a general discharge or seepage, either over or underground, of water borne material, which is not from any readily identifiable point. Also known as non-point source discharges.

DRP refers to "dissolved reactive phosphorus", the most common form of phosphorus found in wastewater, and the type of phosphorus that is most easily taken up by plants.

E.coli (Escherichia coli) is one of the main species of bacteria living in the lower intestines of mammals, known as gut flora. *E.coli* can generally cause several intestinal and extra-intestinal infections such as urinary tract infections, meningitis, peritonitis, mastitis, septicaemia and gram-negative pneumonia. While the presence of coliform bacteria in surface water is a common indicator of faecal contamination, *E.coli* is also commonly used as a model organism for bacteria in general. "Presence" of E. coli numbers beyond a certain cut-off indicates faecal contamination of water and indicates the potential presence of other faecal derived pathogens.

Effluent refers to the wastewater after it has been treated and is then discharged into the ground or to water.

Evapotranspiration refers to the loss of water by evaporation and plant usage.

Groundwater refers to water located beneath the ground surface in soil pore spaces and in the fractures of geologic formations (such as aquifers). The depth at which soil pore spaces become fully saturated with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface naturally; natural discharge often occurs at springs or seeps to form wetlands. Groundwater is also often withdrawn for agricultural, municipal and industrial use by extraction wells. Typically, groundwater is thought of as liquid water flowing through shallow aquifers, but technically it can also include soil moisture, permafrost (frozen soil), and immobile water in very low permeability bedrock.

Guidelines are numeric or narrative indications of a desired state of water quality that do not have the force of standards.

Infiltration refers to groundwater that seeps into pipes, channels or chambers through cracks, joints or breaks

Influent refers to the raw untreated wastewater that enters the treatment plant.

Median refers to the middle value of an ordered set of values (as compared to *average* or *arithmetic mean*, which refers to the value obtained by dividing the sum of a set of quantities by the number of quantities in that set).

Near-field mixing zone refers to an area close to the outfall where the effluent mixes rapidly with the receiving water because of the momentum and/or buoyancy of the effluent and turbulence in the receiving water.

Nutrients Biostimulants essential to the growth of plants, bacteria algae and protozoa. Macro nutrients include nitrogen and phosphorus

Pathogens refer to disease-causing organisms, such as bacteria and viruses.

Peak Dry Weather Flow Rate refers to the peak rate of flow on a dry day. It should be measured on the third of three consecutive dry days. The preferred unit is l/s.

Peak Wet Weather Flow Rate refers to the peak rate of flow on a wet day. The preferred unit is l/s.

Periphyton refers to the community of tiny organisms, such as algae, small crustaceans, insect larvae, and snails, which live attached to plants and surfaces projecting from the bottom of a freshwater aquatic environment.

Point source discharges refers to a discharge from a readily identifiable source, such as from the end of a pipe.

Reasonable mixing refers to the zone where the discharge is reasonably but not fully mixed with the receiving water and underlying standards need not be met.

Standards are statutory or plan requirements which must be met unless a consent provides an exemption.

Summer period for aesthetics and recreational effects is period 1 November - 30 April (MfE 2000)

Suspended Solids Insoluble matter in sewage which could be removed by a standard filtration process to leave a clear liquid.

Threshold flow range refers to a defined band of flows just after the discharge is initiated and before the river becomes markedly affected by upstream contaminants at higher flows (e.g., median flow for summer discharge, threshold flow range of 12.3 – 14.0 m^3/s).

Toxics Poisonous substances

Tradewaste Wastewater from industry, generally excluding human waste