

Wairarapa Municipal Oxidation Ponds

Water Quality Monitoring Report

July 1999 – June 2001

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October 2001

Technical Report No. 01/10

Executive Summary

This report presents the results of the Wairarapa municipal oxidation pond water quality monitoring programme for July 1999 – June 2001. The report provides information on the water quality of effluent discharges from the Wairarapa municipal oxidation ponds, and assesses the effect of effluent discharges on the receiving water quality. Although comparisons with receiving water quality guidelines and objectives in the Regional Freshwater Plan are made and, where appropriate, compliance with conditions in discharge consents is assessed, it is not a consent compliance report. The following provides a brief summary of the results from each system.

Masterton

Effluent from Masterton oxidation ponds is discharged to the Makoura Stream near its confluence with the Ruamahanga River. Effluent analysis found that nitrite-nitrogen and BOD₅ concentrations in the effluent increased significantly over the reporting period. Receiving water quality analysis of the Makoura Stream found there was a significant change downstream of the discharge, in particular:

- Increased nutrient levels (principally ammonia-nitrogen).
- Increased BOD₅.
- A conspicuous change in water clarity.
- Macroinvertebrate community structure decline.

Water quality analysis of the Ruamahanga River found there was a significant change downstream of the Makoura Stream confluence. Of the parameters measured ammonia-nitrogen and soluble reactive phosphorus concentrations showed the greatest increase; a conspicuous change in water clarity was also observed. The increase in *E.coli* downstream of the effluent discharge has not affected the compliance of the Ruamahanga River with contact recreation guidelines.

Carterton

Since the discharge to water consent was issued for the Carterton oxidation pond discharge to the Mangatarere Stream in June 1999, compliance with most of the effluent water quality conditions has been observed. The installation of mechanical aerators in July 1999 has resulted in significant improvements in effluent water quality, with lower BOD₅ and suspended solids concentrations. Results indicate:

- A significant decrease in suspended solids in the Mangatarere Stream downstream of the discharge since June 1999.
- The effluent discharge is contributing to a decline in water quality of the Mangatarere Stream, particularly;
 - an increase in phosphorus
 - conspicuous change in water clarity
 - decline in the macroinvertebrate community structure.

Greytown

Effluent from Greytown oxidation ponds is discharged to Papawai Stream. Since 1994 (when records begin) a degradation in water quality, specifically increased nutrient levels, has occurred. Receiving water quality analysis found:

- The increase in nutrient concentrations in the effluent has caused a corresponding increase in nutrient levels in Papawai Stream downstream of the outfall.
- Significant differences in water quality were observed downstream of the effluent discharge, with;
 - increased nutrient levels
 - a conspicuous change in water clarity
 - decline in the macroinvertebrate community structure.

Featherston

Effluent discharge from Featherston oxidation ponds occurs via a surface flow wetland to Donald's Creek. Several temporal trends in effluent water quality were observed, with the quality degrading since mid-1999. A corresponding degradation of Donald's Creek water quality was also observed, which may in part be a factor of the low flows over summer 2000-2001.

Receiving water analysis found the effluent discharge is causing significant changes in water quality of Donald's Creek with:

- Increased nutrient levels (in particular phosphorus and ammonia-nitrogen).
- A conspicuous change in water clarity.
- Decrease in pH.
- Decline in macroinvertebrate community structure.

Martinborough

Effluent from Martinborough oxidation pond is discharged to the Ruamahanga River. Effluent water quality was found to have degraded significantly over time in terms of nutrient concentrations, although a corresponding degradation was not observed in water quality of the Ruamahanga River. The Ruamahanga River is however affected by the discharge with significant increases in:

- Faecal coliform and *E.coli* counts.
- Ammonia-nitrogen, nitrite-nitrogen and phosphorus concentrations.

The increase in *E.coli* counts caused by the effluent discharge has not affected the compliance of the Ruamahanga River recreational water quality guidelines.

Contents

	Page
1. Introduction	1
1.1 Background	1
1.1.1. Legislative responsibility	1
1.2 Objectives	2
1.3 Approach to analysis	2
2. Methodology	4
2.1 Sampling programme	4
2.2 Data analysis	4
3. Masterton Municipal Oxidation Ponds	5
3.1 Background	5
3.1.1 System description	5
3.1.2 The receiving environment	5
3.2 Effluent analysis	6
3.2.1 Discharge quantity	6
3.2.2 Effluent water quality: compliance	6
3.2.3 Effluent water quality: trends	7
3.2.4 Effluent nutrient loadings	7
3.3. Receiving water quality analysis	7
3.3.1 Temporal trends	7
3.3.2 Inter-site comparisons	8
3.3.2.1 Makoura Stream	8
3.3.2.2 Ruamahanga River at Masterton	9
3.3.3 Achieving water quality objectives	9
3.3.3.1 Dissolved oxygen	10
3.3.3.2 Temperature	11
3.3.3.3 Water clarity	11
3.3.3.4 pH	12
3.3.3.5 Undesirable biological growths	12
3.3.3.6 Water quality for farm animal consumption	13
3.3.3.7 Bathing water quality	14
3.3.3.8 Adverse effects on aquatic life	14
3.4 Summary	15

4.	Carterton Municipal Oxidation Ponds	17
4.1	Background	17
4.1.1	System description	17
4.1.2	The receiving environment	18
4.2	Effluent analysis	18
4.2.1	Discharge quantity	18
4.2.2	Effluent water quality: compliance	19
4.2.2.1	BOD5	19
4.2.2.2	Suspended solids	19
4.2.2.3	Faecal coliforms	20
4.2.3	Effluent quality: trends and comparisons	20
4.2.4	Effluent chemical loadings	21
4.3	Receiving water quality analysis	21
4.3.1	Temporal trends	21
4.3.2	Inter-site comparisons	22
4.3.3	Achieving water quality objectives	23
4.3.3.1	Dissolved oxygen	24
4.3.3.2	Temperature	24
4.3.3.3	Water clarity	24
4.3.3.4	pH	25
4.3.3.5	Undesirable biological growths	25
4.3.3.6	Water quality for farm animal consumption	26
4.3.3.7	Effects on aquatic life	27
4.4	Summary	28
5.	Greytown Municipal Oxidation Ponds	29
5.1	Background	29
5.1.1	System description	29
5.1.2	The receiving environment	30
5.2	Effluent analysis	30
5.2.1	Discharge quantity	30
5.2.2	Effluent water quality: compliance	30
5.2.3	Effluent water quality: trends	30
5.2.4	Effluent nutrient loadings	31
5.3	Receiving water quality analysis	31
5.3.1	Temporal trends	31
5.3.2	Inter-site comparisons	32
5.3.3	Achieving water quality objectives	33
5.3.3.1	Dissolved oxygen	34
5.3.3.2	Temperature	34
5.3.3.3	Water clarity	34
5.3.3.4	pH	35
5.3.3.5	Undesirable biological growths	35
5.3.3.6	Water quality for farm animal consumption	35
5.3.3.7	Effects on aquatic life	35

5.4	Summary	36
6.	Featherston Municipal Oxidation Ponds	38
6.1	Background	38
6.1.1	System description	38
6.1.2	Receiving environment	38
6.2	Effluent analysis	39
6.2.1	Discharge quantity	39
6.2.2	Effluent water quality: compliance	39
6.2.3	Effluent water quality: trends	39
6.2.4	Effluent nutrient loadings	40
6.3	Receiving water quality analysis	41
6.3.1	Temporal trends	41
6.3.2	Inter-site comparisons	41
6.3.3	Achieving water quality objectives	42
6.3.3.1	Dissolved oxygen	43
6.3.3.2	Temperature	43
6.3.3.3	Water clarity	43
6.3.3.4	pH	44
6.3.3.5	Undesirable biological growths	44
6.3.3.6	Water quality for farm animal consumption	44
6.3.3.7	Effects on aquatic life	45
6.4	Summary	46
7.	Martinborough Municipal Oxidation Pond	47
7.1	Background	47
7.1.1	System description	47
7.1.2	Receiving environment	47
7.2	Effluent analysis	48
7.2.1	Discharge quantity	48
7.2.2	Effluent water quality: compliance	48
7.2.3	Effluent water quality: trends	49
7.2.4	Effluent chemical loadings	49
7.3	Receiving water quality analysis	50
7.3.1	Temporal trends	50
7.3.2	Inter-site comparisons	50
7.3.3	Achieving water quality objectives	50
7.3.3.1	Dissolved oxygen	51
7.3.3.2	Temperature	52
7.3.3.3	Water clarity	52
7.3.3.4	pH	52
7.3.3.5	Undesirable biological growths	52
7.3.3.6	Water quality for farm animal consumption	53

7.3.3.7	Bathing water quality	53
7.3.3.8	Effects on aquatic life	54
7.4	Summary	55
	Acknowledgements	56
	References	57
	Appendix 1: Water Quality Determinants	59
	Appendix 2: Analytical Methods and Detection Limits	63
	Appendix 3: Greytown Effluent Compliance	64
	Appendix 4: Recreational Water Quality Notes	66

1. Introduction

1.1 Background

The five main townships of the Wairarapa Valley are served by reticulated sewerage systems with municipal oxidation ponds providing treatment for the effluent. The treated sewage effluent, which is primarily of domestic origin, is in turn discharged into nearby waterways.

These rivers, as well as functioning as receiving waters, have significant ecological value, are of spiritual significance to tangata whenua, and support recreational activities. Therefore the receiving waters should meet water quality standards which the community finds acceptable and which safeguard the life-supporting capacity of aquatic ecosystems^[13].

The five townships and their wastewater discharges are:

- Masterton, discharging to Makoura Stream
- Featherston, discharging to Donald's Creek
- Martinborough, discharging to the Ruamahanga River
- Greytown, discharging to Papawai Stream, and
- Carterton, discharging to the Mangatarere Stream.

The Makoura Stream, Papawai Stream and Mangatarere Stream (via Waiohine River) flow into the Ruamahanga River. Therefore all the municipal oxidation pond discharges, with the exception of Featherston, affect the Ruamahanga River.

1.1.1. Legislative responsibility

The following sets out Wellington Regional Council's legislative responsibility in relation to the wastewater discharges identified above. The Resource Management Act 1991 gives regional councils the responsibility to manage (section 30) and monitor (section 35) water bodies within their regions. In relation to discharge of effluent to water and receiving water quality, the relevant sections are:

- Section 15(1), which restricts discharge of contaminants to water unless allowed by a rule of a regional plan, a resource consent or regulations.
- Section 30(1)(f), which gives regional councils the control of discharges of contaminants into water.
- Section 35(2)(a, b, d), under which local authorities must monitor the state of the environment, the effectiveness of policies or plans, and the exercise of resource consents.
- Section 107(1)(a-g), which restricts the granting of discharge permits by the consent authority if the contaminant is likely to give rise to certain adverse effects in the receiving waters.

Under section 63 of the Resource Management Act 1991, Wellington Regional Council prepared a Regional Freshwater Plan for the Wellington Region^[13]. Section 5 of the Plan sets out policies to meet the following freshwater quality objectives:

- The quality of fresh water meets the range of uses and values for which it is required while the life supporting capacity of water and aquatic ecosystems is safeguarded.

- The quality of fresh water has the potential to meet the reasonable foreseeable needs of future generations.
- The quality of water is, as far as practicable, consistent with the values of the tangata whenua.

Policy 5 of the Plan provides for most water bodies in the Wellington Region to be managed so that water is of a suitable quality for aquatic ecosystem purposes. In addition, certain water bodies of significance are to be managed either in their natural state, for trout fishery and fish spawning purposes, for contact recreation purposes, or for water supply purposes. Receiving water quality guidelines for each of these purposes are contained in Appendix 8 of the Regional Freshwater Plan. Compliance with these guidelines should ensure that the water quality objectives above are achieved downstream of contaminant discharges.

1.2 Objectives

This report presents the results of the Wairarapa municipal oxidation pond water quality monitoring programme, carried out by Wellington Regional Council and local authorities. The objectives of the report are:

- (1) To provide information on the water quality of effluent discharges from the municipal oxidation ponds of the Wairarapa.
- (2) To provide information on the water quality of the receiving water bodies of the Wairarapa municipal oxidation pond discharges.
- (3) To assess compliance of receiving water quality with resource consents (where appropriate) and/or water quality objectives in the Regional Freshwater Plan.

1.3 Approach to analysis

This report assesses monitoring results for the period July 1999 to June 2001. A longer-term analysis is also given (1994 – 2001¹) to identify changes over time. This allows the effects of short-term variability to be identified and to place the current monitoring into context. This report follows on from the previous Wairarapa municipal oxidation pond report, which presented results to June 1999^[11].

Each of the five oxidation pond discharges (Masterton, Carterton, Greytown, Featherston and Martinborough) are analysed in separate chapters. For each system the following are assessed:

- Temporal trends in effluent water quality and receiving water quality.
- Effects of the effluent discharge on receiving water quality.
- Compliance with consent conditions (where appropriate); these usually relate to discharge rate, effluent water quality, and receiving water quality.
- Compliance with the guidelines in the Regional Freshwater Plan, which outline standards for water quality following the discharge of contaminants.

The water quality guidelines presented in the Regional Freshwater Plan are predominantly narrative standards. Numerical criteria are obtained from the

¹ Subject to data limitations.

ANZECC water quality guidelines^[1,2], The New Zealand Periphyton Guideline^[5], and New Zealand Recreational Water Quality Guidelines^[8].

Comparison of water quality data with the above guidelines and conditions should be treated with caution. Assessment of compliance is based on monthly measurements, taken at around the same time on each occasion. The water quality parameters can show considerable diurnal fluctuation and breaches of the guidelines may occur only at certain times of the day (and may or may not be detected under the current monitoring regime).

Although this report discusses compliance with water quality consent conditions, it is not a compliance report. Hence compliance with other conditions, such as adequacy of signage and risk communication strategies, is not assessed.

2. Methodology

2.1 Sampling programme

Wellington Regional Council samples the municipal oxidation ponds and receiving waters on a monthly basis. However, in some instances district councils have taken over the role of monitoring to fulfil consent conditions. Samples are taken of the effluent at the outfall from the ponds, and of the receiving waters upstream and downstream of the discharge point. In each case the downstream site is located at a particular distance from the discharge point to allow for adequate mixing.

Temperature, oxygen saturation and dissolved oxygen are measured in the field. The collected samples are analysed for the water quality determinants listed in Table 2-1. The analytical methods used, and why each determinant is of use, are described in Appendices 1 and 2.

Table 2-1: Water quality determinants included in the Wairarapa oxidation pond monitoring programme

Chemical determinants	Physical determinants	Biological determinants
Nitrate-nitrogen	pH	Faecal coliforms
Nitrite-nitrogen	Conductivity	<i>Escherichia coli</i> (<i>E.coli</i>)
Ammonia-nitrogen	Dissolved oxygen	
Total nitrogen	Temperature	
Soluble reactive phosphorus	Turbidity	
Total particulate phosphorus	Suspended solids	
Biochemical oxygen demand (BOD ₅)		

In addition to the monthly water quality monitoring, sampling of macroinvertebrate communities is undertaken. These samples are typically taken in summer (between November and March).

2.2 Data analysis

All statistical analyses included in this report were performed using a 95% level of confidence. Statistical tests were performed using the WQSTAT PLUS for Windows programme. The following non-parametric statistical tests were used:

- Mann-Kendall statistic and Sen Slope estimate, to test for significant time-dependant trends.
- Wilcoxon signed rank test, to compare medians of a group of samples (i.e. to compare water quality upstream of the discharge with that downstream).

Results from macroinvertebrate samples were used to calculate the Macroinvertebrate Community Index (MCI) and Semi-Quantitative Macroinvertebrate Community Index (SQMCI) using the methods of Stark^[12]. These were then compared to Stark's water quality habitat categories. The number of taxa present was also noted.

3. Masterton Municipal Oxidation Ponds

3.1 Background

3.1.1 System description

Masterton wastewater treatment plant is located about 4km south-east of Masterton, and serves a population of about 19200. The two-stage aerated primary oxidation pond system (Figure 3-1) was upgraded in 1991 to add fine screening and a plant building. Currently investigations are in progress for upgrading and possible improvements to the sewerage reticulation system^[3].



Figure 3-1: Masterton oxidation ponds and receiving environment

The consent for discharge of effluent to water (WAR 860009) was granted in 1986 and expired in 1996. The consent renewal is on hold while upgrade options are being developed. In the mean time the system continues to operate under the conditions of the 1986 consent. Effluent water quality sampling is performed by Masterton District Council at the discharge point. Water quality data are available as monthly results since 1994.

3.1.2 The receiving environment

Effluent from Masterton oxidation ponds is discharged into Makoura Stream. This is an urban stream, which flows from Masterton across farmland to the Ruamahanga River. The point of effluent discharge is about 850m upstream of the Makoura Stream confluence with the Ruamahanga River. Under the Regional Freshwater Plan the Makoura Stream is identified as needing enhancement for aquatic ecosystem purposes. The Ruamahanga River at this location is identified in the Regional

Freshwater Plan as having important recreational values, particularly for angling. It is therefore to be managed for aquatic ecosystem and contact recreation purposes.

Wellington Regional Council monitored water quality of the receiving waters on a monthly basis until June 2001, when the programme was taken over by Masterton District Council. Samples are taken of the Makoura Stream upstream (Makoura 1) and downstream (Makoura 2) of the effluent outfall. In addition, the Ruamahanga River is sampled upstream (Ruamahanga 1) and downstream (Ruamahanga 2) of the Makoura Stream confluence².

3.2 Effluent analysis

3.2.1 Discharge quantity

The maximum permitted discharge from Masterton oxidation ponds, as stated in the expired consent, is 284 m³/hour. Hourly flow data for one day per month is available for analysis. Figure 3-2 shows the median flow for each day compared to the maximum permitted flow. Flows exceeded the limit on all occasions for the data available, and the median was about 445 m³/hour. The causes of these high flows (which are higher than expected from a population of about 19200) have been attributed to leaks in the reticulation system and partial submersion of the system below groundwater level at times^[3]. Upgrade options to prevent these problems are being investigated.

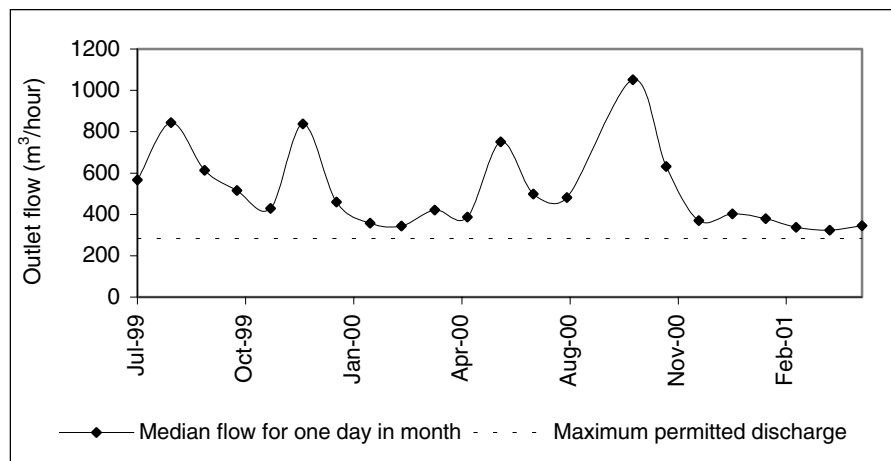


Figure 3-2: Outflow rate from Masterton oxidation ponds, July 1999 – May 2001

3.2.2 Effluent water quality: compliance

The expired consent for discharge from the Masterton oxidation ponds specifies effluent water quality conditions for BOD₅ loadings and dissolved oxygen. The BOD₅ loading cannot be assessed due to lack of influent data. However, dissolved

² Referred to as 'Ruamahanga River at Masterton' to avoid confusion with results for Martinborough oxidation pond

oxygen was consistently above the lower limit of 4 mg/L, with the lowest measurement being 5.3 mg/L.

3.2.3 Effluent water quality: trends

Time series analysis of effluent from Masterton oxidation ponds found few significant trends in water quality. Over the period July 1999 – June 2001 nitrite-nitrogen and BOD₅ increased significantly. The magnitude of the increase was about 0.14 g/m³/year for nitrite-nitrogen and 8 g/m³/year for BOD₅. Since 1994, total nitrogen has been increasing at a rate of about 1.4 g/m³/year. Apart from these changes in nitrogen concentrations effluent water quality has generally remained consistent over the last seven years. This is in agreement with results from previous years^[9,10].

3.2.4 Effluent nutrient loadings

In consideration of this discharge being a point source nutrient load to the river system, it is worthwhile to determine the contribution to the receiving environment. Based on the 1999 – 2001 effluent water quality results and the median flow estimate of the outfall (445 m³/hour), an estimation of the loadings to the Makoura Stream is:

58 tonnes/year of total nitrogen
12.5 tonnes/year of total particulate phosphorus

With regard to the nitrogen loading this would be the equivalent of an aerial application of nitrogenous fertiliser to about 387 hectares (based on 150 kg/ha/year). The background loading of the Makoura Stream (i.e. the accumulative effect from other landuse practises upstream of the effluent discharge point) is estimated as:

16 tonnes/year of total nitrogen
0.16 tonnes/year of total particulate phosphorus

This is based on a low flow gauging of Makoura Stream (163 L/s) and 1999 – 2001 median nutrient concentrations measured at Makoura 1³. Although only an estimate, and based on low-flow conditions, it shows that the discharge has a considerably higher loading than the background loading of Makoura Stream.

3.3. Receiving water quality analysis

3.3.1 Temporal trends

Temporal analysis of the data has identified few significant trends in water quality of both the Makoura Stream and the Ruamahanga River at Masterton. Between July 1999 and June 2001 conductivity and BOD₅ of Makoura Stream increased downstream of the outfall, yet no difference was observed upstream. The trend of increasing BOD₅ of Makoura Stream is likely a result of the increase in BOD₅ in the effluent (reported in Section 3.2.3), as the increases were of about the same magnitude.

³ Median values: Total nitrogen = 3.067 g/m³; Total particulate phosphorus = 0.031 g/m³

Over the seven years of record (1994 – 2001) nitrite-nitrogen, total nitrogen, soluble reactive phosphorus and total particulate phosphorus concentrations increased at the Makoura Stream downstream site. These trends were not observed upstream, or in the case of total nitrogen, the rate of increase was greater downstream. The magnitude of the observed increases is shown in Table 3-1.

Table 3-1: Changes in Makoura Stream water quality downstream of Masterton effluent discharge, 1994 – 2001

	1994-95 median	2000-01 median	Magnitude of increase
NO ₂ -N (g/m ³)	0.09	0.14	60%
Total N (g/m ³)	5.33	7.16	34%
SRP (g/m ³)	0.94	1.38	47%
TPP(g/m ³)	1.16	1.76	51%

No significant temporal trends in water quality have emerged for the Ruamahanga River downstream of Makoura Stream confluence. Therefore the degradation in terms of nutrient concentrations in Makoura Stream did not cause a corresponding degradation in Ruamahanga River water quality over time.

3.3.2 Inter-site comparisons

3.3.2.1 Makoura Stream

Comparison of the Makoura Stream water quality downstream of the outfall (Makoura 2) with that upstream (Makoura 1) found a significant difference in all of the parameters measured except temperature, pH and nitrate-nitrogen. Dissolved oxygen and oxygen saturation were lower downstream, with all other variables increasing. The magnitude of the downstream differences is shown in Table 3-2.

Table 3-2: Water quality of Makoura Stream upstream and downstream of Masterton effluent discharge, July 1999 – June 2001

	Makoura 1 median	Makoura 2 median	Magnitude of downstream change
Faecal coliforms (/100ml)	110	530	382%
<i>E.coli</i> (/100ml)	220	480	118%
Conductivity (µS/cm)	161	213	32%
Suspended solids (g/m ³)	0.75	18.50	2367%
Turbidity (NTU)	1.3	4.8	269%
NH ₄ -N (g/m ³)	0.01	2.46	24500%
NO ₂ -N (g/m ³)	0.01	0.12	1100%
Total N (g/m ³)	3.01	7.23	140%
SRP (g/m ³)	0.02	1.25	6150%
TPP (g/m ³)	0.03	1.43	4667%
Dissolved oxygen (g/m ³)	9.57	8.10	-15%
Oxygen saturation (%)	90.9	81.1	-11%
BOD ₅ (g/m ³)	0.19	9.29	4789%

The downstream changes can be attributed to the oxidation pond effluent discharge, due to the short distance between sites and dense riparian vegetation of the Makoura Stream margins mitigating against the influences of overland runoff. The largest

downstream changes caused by the effluent discharge are in chemical water quality, BOD₅ and suspended solid levels.

3.3.2.2 Ruamahanga River at Masterton

Water quality of the Ruamahanga River downstream of the Makoura Stream confluence (Ruamahanga 2) was compared with the results from upstream (Ruamahanga 1). Significant differences were found for nearly all parameters measured, with the exception of pH and temperature. Oxygen saturation was lower downstream and all other water quality variables were significantly higher at the downstream site. The magnitude of the downstream differences is shown in Table 3-3.

Table 3-3: Water quality of Ruamahanga River upstream and downstream of Makoura Stream confluence, July 1999 – June 2001

	Ruamahanga 1 median	Ruamahanga 2 median	Magnitude of downstream change
Faecal coliforms (/100ml)	32.5	70	115%
<i>E.coli</i> (/100ml)	50	100	100%
Conductivity (µS/cm)	137	147	7%
Suspended solids (g/m ³)	2	4	100%
Turbidity (NTU)	1.6	3.3	106%
NH ₄ -N (g/m ³)	0.01	0.14	1300%
NO ₂ -N (g/m ³)	0.002	0.017	750%
NO ₃ -N (g/m ³)	0.54	0.81	50%
Total N (g/m ³)	0.63	1.28	103%
SRP (g/m ³)	0.01	0.11	1000%
TPP (g/m ³)	0.02	0.13	550%
Oxygen saturation (%)	97.8	95.6	-2%
BOD ₅ (g/m ³)	0.26	1.62	523%

The largest differences downstream of the Makoura Stream confluence were found to be in chemical water quality and BOD₅. However, whether or not this is entirely due to the oxidation pond discharge is not known. Previous reports have found that increases in nitrogen concentrations and faecal coliforms in the Ruamahanga River are also due to agricultural and urban runoff^[10,11] which the Makoura Stream would contribute to the river in the absence of the effluent discharge.

Although the magnitude of the downstream changes can be considered significantly large, they are of smaller magnitude than the changes to the Makoura Stream downstream of the effluent discharge (Table 3-2). This is due to the higher dilution capacity of the Ruamahanga River. In addition, because of the Ruamahanga River's headwaters in the Tararua ranges, during summer the river receives periodic freshes. Freshes in the Makoura Stream occur considerably less often over summer.

3.3.3 Achieving water quality objectives

In the expired consent no conditions are stated for receiving water quality. However, in the Regional Freshwater Plan the Ruamahanga River is to be managed for aquatic ecosystem and contact recreation purposes, and the Makoura Stream requires

enhancement for aquatic ecosystem purposes. The water quality guidelines for minimum water quality standards in the RMA 1991 to be met are⁴:

“After reasonable mixing, the contaminant, either by itself or in combination with other contaminants, is not likely to cause any of the following effects:

- (1) The production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials.*
- (2) Any conspicuous change in the colour or visual clarity.*
- (3) Any emission of objectionable odour.*
- (4) The rendering of freshwater unsuitable for consumption by farm animals.*
- (5) Any significant adverse effects on aquatic life.”*

The additional guidelines for water to be managed for aquatic ecosystem purposes are that a contaminant must not cause any of the following effects⁵:

- (6) The natural temperature of the water shall not be changed by more than 3°C.*
- (7) The following shall not be allowed if they have an adverse effect on aquatic life:*
 - Any pH change*
 - Any increase in the deposition of matter on the bed of the water body or coastal water*
 - Any discharge of a contaminant into the water.*
- (8) The concentration of dissolved oxygen to fall below 80% of saturation concentration.*
- (9) There shall be no undesirable biological growths as a result of any discharge of a contaminant into the water.*

As well as the above guidelines, the Ruamahanga River at Masterton must meet contact recreation guidelines. These state that a contaminant must not cause the following effects⁶:

- The visual clarity of the water to be so low as to be unsuitable for bathing.*
- The water to be rendered unsuitable for bathing by the presence of contaminants.*

With the data available, some of the conditions cannot be tested, such as presence of oil or grease films and significant change in colour. The following is an assessment of compliance where possible.

3.3.3.1 Dissolved oxygen

The concentration of dissolved oxygen was consistently greater than 80% saturation at both Ruamahanga River at Masterton sites. However, as shown by Figure 3-3, the compliance of the Makoura Stream with this guideline was poor. The Makoura Stream downstream of the effluent discharge fell below 80% saturation on ten of the twenty-four sampling occasions. All measurements taken of the Makoura Stream upstream of the effluent discharge complied with the lower limit.

⁴ Regional Freshwater Plan Appendix 8, Guidelines A8.1

⁵ Regional Freshwater Plan Appendix 8, Guidelines A8.2

⁶ Regional Freshwater Plan Appendix 8, Guidelines A8.3

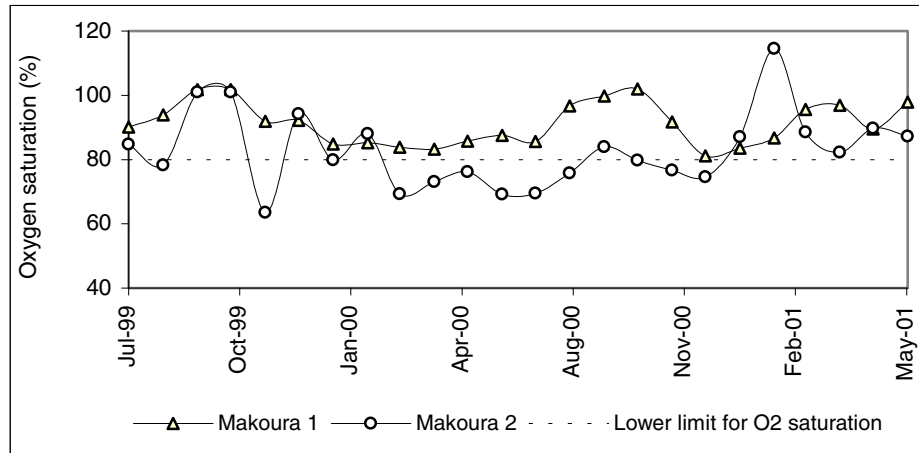


Figure 3-3: Oxygen saturation of Makoura Stream upstream and downstream of Masterton effluent discharge, July 1999 – June 2001

3.3.3.2 Temperature

The median temperature increase between Makoura 1 and Makoura 2 was 1.6°C, with the increase less than the 3°C maximum increase level on nearly all occasions. Compliance was observed for the Ruamahanga River at Masterton, with a median temperature change downstream of the Makoura Stream confluence of 0.4°C.

3.3.3.3 Water clarity

As water clarity is not directly measured as part of this programme, turbidity measured upstream and downstream of the discharge is used to assess whether a conspicuous change in clarity has occurred. A ‘conspicuous change’ is taken to be the maximum turbidity change of 10% recommended by ANZECC^[2]. Water clarity in the contact recreation guidelines^[8] requires black disk or secchi disk measurements, therefore compliance with these guidelines for the Ruamahanga River cannot be assessed.

The increase in turbidity at the downstream sites (as percentage increase compared to turbidity at the upstream sites) is shown in Figures 3-4 and 3-5.

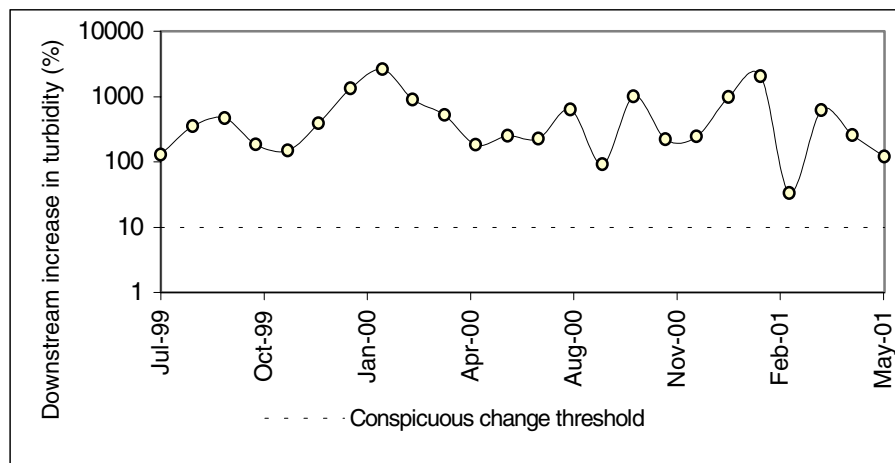


Figure 3-4: Change in Makoura Stream turbidity downstream of Masterton effluent outfall, July 1999 – June 2001

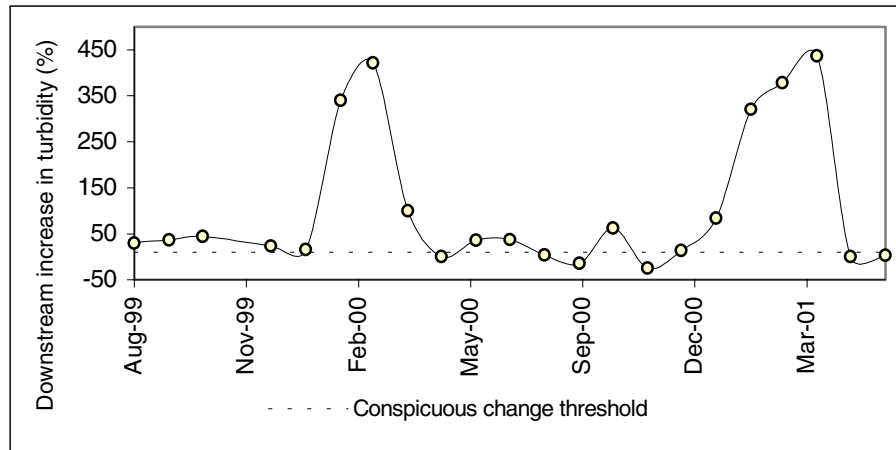


Figure 3-5: Change in Ruamahanga River downstream of Makoura Stream confluence, July 1999 – June 2001

On all occasions Makoura Stream turbidity was found to have been increased more than 10% downstream of the effluent discharge. Therefore the Masterton oxidation ponds are causing a conspicuous change in water clarity of the Makoura Stream. On most (16 out of 22) occasions the turbidity of the Ruamahanga River at Masterton was more than 10% greater downstream of the Makoura Stream confluence. The difference in turbidity between the upstream and downstream Ruamahanga River sites was greatest during the summer months. Therefore a conspicuous change in water clarity of the Ruamahanga is caused by the Makoura Stream, with the magnitude of change being seasonally linked.

The change in turbidity of the Ruamahanga River at Masterton is assumed⁷ to be a result of the effluent discharge. However it is possible that the Makoura Stream could cause an increase in turbidity of the Ruamahanga River (depending on conditions) in the absence of the effluent discharge. Water quality data prior to the commencement of discharge to the stream is not available to prove or disprove this point. However, as the median Makoura 1 turbidity is about the same as the upstream Ruamahanga River turbidity it is likely that the Makoura Stream would not cause a ‘conspicuous change’ in the absence of the Masterton effluent discharge.

3.3.3.4 pH

No change in pH was observed for the Makoura Stream downstream of the Masterton effluent discharge, nor was any pH change observed between the two Ruamahanga River at Masterton sites. Therefore compliance with the pH guideline is good.

3.3.3.5 Undesirable biological growths

Periphyton cover is not assessed as part of this monitoring programme. However, as the growth of periphyton is promoted by nutrient enrichment, nutrient concentrations can be used to assess compliance with this condition. The New Zealand Periphyton Guideline suggest maximum values of 34 mg/m³ soluble inorganic nitrogen and 2.8

⁷ The change is likely to be attributable to the localised nutrient input and associated increase in primary productivity (algae) caused by the discharge.

mg/m³ soluble reactive phosphorus, above which growth may be promoted given suitable flow conditions^[5].

Although soluble reactive phosphorus concentrations were significantly increased at the downstream sites (Tables 3-2 and 3-3), the 2.8 mg/m³ guideline was exceeded on all occasions at all sites. Similarly, the concentrations of soluble inorganic nitrogen were significantly higher than the 34 mg/m³ threshold for all samples taken. Therefore both the Makoura Stream and the Ruamahanga River at Masterton have sufficiently high nutrient concentrations to not limit the growth of periphyton. The presence of undesirable biological growths is likely, given suitable flow conditions, in the absence of the Masterton effluent discharge.

3.3.3.6 Water quality for farm animal consumption

Good water quality is essential for farm animal consumption, as poor water quality may reduce production and impair fertility^[1]. Water quality guidelines for livestock watering recommended by ANZECC^[1] are that:

- nitrate-nitrogen should not exceed 400 mg/L
- nitrite-nitrogen should not exceed 30 mg/L
- median faecal coliform count should not exceed 100 cfu/100ml.

As shown by Figure 3-6 nitrate-nitrogen and nitrite-nitrogen concentrations were significantly below the guideline values at both the Makoura Stream and Ruamahanga River at Masterton downstream sites.

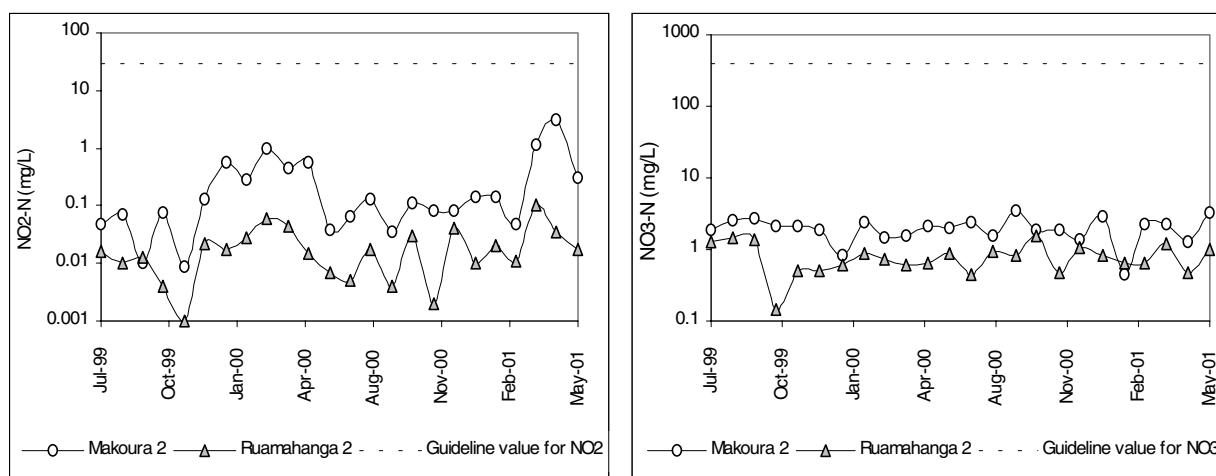


Figure 3-6: Nitrate and nitrite concentrations of downstream Makoura Stream and Ruamahanga River sites compared to livestock watering guidelines, July 1999 – June 2001

In terms of faecal coliforms, the Ruamahanga River complied with the 100 cfu/100ml median guideline at both sites. Compliance of the Makoura Stream was not as good. The median at Makoura 1 was 110 cfu/100ml and 530 cfu/100ml at Makoura 2. Therefore, as both sites exceeded the stock watering guideline for faecal coliforms the Masterton effluent discharge is not considered to have rendered the stream unsuitable for drinking by farm animals. Although the discharge does significantly increase faecal coliform counts (Table 3-2) upstream inputs have already caused an exceedance of the guidelines.

3.3.3.7 Bathing water quality

Current contact recreation guidelines^[8] specify a single-sample *E.coli* limit of 410 cfu/100ml. Testing for *E.coli* began in December 1999. Since this time the guideline value has been exceeded on one occasion (Figure 3-7). However, as the exceedance occurred at both sites (both upstream and downstream of the Makoura Stream confluence), the Masterton effluent discharge is not considered to have rendered the Ruamahanga River at Masterton unsuitable for bathing⁸.

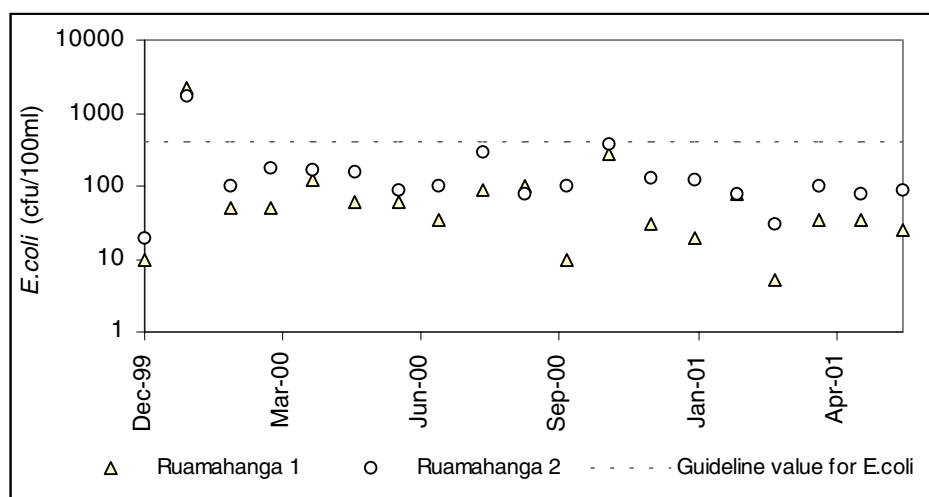


Figure 3-7: *E.coli* counts for the Ruamahanga River upstream and downstream of Makoura Stream confluence compared to contact recreation guidelines, 1999 - 2001

3.3.3.8 Adverse effects on aquatic life

Macroinvertebrate sampling of the Makoura Stream was performed on only one occasion in the two-year period, (February 2000). Unfortunately no macroinvertebrate results for the Ruamahanga River upstream and downstream of Makoura Stream confluence are available for analysis.

The median MCI and SQMCI results for the Makoura Stream in February 2000 are shown in Figure 3-8. Both of these indicators showed a substantial decrease downstream of the discharge; this is of the same magnitude as observed in previous years^[10,11]. For both indices the classification degraded from 'probable mild pollution' upstream to 'probable severe pollution' downstream of the discharge.

As well as the changes in MCI and SQMCI scores, the number of taxa present was considerably less downstream (median of 5 taxa present at Makoura 2, as opposed to 9 present at Makoura 1). Mayflies (*Ephemeroptera*), which are particularly sensitive to organic enrichment, were rare at the upstream site and absent downstream. These results show an adverse effect on aquatic life downstream of the effluent discharge, and although based on only one sampling occasion the results are very similar to samples collected in 1998^[10] and 1999^[11].

⁸See Appendix 4

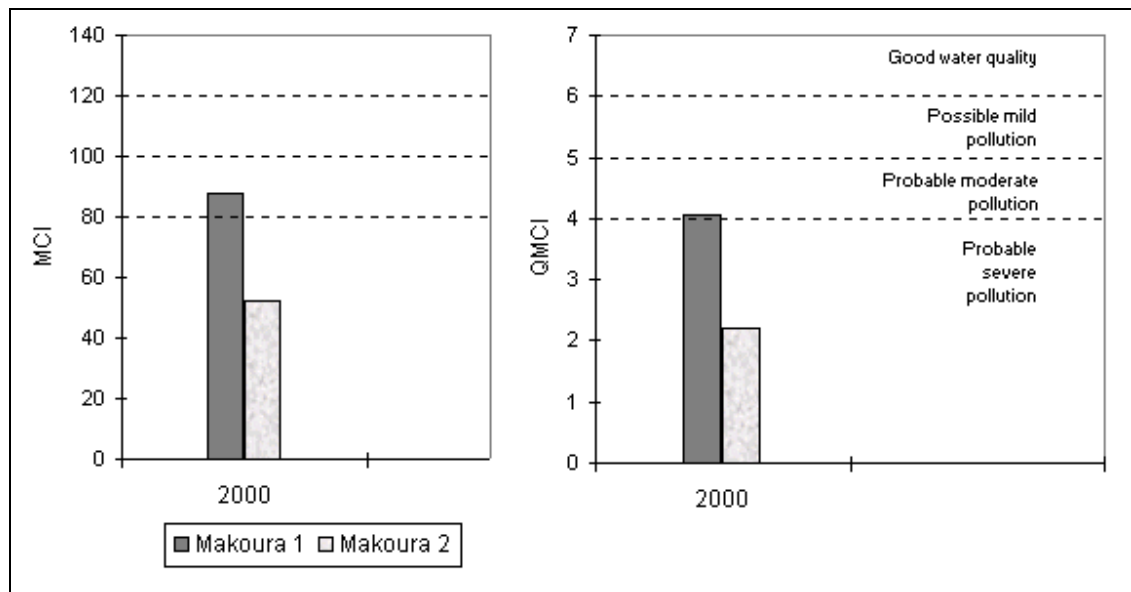


Figure 3-8: Makoura Stream MCI and SQMCI results upstream (Makoura 1) and downstream (Makoura 2) of Masterton oxidation pond discharge, February 2000

3.4 Summary

The Masterton oxidation ponds discharge effluent to the Makoura Stream, at a flow rate much higher than expected from a population of 19200. Causes of high flows and options for plant upgrades are being investigated as part of the resource consent process.

Trends

Between July 1999 and June 2001 the trends in effluent water quality observed were an increase in nitrite-nitrogen and BOD₅. The increase in BOD₅ in the effluent is probably the cause of the increase in this variable in the Makoura Stream downstream of the discharge. Other trends observed for Makoura Stream water quality since 1994 were increases in nitrite-nitrogen, total nitrogen, soluble reactive phosphorus and total particulate phosphorus concentrations. No trends were found for the water quality of the Ruamahanga River at Masterton.

Inter-site median comparisons

The Makoura Stream water quality downstream of the discharge was significantly different to that upstream. All variables measured showed a significant change, except temperature, pH and nitrate-nitrogen, with the largest increases in ammonia-nitrogen and BOD₅. The Ruamahanga River downstream of the Makoura Stream confluence was found to be significantly different from the upstream site in all water quality variables measured except temperature, and pH. The largest increases were in ammonia-nitrogen and soluble reactive phosphorus concentrations.

Achieving water quality objectives

Under the Regional Freshwater Plan the Makoura Stream is to be managed for aquatic ecosystem purposes. Comparison of Makoura Stream water quality with water quality guidelines for contaminant discharges showed compliance with the conditions for pH and temperature. However, the discharge was found to be causing a conspicuous change in water clarity and at times non-compliance with the dissolved oxygen condition. Exceedances of the guideline values for undesirable biological growths and livestock drinking water quality occurred. However background water quality of the Makoura Stream also showed non-compliance and so the Masterton effluent discharge is not considered to be causing the exceedance. Based on one macroinvertebrate sampling occasion the discharge may be having an adverse effect on aquatic life of the Makoura Stream.

The Ruamahanga River water quality is to be managed for aquatic ecosystem and recreational water quality purposes. Comparison of Ruamahanga River with the water quality guidelines for contaminant discharges showed compliance with the conditions for pH, temperature, dissolved oxygen and livestock watering standards. The river generally complied with bathing water quality guidelines although one exceedance of the *E.coli* guideline did occur. However as this was both upstream and downstream of the Makoura Stream confluence, the exceedance was not a result of the oxidation pond discharge. However, the Makoura Stream confluence was found to be causing a conspicuous change in water clarity of the Ruamahanga River, in particular during summer months. This is probably due to the Masterton oxidation pond discharge.

4. Carterton Municipal Oxidation Ponds

4.1 Background

4.1.1 System description

Carterton District Council manages a tertiary oxidation pond system to service a population of about 4100 people (Figure 4-1). The system consists of primary sedimentation, a secondary oxidation pond and a single tertiary pond with mechanical aerators. Discharge occurs from the system into the nearby Mangatarere Stream, for which a consent (WAR 950148) was granted in March 1999. This consent specifies, among other conditions, that from 31 December 2002 discharges to the stream will be suspended seasonally, with a land-based disposal system used over summer.



Figure 4-1: Carterton oxidation ponds

Good Earth Matters^[7] assessed the environmental effects of effluent discharge from Carterton oxidation ponds, and recommended installing mechanical aerators. This was part of a strategy to improve effluent water quality and produce more consistent water quality. Following this advice mechanical aerators were installed in June 1999.

As specified in the consent, Carterton District Council takes samples of the effluent at the discharge point on 10 days per month, which are tested for faecal coliforms, suspended solids and BOD₅. Once a month a more detailed analysis is performed on a sample. These data (from July 1999) and data collected by Wellington Regional Council (1994 – 1999), have been used in the following analysis.

4.1.2 The receiving environment

The Mangatarere Stream is a rural stream with headwaters in the Tararua Forest Park and confluence with the Waiohine River. Water quality has been found to be lower in comparison to other Western Wairarapa rivers^[9], a result of predominantly agricultural pressures. The Regional Freshwater Plan identifies the Mangatarere Stream as both a water body needing enhancement, and a water body with important trout habitat. The water quality is therefore to be managed under Policy 5.2.3 for trout fishery and fish spawning purposes.

As part of their consent requirements, Carterton District Council samples the Mangatarere Stream upstream (Mangatarere 1) and downstream (Mangatarere 2) of the effluent discharge point on a monthly basis.

4.2 Effluent analysis

4.2.1 Discharge quantity

The consent for discharge to the Mangatarere Stream from Carterton oxidation pond specifies a maximum permitted discharge rate of 3270 m³/day. The daily discharge is estimated from stage readings taken at a V-notch weir at the pond outlet. Once an automated flow measuring device is installed, compliance with consent conditions can be more accurately and continuously assessed.

Flow estimates (from November 1999), show compliance was good, with only one estimate greater than the maximum permitted discharge rate (Figure 4-2). The median flow was 762 m³/day, and flow was highly variable (90th percentile of 1813 m³/day).

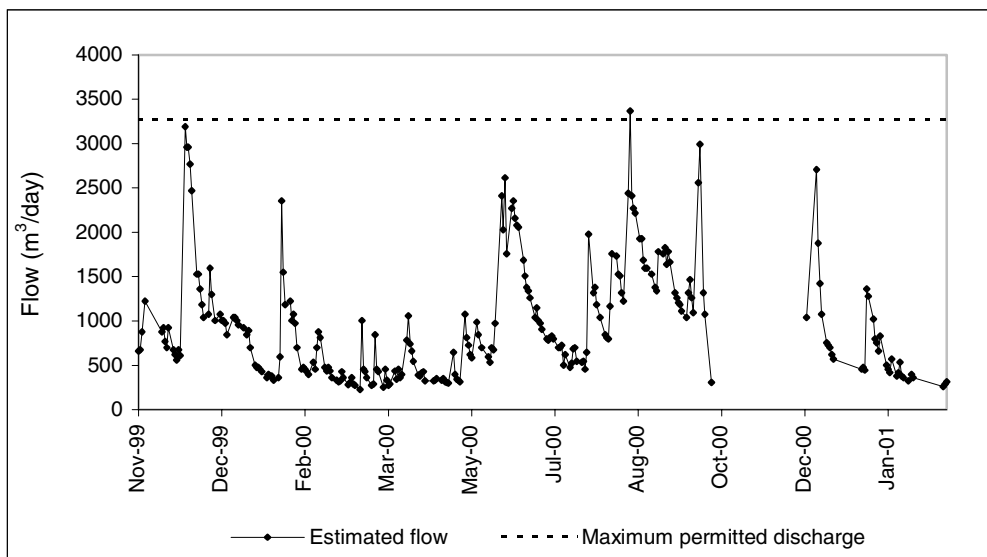


Figure 4-2: Outflow rate from Carterton oxidation ponds, 1999 – 2001

4.2.2 Effluent water quality: compliance

The consent for discharge to water specifies effluent water quality criterion that must be met (Condition 22). These relate to BOD₅, suspended solids and faecal coliforms.

4.2.2.1 BOD₅

Condition 22a requires that the geometric mean BOD₅ of 40 consecutive samples must not exceed 25 g/m³, with no more than ten percent of 40 consecutive samples greater than 50 g/m³. For the period July 1999 – February 2001, the geometric mean exceeded 25 g/m³ between 10 May and 8 June 2000, since this time compliance has occurred (Figure 4-3). No samples greater than 50 g/m³ have been recorded.

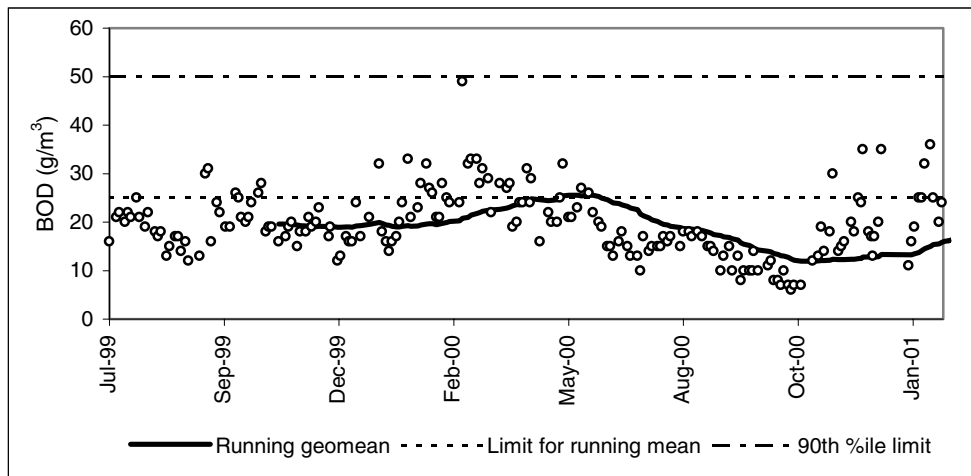


Figure 4-3: BOD₅ in Carterton oxidation pond effluent, July 1999 – February 2001

4.2.2.2 Suspended solids

Condition 22b relates to suspended solids, for which the geometric mean of 40 consecutive samples must not exceed 45 g/m³, with no more than ten percent of samples exceeding 90 g/m³. As shown by Figure 4-4, the first part of the condition was exceeded between 8 May and 2 June 2000, however since this time compliance has occurred. The second part of the condition has been met.

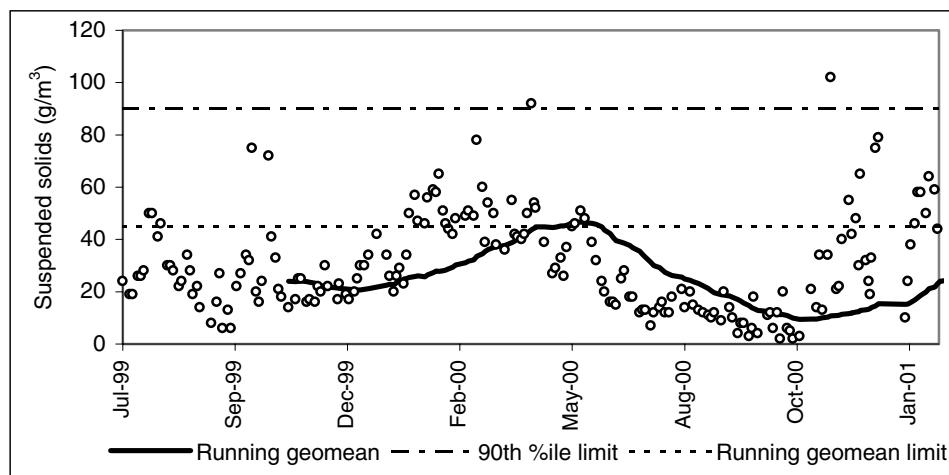


Figure 4-4: Suspended solids in Carterton oxidation pond effluent, July 1999 – February 2001

Non-compliance of the geometric mean appears to be related to seasonal variations in suspended solids. This is probably due to an increase in primary productivity, caused by the increased biological activity over summer.

4.2.2.3 Faecal coliforms

The condition for faecal coliforms states the geometric mean of 40 samples shall not exceed 5000 cfu/100ml. For the period July 1999 – February 2001, compliance with this condition has only occurred between 19 September and 11 November 2000 and again between 7 December 2000 and 12 January 2001 (Figure 4-5). The cause of this poor compliance is being investigated.

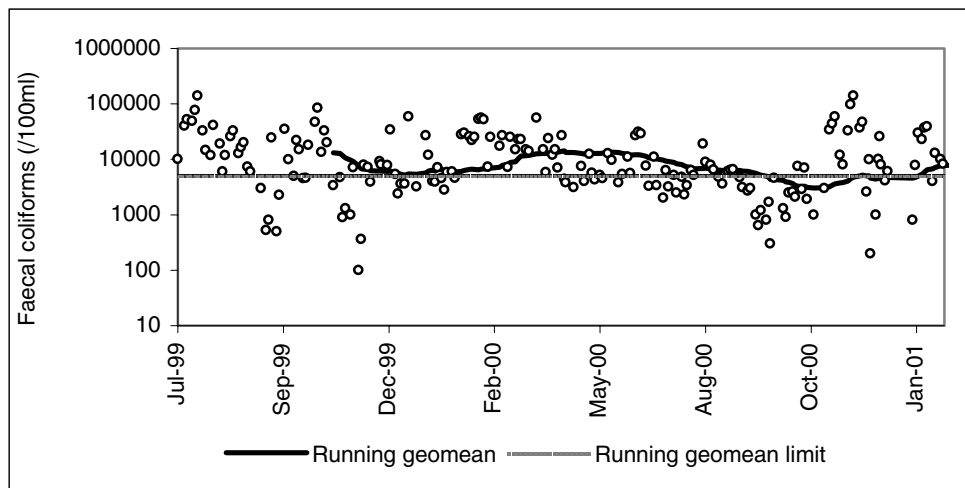


Figure 4-5: Faecal coliforms levels in Carterton effluent, July 1999 – February 2001

4.2.3 Effluent quality: trends and comparisons

Temporal trend analysis of the 1994 – 1999 Wellington Regional Council dataset found no significant changes in effluent water quality over this period. Similarly, the Carterton District Council data collected since July 1999 shows no significant change in the water quality parameters measured. This suggests that the inflow and outflow quality has remained consistent, i.e. any changes in domestic and industrial inputs have not been significant.

Comparison of the Wellington Regional Council data (pre-July 1999) with the Carterton District Council data collected since July 1999 shows no difference in temperature, conductivity, dissolved oxygen, soluble reactive phosphorus, total phosphorus or nitrate-nitrogen. However, the data from July 1999 shows significantly lower suspended solids and BOD₅ levels than the 1994 – 1999 data with an accompanying lower variability. This improvement in effluent water quality and a more consistent water quality was an anticipated outcome of installing mechanical aerators in June 1999^[7].

Total nitrogen and faecal coliform levels are significantly higher in the data collected since July 1999 (faecal coliforms increased from a median of 2350 cfu/100ml to 7250 cfu/100ml; total nitrogen from a median of 14.0 g/m³ to 26.7 g/m³). However, both of the parameters have shown a sudden increase at the time Carterton District Council began sampling the effluent in July 1999 (the laboratory analysing the

results also changed). This indicates that an increase could be due to the change in sampling or analytical practises.

4.2.4 Effluent chemical loadings

Considering that this discharge is a point source load to the river system, it is worthwhile to determine what the contribution to the receiving environment is. Based on the 1999 – 2001 effluent water quality results and flow estimates of the outfall (median 762 m³/day), an estimation of the loadings of nitrogen and phosphorus contributed to the Mangatarere Stream is:

7.4 tonnes/year of total nitrogen
1.6 tonnes/year of total particulate phosphorus

With regard to the nitrogen loading this would be the equivalent of an aerial application of nitrogenous fertiliser to about 49 hectares (based on 150 kg/ha/year). The background loading of the Mangatarere Stream (i.e. the accumulative effect from other landuse practises upstream of the effluent discharge point) is estimated as:

109 tonnes/year of total nitrogen
2.8 tonnes/year of total particulate phosphorus

This is assessed using the mean 1999 – 2000 flow estimate for Mangatarere Gorge of 1.78m³/s^[14] and median concentrations of total nitrogen (1.95 g/m³) and total particulate phosphorus (0.05 g/m³) measured monthly at Mangatarere ⁹. This is not considered an accurate calculation but indicates that the loading of the effluent is roughly adding about 7% more total nitrogen and 75% more phosphorus. Obviously during low flow conditions the receiving water load will be lower.

4.3 Receiving water quality analysis

4.3.1 Temporal trends

During 1994 – 1999 there were no changes in the measured water quality variables (with the exception of turbidity) at the downstream site that did not also have a corresponding change at the upstream site. However, the identified gradual decrease in turbidity upstream was not found downstream of the outfall. At both locations faecal coliforms were found to have significantly increased, but the rate of increase was greater downstream of the outfall (82 cfu/100ml/year, as opposed to 35 cfu/100ml/year upstream of the outfall).

Similarly, from July 1999 to February 2001 few changes in receiving water quality were observed over time, except that a significant increase in BOD₅ was found downstream of the outfall. This increase has predominantly occurred between November 2000 and February 2001, so is probably due to the prolonged period of low flows experienced, as no change in effluent water quality was observed (Section 4.2.3). Data collected over autumn and winter 2001 will show whether BOD₅ levels decrease once receiving water flow increases.

Comparing the two datasets (1994 – June 1999 and July 1999 – February 2001) found the downstream site was significantly lower in suspended solids post-July

⁹ Median values: Total nitrogen = 1.95 g/m³; Total particulate phosphorus = 0.05 g/m³

1999 (Figure 4-6). This is probably a result of lower suspended solids in the effluent following installation of mechanical aerators: no difference was observed at the upstream site.

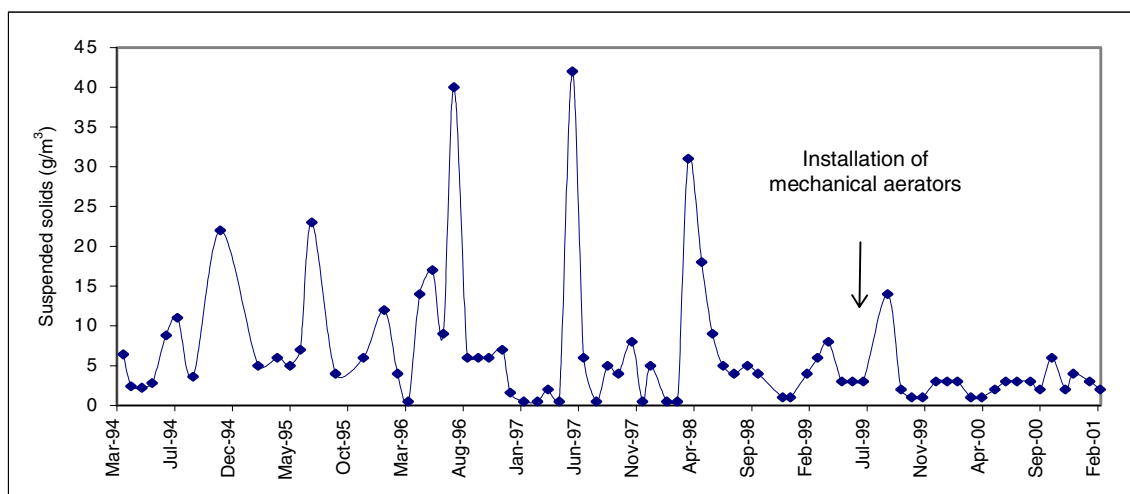


Figure 4-6: Suspended solids levels in Mangatarere Stream downstream of effluent discharge

Other differences found between the two datasets were: significantly higher conductivity, faecal coliform counts, nitrate-nitrogen, total nitrogen, soluble reactive phosphorus and total phosphorus in the post-July 1999 data. As these differences occurred suddenly in July 1999, and occurred at both the upstream and downstream sites, it is likely these are an effect of changing analytical practises¹⁰, rather than a decline in water quality. For example, the observed increase in total phosphorus is probably to be due to a change in detection levels post-July 1999¹¹.

4.3.2 Inter-site comparisons

Statistical tests to compare water quality of the Mangatarere Stream upstream and downstream of the outfall found that the downstream site was significantly higher in:

- conductivity
- soluble reactive phosphorus
- total particulate phosphorus
- turbidity
- BOD₅
- faecal coliforms
- total nitrogen

over both 1994 – 1999 and 1999 – 2001. Between 1994 and 1999 the downstream site was also significantly higher in suspended solids. However, from July 1999 there was no difference between the sites in suspended solids, once again a result due to improved water quality of the effluent. The magnitude of the observed differences between the upstream ('Mangatarere 1') and downstream ('Mangatarere 2') sites is shown in Table 4-1.

¹⁰ Analysis of samples from July 1999 has been done by ELS, Lower Hutt; before this time analysis was performed by Wairarapa Laboratory Services. Sampling performed by P.Leighton (CDC) throughout.

¹¹ Pre-July 1999 detection level was 0.003g/m³; post July-1999 detection limit is 0.1g/m³

Table 4-1: Water quality of Mangatarere Stream upstream and downstream of Carterton effluent discharge, July 1999 – February 2001

	Mangatarere 1 median	Mangatarere 2 median	Magnitude of downstream change
Faecal coliforms (cfu/100ml)	420	700	67%
Turbidity (NTU)	1.3	1.9	46%
Conductivity ($\mu\text{S/m}$)	10.6	11.6	9%
SRP (g/m^3) ¹²	0.06	0.125	108%
TPP (g/m^3)	0.05	0.30	500%
Total nitrogen (g/m^3)	2.0	2.6	30%
BOD ₅ (g/m^3)	0.40	0.72	80%

The largest differences were found to be in phosphorus concentrations, BOD₅ and faecal coliform counts. This is in contrast to previous years' results. For 1998 – 1999 the downstream site was significantly higher in ammonia-nitrogen, nitrite-nitrogen and phosphorus but not faecal coliforms and BOD₅^[10]. Therefore the downstream difference may have only just become significant, due to the trend of increasing faecal coliforms and BOD₅ at the downstream site (see Section 4.3.1).

4.3.3 Achieving water quality objectives

Under the Regional Freshwater Plan the Mangatarere Stream is to be managed for fishery and fish spawning purposes. These classifications are incorporated into receiving water quality standards in the consent for discharging effluent to water, hence compliance with the consent should mean compliance with the Regional Freshwater Plan. The consent conditions state that the Carterton oxidation pond effluent discharge should not cause the following in the Mangatarere Stream:

- *The production of conspicuous oil or grease films, scums or foams or floatable or suspended material.*
- *Any conspicuous change in colour or water clarity.*
- *The rendering of freshwater unsuitable for consumption by farm animals.*
- *Any significant adverse effect on aquatic life.*
- *Any pH change.*
- *A change of more than 3°C in the natural temperature of the water.*
- *Undesirable biological growths.*

In addition, the Regional Freshwater Plan water quality guidelines recommend that for water bodies managed for aquatic ecosystem and fish spawning purposes:

- *There should be no increase in the deposition of matter on the bed of the water body dissolved oxygen, if this causes adverse effects on aquatic life.*
- *Dissolved oxygen should not fall below 80% saturation.*
- *Temperature should not exceed 25°C¹³.*

With the data available, some of the conditions cannot be tested, such as presence of oil or grease films, significant change in colour and deposition of matter on the bed. The following is an assessment of compliance where possible.

¹² Mean used rather than median, as although Wilcoxon Rank Sum test showed a significant difference, both medians were below the detection limit of 0.1 g/m^3 .

¹³ Regional Freshwater Plan Appendix 8, Guidelines A8.2 and A8.4

4.3.3.1 Dissolved oxygen

For management of water bodies for fish spawning purposes, the Regional Freshwater Plan recommends a lower-limit guideline value of 80% oxygen saturation. As saturation concentration measurements are not available¹⁴, a lower limit of 5 mg/L dissolved oxygen is used, as below this freshwater fish may become stressed¹⁵.

In general, compliance with this guideline has been good (Figure 4-7), with no significant difference between the upstream and downstream sites. On two of the three occasions when dissolved oxygen was found to be below 5 mg/L, the upstream site was also below the limit, and so the Carterton effluent discharge was not the contributing factor. The only occasion when the downstream site fell significantly below the upstream value was during summer flow conditions (January 2000). Since this time compliance with the guideline has occurred.

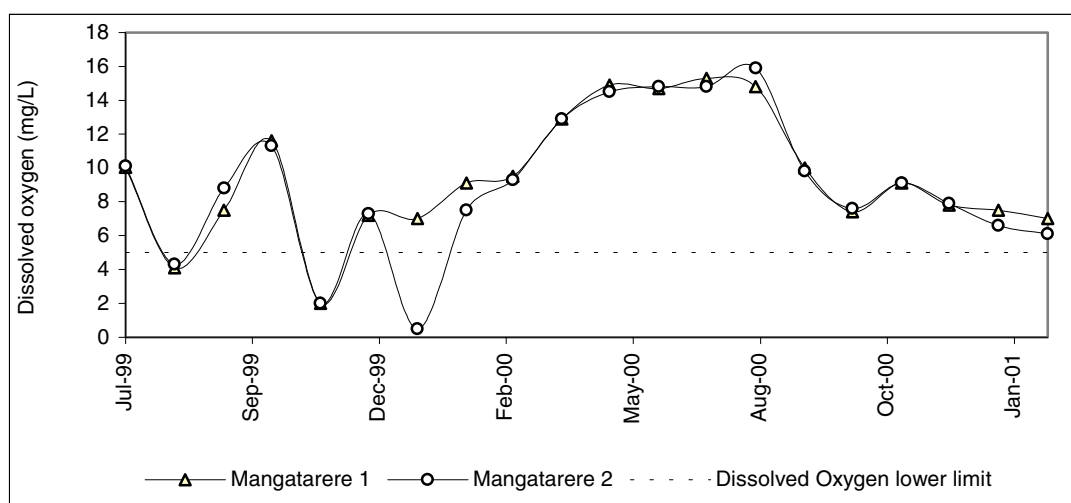


Figure 4-7: Mangatarere Stream dissolved oxygen levels, upstream and downstream of CDC effluent outfall, 1999-2001

4.3.3.2 Temperature

As stated in the consent Condition 19, the natural temperature of the Mangatarere Stream must not be altered more than 3°C. This condition has generally been complied with, with two exceedances since July 1999. The average downstream temperature increase is 0.5°C. Temperature measurement have never exceeded 25°C, the guideline limit for fish spawning protection in the Regional Freshwater Plan.

4.3.3.3 Water clarity

As water clarity is not directly measured as part of this programme, turbidity measured upstream and downstream of the discharge is used to assess whether a conspicuous change in clarity has occurred. A 'conspicuous change' is taken to be the maximum turbidity change of 10% recommended by ANZECC^[2]. As previously

¹⁴ Samples are analysed for dissolved oxygen, rather than oxygen saturation

¹⁵ Dissolved oxygen is used as an indicator only. The standard in the ANZECC (2001) guidelines is oxygen saturation, which takes into account the effects of altitude and barometric pressure.

mentioned (section 4.3.2) turbidity was significantly higher at Mangatarere 2, with the median increase in turbidity downstream of the discharge being 47% (Table 4-1).

Figure 4-8 shows the difference in turbidity between Mangatarere 2 and Mangatarere 1 since July 1999. On most occasions turbidity was more than 10% greater at the downstream site compared to that at the upstream site, and the difference was greatest during the summer months. Therefore the Carterton effluent discharge is assumed to be causing a conspicuous change in water clarity.

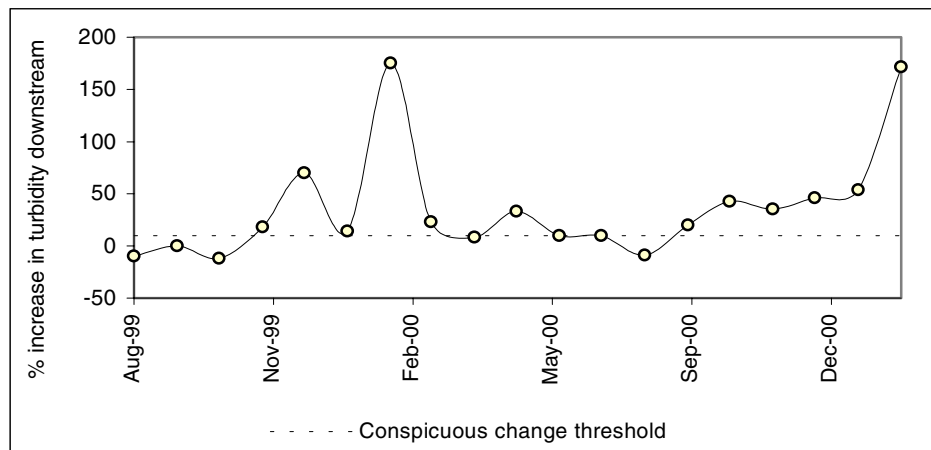


Figure 4-8: Change in Mangatarere Stream turbidity downstream of Carterton effluent discharge, 1999 – 2001

4.3.3.4 pH

Inter-site comparisons (Section 4.3.2) found there was no observed difference in pH downstream of the effluent discharge. Therefore compliance with this consent condition was good.

4.3.3.5 Undesirable biological growths

As periphyton cover is not assessed during receiving water sampling, it is difficult to assess whether the effluent discharge is causing undesirable biological growths. A recent report found that increased periphyton cover during the 1999-2000 and 2000-2001 summers degraded habitat quality downstream of the discharge point^[6]. However, as this was recorded on only two occasions, and because other factors contribute to such growths, this is not considered significant. Presence of sewage fungus was also noted in the mixing zone downstream of the outfall during 1994 and 1996^[6]; lack of recent data prevents assessment of whether this is currently causing non-compliance with consent conditions.

The growth of periphyton is promoted by nutrient enrichment. The New Zealand Periphyton Guideline suggests maximum values of 34 mg/m³ soluble inorganic nitrogen and 2.8 mg/m³ soluble reactive phosphorus, above which growth may be promoted given suitable flow conditions^[5]. As shown by Figure 4-9, soluble inorganic nitrogen concentrations were consistently greater than the guideline value at both the upstream and downstream sites. Soluble reactive phosphorus

concentrations were also greater than the guideline value at both sites, although it must be noted that the guideline value was below the detection limit of the test^γ.

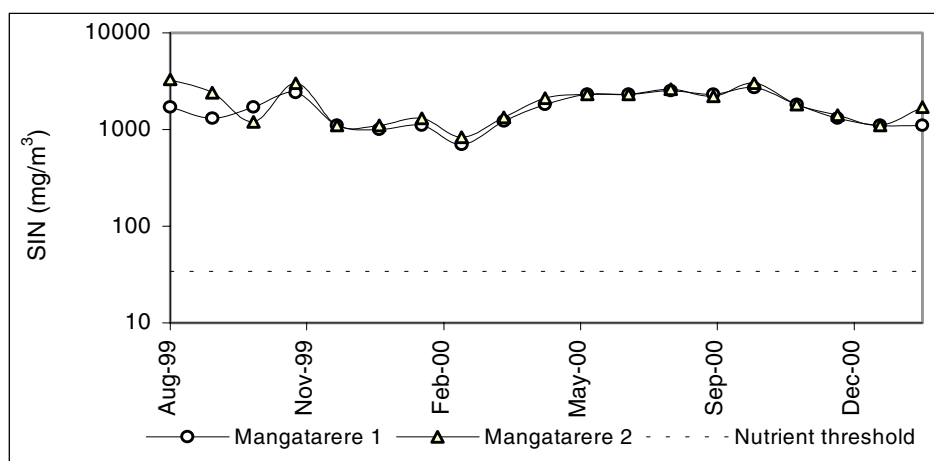


Figure 4-9: Mangatarere Stream soluble inorganic nitrogen concentrations upstream and downstream of Carterton effluent discharge, 1999 – 2001

Nitrogen concentrations in the Mangatarere Stream are therefore not a limiting factor for the growth of periphyton. In the absence of the Carterton effluent discharge nutrient levels would probably still be high enough to be non-limiting for undesirable biological growths given suitable flow conditions. Lack of phosphorus data below the detection level prevent this from being concluded.

4.3.3.6 Water quality for farm animal consumption

Good water quality is essential for farm animal consumption, as poor water quality may reduce production and impair fertility^[1]. Water quality guidelines for livestock watering recommended by ANZECC^[1] are:

- nitrate-nitrogen should not exceed 400 mg/L
- nitrite-nitrogen should not exceed 30 mg/L
- median faecal coliform count should not exceed 100 cfu/100ml.

For Carterton oxidation pond effluent receiving water nitrite-nitrogen results were not available. However nitrate-nitrogen concentrations at both the upstream and downstream Mangatarere Stream sites were consistently below the recommended value. Compliance with the faecal coliform condition was poor. The median count for the Mangatarere Stream downstream of the effluent discharge was 700 cfu/100ml (July 1999 – February 2001). However, the guideline was also exceeded upstream of the discharge, where the median was 420 cfu/100ml. Therefore, the Mangatarere Stream may not be suitable for livestock watering in terms of bacteriological water quality.

^γ Detection limit of the SRP analysis performed by Environmental Laboratory Services was 0.1 g/m³ (100 mg/m³)

4.3.3.7 Effects on aquatic life

To assess whether the effluent outfall has significant adverse effects on aquatic life, macroinvertebrate community structure upstream and downstream of the outfall are compared. Macroinvertebrate monitoring surveys of the Mangatarere Stream upstream and downstream of the Carterton effluent outfall are carried out twice yearly, to fulfil Condition 18 of the consent for discharge to water. The results used in this report were those presented by Brian T. Coffey & Associates Ltd^[6].

MCI, SQMCI and EPT index values have been consistently lower at the downstream site between October 1999 and March 2001 (4 sampling occasions). Figure 4-10 shows the median MCI and SQMCI results for each occasion, compared with the guideline values of Stark^[12].

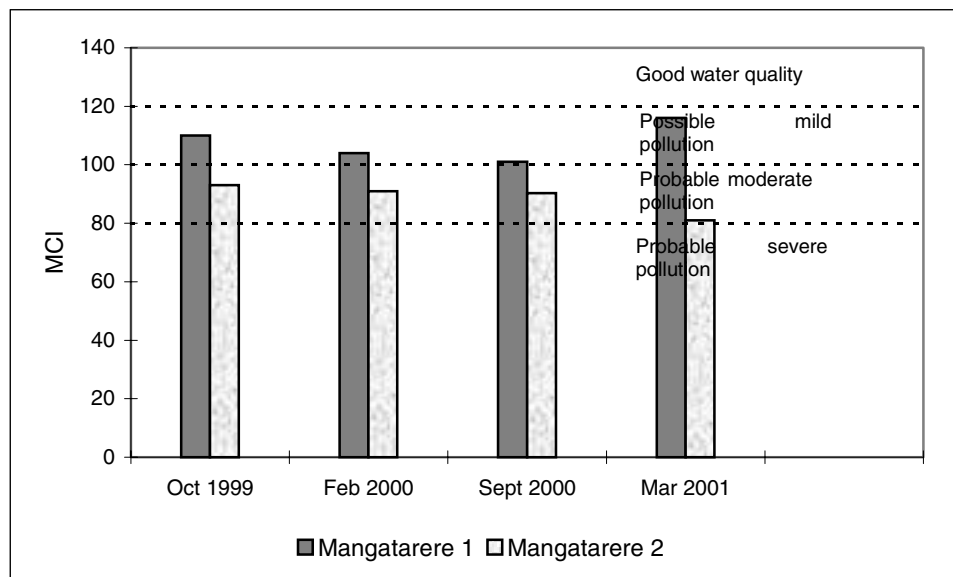


Figure 4-10: Mangatarere Stream MCI scores upstream and downstream of CDC effluent outfall

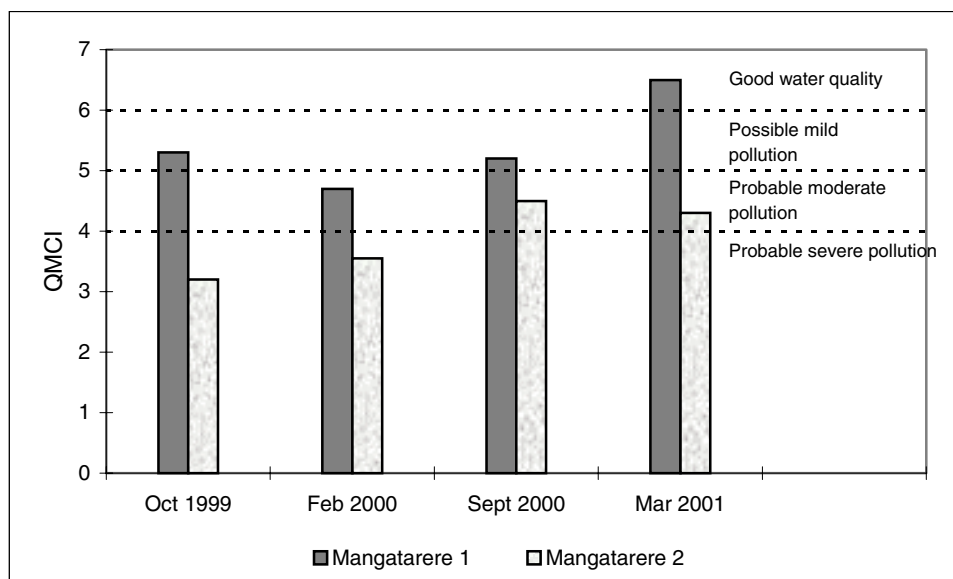


Figure 4-11: Mangatarere Stream SQMCI scores upstream and downstream of CDC effluent outfall

For the MCI scores, the downstream site is consistently in the 'probable moderate pollution' category, a degradation from 'possible mild pollution' upstream. The SQMCI scores were more variable. The downstream site varied from probable moderate to severe pollution, once again degrading from possible mild pollution/good water quality upstream of the outfall. The presence of *Ephemeroptera* (mayflies), which are particularly sensitive to organic enrichment, was considerably lower downstream of the effluent outfall. Therefore the results indicate that the Carterton effluent discharge is having an adverse effect on the aquatic community structure of the Mangatarere Stream; this was also concluded by Coffey^[6].

4.4 Summary

A new consent for discharge to water from Carterton oxidation ponds was granted in June 1999. Since this time effluent from the ponds has generally complied with the conditions in the consent for flow rate, BOD₅ and suspended solids. However, compliance with the faecal coliform condition was poor.

Since the installation of mechanical aerators in July 1999, BOD₅ and suspended solid concentrations in the effluent have significantly decreased. However, at this time faecal coliform and chemical water quality variables increased substantially. This could be due to a change in analytical practises that occurred at this time. Receiving water quality also benefitted from the installation of mechanical aerators with a significant decrease in suspended solids downstream of the effluent discharge since July 1999. However a degradation occurred in terms of BOD₅ levels at the downstream site over time; this could be due to low flows over summer 2000 – 2001.

The effluent discharge caused significantly increased faecal coliform counts, turbidity, conductivity, BOD₅, phosphorus and total nitrogen concentrations in the Mangatarere Stream. The largest increases downstream of the outfall were in soluble reactive phosphorus and total particulate phosphorus concentrations.

Comparison with consent conditions and Regional Freshwater Plan guidelines for water quality found compliance with conditions for dissolved oxygen, temperature change and pH. Non-compliance of the Mangatarere Stream with nutrient levels for promoting undesirable biological growths and with livestock drinking water standards was not caused by the effluent discharge. Upstream inputs meant that exceedances of these guidelines occurred. However, the Carterton effluent discharge was found to have caused a 'conspicuous change' in water clarity, and is potentially having an adverse effect on aquatic life.

5. Greytown Municipal Oxidation Ponds

5.1 Background

5.1.1 System description

South Wairarapa District Council operates a two-pond sewage treatment plant for Greytown, serving a population of about 2000 (Figure 5-1). The average retention time of the treatment ponds is approximately 35 days^[4], after which the treated effluent is discharged into Papawai Stream. The consent for discharge to water (WAR 960286) states that South Wairarapa District Council should investigate and identify preferred long-term sewage effluent disposal options. At the time of writing this report, works were in progress to divide the second pond into three to ensure adequate retention time for treatment. Therefore information presented in this report will allow future assessment of improvements in effluent water quality due to such changes to the system.

As the consent for discharge to water (WAR 960286) became effective on 13 June 2001, compliance with the new consent conditions will not be assessed.

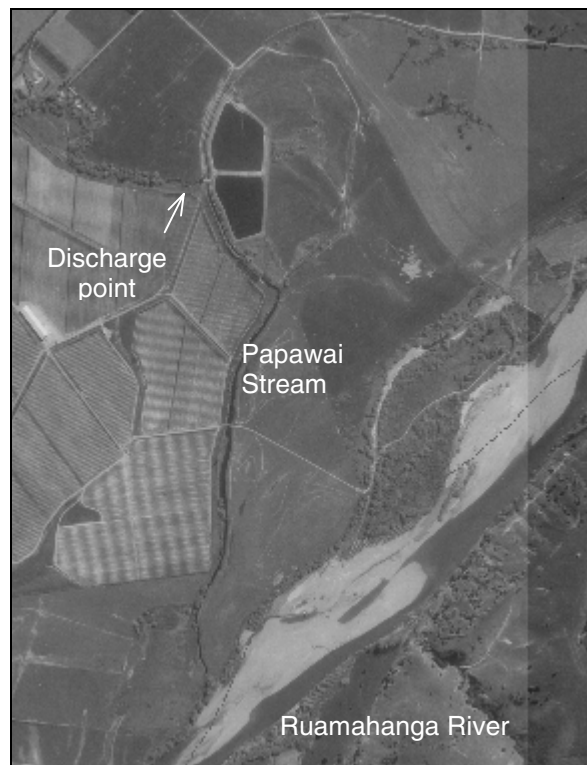


Figure 5-1: Greytown oxidation ponds

Effluent water quality has been tested by Wellington Regional Council on a monthly basis since 1994. Samples are taken from the pond, at the entrance to the outfall pipe. Sampling will be taken over by South Wairarapa District Council to fulfil monitoring conditions of the consent from August 2001.

5.1.2 The receiving environment

Papawai Stream flows from the urban area of Greytown in a south-easterly direction through farmland to the Ruamahanga River. The stream is predominantly spring-fed, with a summer low-flow of about 400 L/s^[4]. Under Policy 5.2.6 of the Regional Freshwater Plan water quality of the stream is to be managed for aquatic ecosystem purposes. Effluent from the Greytown oxidation ponds is discharged into Papawai Stream about 1.5 km upstream of the confluence with the Ruamahanga River. Wellington Regional Council has monitored water quality of the Papawai Stream upstream and downstream of Greytown oxidation ponds on a monthly basis since 1994.

5.2 Effluent analysis

5.2.1 Discharge quantity

Under the expired consent for discharge to water, the permitted mean flow from Greytown oxidation ponds was 1325 m³/day. In the new consent this has increased to 1350 m³/day (15.6 L/s). Data from a flow monitor installed on the outfall was supplied in graphical format from February 2001. This data has an estimated median flow of about 8 L/s^[6]; however this does not take into account seasonal fluctuations in flow.

5.2.2 Effluent water quality: compliance

Conditions in the old consent for effluent water quality relate to BOD₅, suspended solids and total phosphorus. The limits for BOD₅ (65 g/m³) and suspended solids (80 g/m³) apply under the new consent until 1 August 2001, at which time the allowable limits decrease and faecal coliforms become an indicator. Compliance with effluent water quality conditions in the expired consent is discussed in Appendix 3, as compliance with the new consent cannot be assessed as part of this report.

5.2.3 Effluent water quality: trends

From July 1999 – June 2001 effluent water quality displayed few trends. Soluble reactive phosphorus concentrations increased significantly at a rate of about 0.6 g/m³/year. No changes were observed in any of the other variables. The trend of increasing total nitrogen observed between 1998 and 1999^[10] did not continue over the last two years.

Over the seven years of available record (1994 – 2001) several trends were apparent. Soluble reactive phosphorus and total particulate phosphorus increased significantly. This is consistent with the findings of the previous report^[10]. Turbidity and ammonia-nitrogen concentration of the effluent were also found to have increased. No changes in bacteriological water quality emerged, and an improvement in terms of nitrate-nitrogen levels decreasing was observed.

¹⁶ Estimated from graph of outlet flow. This is a personal interpretation of raw data that had not undergone quality assurance procedures.

The magnitude of the increase in nutrient concentrations is indicated in Table 5-1. This degradation in terms of chemical water quality would suggest that either the influent quality has changed (higher strength influent), or pond performance has diminished.

Table 5-1: Changes in Greytown effluent water quality, 1994 – 2001

	1994-1996 median	2000-2001 median	Magnitude of increase
NH ₄ -N (g/m ³)	8.9	10.7	20%
SRP (g/m ³)	4.0	5.4	35%
TPP (g/m ³)	4.9	6.5	33%
Turbidity (NTU)	10.6	18.0	70%

5.2.4 Effluent nutrient loadings

In consideration of this discharge being a point source load to the river system, it is worthwhile to determine the contribution to the receiving environment. Based on the 1999 – 2001 effluent water quality results and median flow estimate at the outfall (8 L/s¹⁷), an estimation of the loadings of nitrogen and phosphorus contributed to the Papawai Stream is:

5.0 tonnes/year of total nitrogen
1.6 tonnes/year of total particulate phosphorus

With regard to the nitrogen loading this would be the equivalent of an aerial application of nitrogenous fertiliser to about 33 hectares (based on 150 kg/ha/year). The background loading of the Papawai Stream (i.e. the accumulative effect from other landuse practises upstream of the effluent discharge point) is estimated as:

20.6 tonnes/year of total nitrogen
0.4 tonnes/year of total particulate phosphorus

This is based on a Papawai Stream low flow estimate of 400 L/s¹⁴ and median nutrient concentrations at Papawai 1¹⁸. These numbers are indicative only but provide a basis for assessing the relative loading. The calculation does indicate that the effluent is adding a considerably greater load of phosphorus than is already present in the stream.

5.3 Receiving water quality analysis

5.3.1 Temporal trends

No temporal trends in water quality of the receiving waters were observed for the reporting period (July 1999 – June 2001). However, over the seven years of available record (1994 – 2001) ammonia-nitrogen, soluble reactive phosphorus and total particulate phosphorus concentrations have increased significantly in Papawai Stream downstream of the discharge. These trends are not apparent at the upstream

¹⁷ This flow estimate is taken from a limited dataset (from February 2001) and is raw data that has not undergone quality assurance procedures. It is also a personal interpretation of data which was supplied in graphical format.

¹⁸ Median values: Total nitrogen = 1.63 g/m³; Total particulate phosphorus = 0.032 g/m³

site. Similarly, a decrease in suspended solids and total nitrogen at the upstream site has not occurred downstream, where there has been no change in these variables. The increase in soluble reactive phosphorus, total particulate phosphorus and ammonia-nitrogen in Papawai Stream below the outfall is accounted for by the increase in concentration of these in the effluent (Section 5.2.3). The graphs below (Figure 5-4) show the change in these nutrient concentrations since 1994.

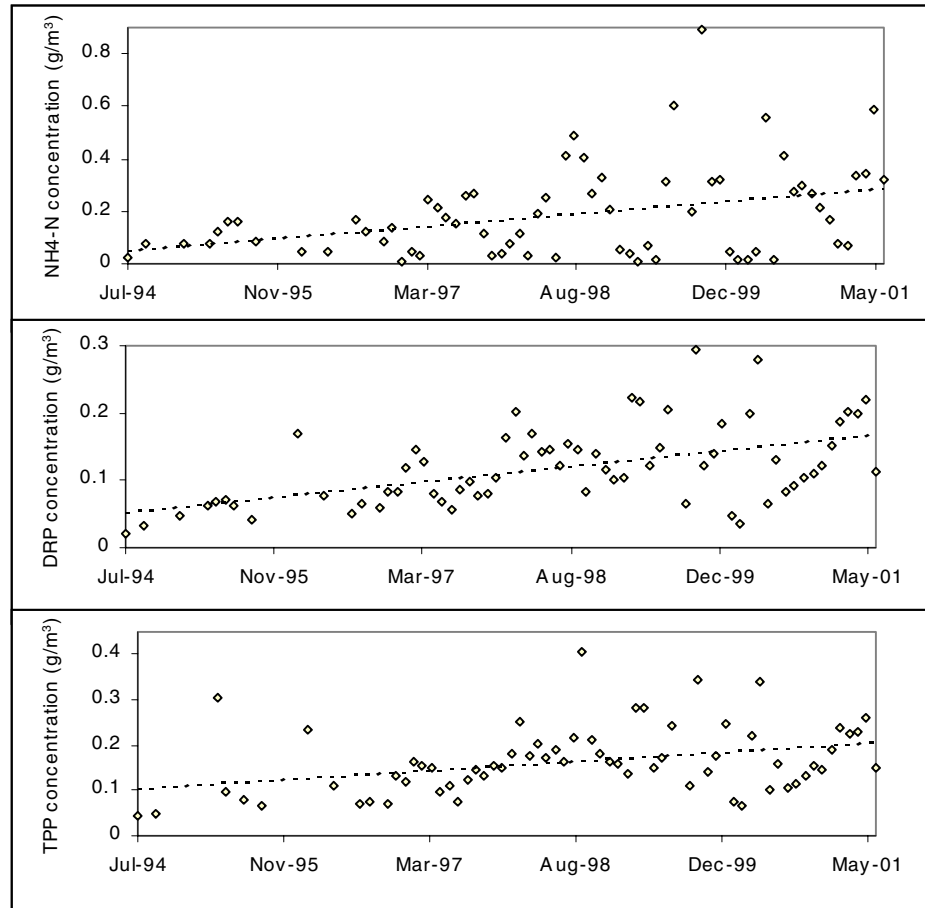


Figure 5-2: Temporal trends in Papawai Stream water quality downstream of Greytown effluent discharge, 1994 – 2001

5.3.2 Inter-site comparisons

Statistical tests have identified that during the period July 1999 – June 2001 Papawai Stream downstream of the effluent discharge was significantly higher in:

- suspended solids
- turbidity
- ammonia-nitrogen
- nitrite-nitrogen
- total nitrogen
- soluble reactive phosphorus
- total particulate phosphorus
- BOD₅.

These differences were also apparent for the entire length of record (1994 – 2001). The magnitude of the downstream change is shown in Table 5-2.

Table 5-2: Water quality of Papawai Stream upstream and downstream of Greytown effluent discharge, July 1999 – June 2001

	Papawai 1 median	Papawai 2 median	Magnitude of downstream increase
Suspended solids (g/m ³)	0.8	2.0	150%
Turbidity (NTU)	1.1	1.7	55%
NH ₄ -N (g/m ³)	0.01	0.27	2600%
NO ₂ -N (g/m ³)	0.003	0.006	100%
Total nitrogen (g/m ³)	1.633	2.139	31%
SRP (g/m ³)	0.022	0.130	491%
TPP (g/m ³)	0.03	0.16	433%
BOD ₅ (g/m ³)	0.295	1.095	271%

The largest changes downstream of the effluent discharge were in chemical water quality. This is consistent with findings of previous years^[10,11]. However, the significant increase in suspended solids and turbidity of the Papawai Stream downstream of the discharge has not been reported previously. This could be due to the significant increase in turbidity of the effluent that has occurred in recent years (Table 5-1).

5.3.3 Achieving water quality objectives

Under the Regional Freshwater Plan the water quality of Papawai Stream is to be managed for aquatic ecosystem purposes. The water quality guidelines for minimum water quality standards in the RMA 1991 to be met are¹⁹:

“After reasonable mixing, the contaminant, either by itself or in combination with other contaminants, is not likely to cause any of the following effects:

- (1) The production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials.*
- (2) Any conspicuous change in the colour or visual clarity.*
- (3) Any emission of objectionable odour.*
- (4) The rendering of freshwater unsuitable for consumption by farm animals.*
- (5) Any significant adverse effects on aquatic life.”*

The additional guidelines for water to be managed for aquatic ecosystem purposes are that a contaminant must not cause any of the following effects²⁰:

- (6) The natural temperature of the water shall not be changed by more than 3°C.*
- (7) The following shall not be allowed if they have an adverse effect on aquatic life:*
 - Any pH change*
 - Any increase in the deposition of matter on the bed of the water body or coastal water*
 - Any discharge of a contaminant into the water.*
- (8) The concentration of dissolved oxygen to fall below 80% of saturation concentration.*
- (9) There shall be no undesirable biological growths as a result of any discharge of a contaminant into the water.*

¹⁹ Regional Freshwater Plan Appendix 8, Guidelines A8.1

²⁰ Regional Freshwater Plan Appendix 8, Guidelines A8.2

These guidelines have been incorporated into conditions in the consent for discharge to water (WAR 960286). Compliance with consent conditions will not be assessed (as it was granted June 2001), but compliance with the Regional Freshwater Plan is discussed here. With the data available, some of the conditions cannot be assessed, such as presence of oil or grease films and significant change in colour. The following is an assessment of compliance where possible.

5.3.3.1 Dissolved oxygen

Compliance with the oxygen saturation lower limit in the Regional Freshwater Plan was achieved, with the lowest measurement over July 1999 – June 2001 being 83%. There was no significant difference in oxygen saturation between the upstream and downstream sites reported in Section 5.3.2.

5.3.3.2 Temperature

The median temperature change in Papawai Stream downstream of the effluent outfall over the two year period was -0.15°C . On none of the sampling occasions was the downstream temperature more than 3°C different from that upstream (the maximum measured difference was -0.7°C). Therefore compliance was achieved.

5.3.3.3 Water clarity

As water clarity is not directly measured as part of this programme, turbidity measured upstream and downstream of the discharge is used to assess whether a conspicuous change in clarity has occurred. A ‘conspicuous change’ is taken to be the maximum turbidity change of 10% recommended by ANZECC^[2]. As shown by Figure 5-5, the 10% threshold was exceeded on most (18/24) sampling occasions. Therefore the effluent discharge is considered to be causing a conspicuous change in water clarity.

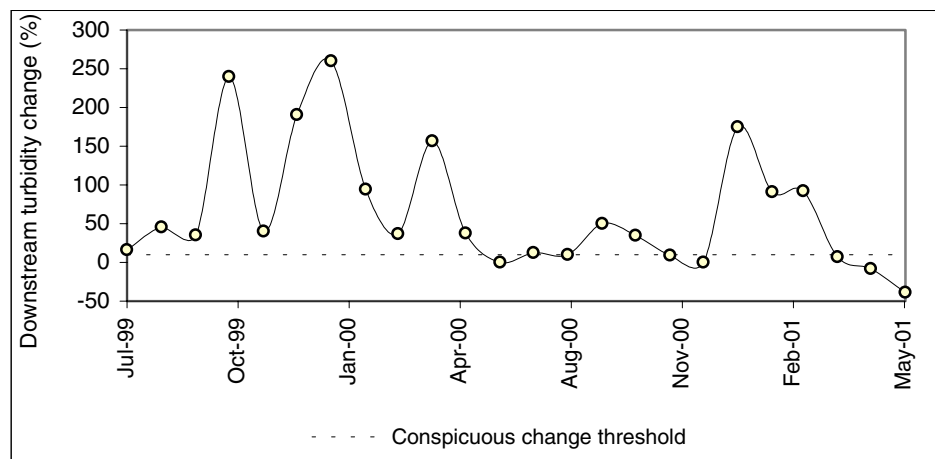


Figure 5-3: Change in Papawai Stream turbidity downstream of Greytown effluent outfall, July 1999 – June 2001

5.3.3.4 pH

There was no significant difference in pH between Papawai 1 and Papawai 2. Therefore the effluent discharge is not causing a significant change in pH of the receiving water, and compliance with the condition was achieved.

5.3.3.5 Undesirable biological growths

Periphyton cover is not assessed as part of this monitoring programme. However, as the growth of periphyton is promoted by nutrient enrichment, nutrient concentrations can be used to assess compliance with this condition. The New Zealand Periphyton Guideline suggest maximum values of 34 mg/m³ soluble inorganic nitrogen and 2.8 mg/m³ soluble reactive phosphorus, above which growth may be promoted given suitable flow conditions^[5].

Papawai Stream soluble inorganic nitrogen and soluble reactive phosphorus concentrations exceeded the above guideline values on all sampling occasions. This was for both the upstream (Papawai 1) and downstream (Papawai 2) sites. This means nutrient levels in the stream are not limiting for periphyton growth. Due to upstream inputs of nitrogen and phosphorus the Greytown oxidation pond effluent discharge has not in itself caused nutrients to be elevated to levels able to support undesirable biological growths.

5.3.3.6 Water quality for farm animal consumption

Good water quality is essential for farm animal consumption, as poor water quality may reduce production and impair fertility^[1]. Water quality guidelines for livestock watering recommended by ANZECC^[1] are that:

nitrate-nitrogen should not exceed 400 mg/L

nitrite-nitrogen should not exceed 30 mg/L

median faecal coliform count should not exceed 100 cfu/100ml.

Nitrate-nitrogen and nitrite-nitrogen concentrations were consistently below the guideline values at both Papawai Stream sites between July 1999 and June 2001. The faecal coliform guideline was also complied with, with the median count over the two year period being 65 cfu/100ml at Papawai 2.

5.3.3.7 Effects on aquatic life

To assess whether the discharge is having a significant adverse effect on aquatic life, macroinvertebrate community structures upstream (Papawai 1) and downstream (Papawai 2) of the discharge are compared. Macroinvertebrate communities were sampled on two occasions, in February 2000 and March 2001. Four replicate samples were taken on each occasion, the median of which is compared to the pollution guidelines of Stark^[12] (Figure 5-7).

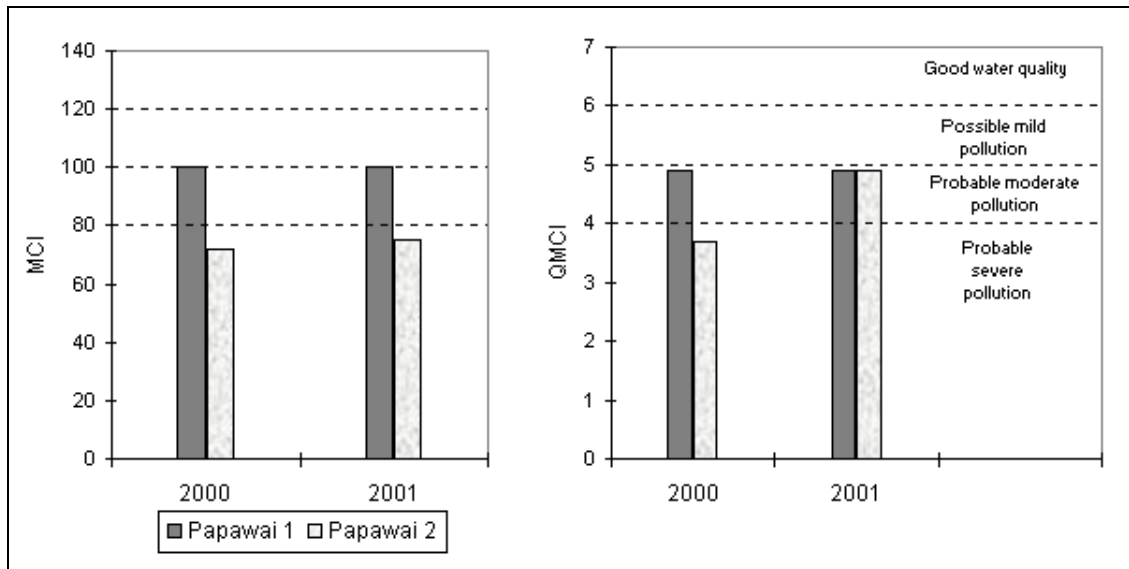


Figure 5-4: MCI and SQMCI results for Papawai Stream upstream and downstream of Greytown effluent outfall

MCI scores were lower at Papawai 2 (downstream of the outfall) on both occasions. The downstream samples fitted into the ‘probable severe pollution’ category, whereas the upstream samples were on the threshold of the ‘possible mild pollution’ category. This is consistent with results from the previous two years^[10,11]. SQMCI scores were not significantly different between the sites in 2001. However, the 2000 results were similar to those of both 1998 and 1999, when the downstream site was classed as ‘probable severe pollution’, a degradation from the upstream pollution classification. On both occasions the presence of *Ephemeroptera* (mayflies) was considerably less downstream of the outfall compared to upstream. Mayflies are particularly sensitive to organic enrichment.

The results for the July 1999 to June 2001 period therefore support previous years’ results, and indicate that the Greytown effluent discharge could be causing aquatic communities to be adversely affected.

5.4 Summary

Trend analysis of effluent water quality from Greytown oxidation ponds found few significant trends in the last two years. However, since 1994, significant increases in soluble reactive phosphorus, total particulate phosphorus, ammonia-nitrogen and turbidity were observed. This decrease in effluent water quality was reflected in the receiving water, where increases in soluble reactive phosphorus, total particulate phosphorus and ammonia nitrogen were also found since 1994.

Comparison of the Papawai Stream upstream water quality with that downstream of the discharge found that the Greytown effluent discharge caused significant increases in suspended solids, turbidity, ammonia-nitrogen, nitrite-nitrogen, total nitrogen, soluble reactive phosphorus, total particulate phosphorus and BOD₅. The largest downstream changes were in chemical water quality.

Compliance with the conditions for pH, temperature, dissolved oxygen and livestock drinking water standards in the Regional Freshwater Plan was good. Similarly the condition whereby a contaminant must not cause undesirable biological growths was met, as nutrient guidelines for periphyton growth promotion were exceeded at both the upstream and downstream sites. However, the Greytown effluent discharge was found to have caused a 'conspicuous change' in water clarity, and there is evidence that an adverse effect on aquatic life has occurred.

6. Featherston Municipal Oxidation Ponds

6.1 Background

6.1.1 System description

South Wairarapa District Council operates a wastewater treatment plant for the township of Featherston, serving a population of about 2500. The plant comprises two ponds followed by 'surface flow' wetland (Figure 6-1). This surface flow extends for approximately 220m before discharging into Donald's Creek. A consent for discharge of effluent to water was granted to Featherston Borough Council in 1987 which expired in 1997. Application for consent renewal has been made and is in process.

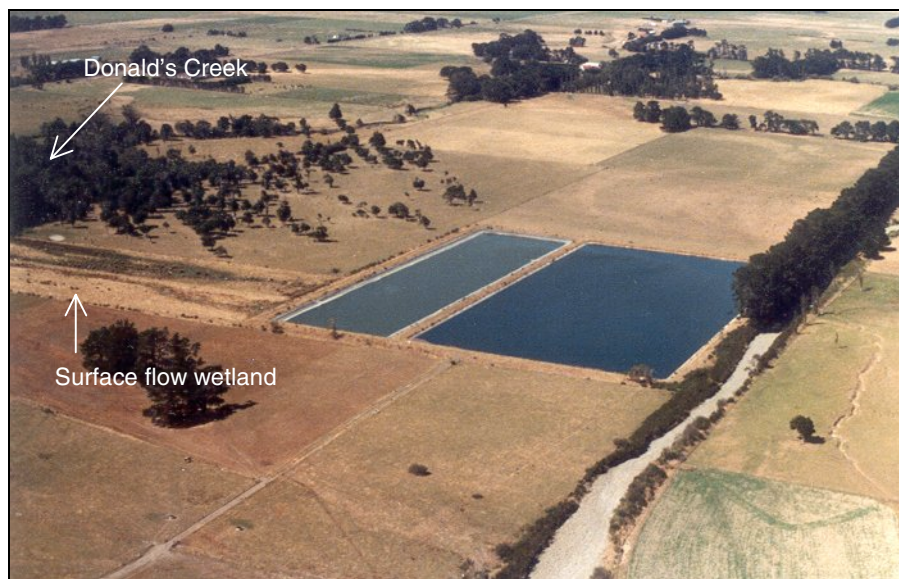


Figure 6-1: Featherston oxidation ponds

Wellington Regional Council have collected water quality samples of the effluent on a monthly basis since 1994. Samples are taken from the surface flow, a few metres above the confluence with Donald's Creek.

6.1.2 Receiving environment

Donald's Creek is a small rural stream with its headwaters in the Tararua Ranges and mouth at the northern end of Lake Wairarapa. Under Policy 5.2.6 of the Regional Freshwater Plan the stream is to be managed for aquatic ecosystem purposes. Wellington Regional Council monitors the water quality of Donald's Creek upstream and downstream of the effluent discharge on a monthly basis. Limited flow statistics are available, as gaugings are only occasional.

6.2 Effluent analysis

6.2.1 Discharge quantity

The expired consent for discharge to water specifies a maximum permitted discharge from the oxidation ponds of 137 m³/hour (38 L/s). Flow records are only available for June 2001, which show compliance with the condition. For this month flow varied between 10 and 25 L/s. A previous gauging undertaken by the Wellington Regional Council (March 2001) estimated the discharge rate to be about 8 L/s. As no long-term records are available determination of the wastewater treatment system hydraulics is not possible, and the normality of the June records cannot be assessed.

6.2.2 Effluent water quality: compliance

Conditions for water quality in the old consent relate to BOD₅ influent loadings, dissolved oxygen levels in the pond. BOD₅ loadings cannot be assessed due to lack of influent data. Compliance with the dissolved oxygen lower limit of 4 mg/L was good, with only one sample below the limit since July 1999 (Figure 6-2).

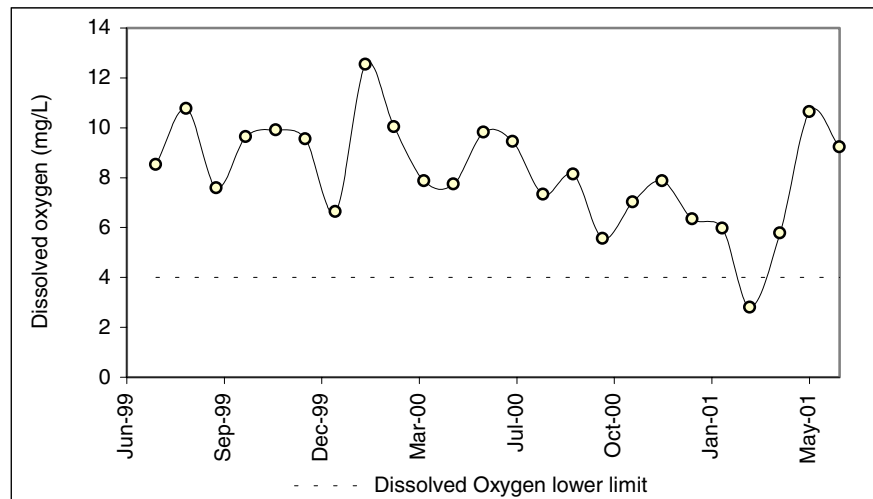


Figure 6-2: Dissolved oxygen levels in Featherston oxidation pond effluent, July 1999 – June 2001

6.2.3 Effluent water quality: trends

Using the available data (from 1994) there are generally no trends in effluent water quality. The only apparent change was a significant increase in nitrite-nitrogen (about a 54% increase between 1997 and 2001).

However, for the period of this report (July 1999 – June 2001) several trends in effluent water quality emerged. Conductivity, nitrite-nitrogen, ammonia-nitrogen, total nitrogen, soluble reactive phosphorus, and total particulate phosphorus have increased. Dissolved oxygen and oxygen saturation levels in the effluent have decreased over this time period. The magnitude of these changes is shown in Table 6-1.

Table 6-1: Changes in effluent water quality July 1999 – June 2001

	1999-2000 median	2000-2001 median	Magnitude of change
Conductivity ($\mu\text{S/cm}$)	236	290	23%
$\text{NH}_4\text{-N}$ (g/m^3)	3.81	6.94	82%
$\text{NO}_2\text{-N}$ (g/m^3)	0.12	0.23	92%
Total N (g/m^3)	9.92	10.14	2%
SRP (g/m^3)	2.44	4.69	92%
TPP (g/m^3)	3.02	4.98	65%
Dissolved oxygen (g/m^3)	9.55	7.02	-26%
Oxygen saturation (%)	88.9	72.2	-19%

As no trends were found in the previous report^[10], this degradation in effluent water quality has occurred recently. It has also occurred since an apparent improvement in water quality at the beginning of the analysis period (late 1999). Therefore future monitoring will establish whether the degradation is an ongoing trend or a temporary fluctuation in effluent water quality.

6.2.4 Effluent nutrient loadings

In consideration of this discharge being a point source load to the river system, it is worthwhile to determine the contribution to the receiving environment. Based on the 1999 – 2001 effluent water quality results and outlet flow estimate of 10 L/s²¹, an estimation of the loadings of nitrogen and phosphorus contributed to Donald's Creek is:

3.2 tonnes/year of total nitrogen
1.0 tonnes/year of total particulate phosphorus

With regard to the nitrogen loading this would be the equivalent of an aerial application of nitrogenous fertiliser to about 21 hectares (based on 150 kg/ha/year). The background loading of Donald's Creek (i.e. the accumulative effect from other landuse practises upstream of the effluent discharge point) is estimated as:

0.97 tonnes/year of total nitrogen
0.03 tonnes/year of total particulate phosphorus

This estimate is based on a low flow gauging by Wellington Regional Council of Donald's Creek in March 2001 (which found the flow to be 25 L/s) and median concentrations of total nitrogen and total particulate phosphorus measured monthly at the upstream site²². Although this should not be taken as an accurate calculation due to the lack of accurate flow data, it indicates that the effluent discharge is probably contributing significantly more nitrogen and phosphorus than is already present in Donald's Creek from upstream inputs.

²¹ This is an estimate from limited flow data which was supplied in graphical format and subject to personal interpretation. The flow data was also raw data that has not been subject to quality assurance procedures.

²² Median values: Total nitrogen = 1.22 g/m³; Total particulate phosphorus = 0.033 g/m³

6.3 Receiving water quality analysis

6.3.1 Temporal trends

Time series analyses found several significant trends in water quality of Donald's Creek:

- (1) Ammonia-nitrogen levels in Donald's Creek increased significantly since July 1999; the rate of increase downstream of the effluent discharge was 2 orders of magnitude greater than the rate of increase upstream.
- (2) Over the last two years, oxygen saturation and dissolved oxygen levels downstream of the outfall have decreased in comparison to upstream.
- (3) Conductivity, BOD₅, nitrite-nitrogen, soluble reactive phosphorus and total particulate phosphorus concentrations have all increased downstream of the outfall in comparison to upstream.

The reason for the increase in BOD₅ levels is unclear, as there was no significant increase in BOD₅ of the effluent. A decrease in receiving water flow could be responsible; however lack of flow data prevents this from being concluded. The increases in conductivity and nutrient concentrations in Donald's Creek downstream of the effluent discharge are probably attributed to the recent increase in their concentration in the effluent (see Section 6.2.3). Similarly, the drop in oxygen saturation and dissolved oxygen downstream corresponds with a decrease in oxygen levels in the effluent and the increase in BOD₅ of Donald's Creek.

These trends are recent, as no change in either effluent or receiving water quality was reported for the year to June 1999^[10]. In addition, low flow conditions experienced over summer 2000 – 2001 will have meant that the dilution capacity of Donald's Creek was reduced below usual.

6.3.2 Inter-site comparisons

Comparison of Donald's Creek water quality upstream ('Featherston 1') and downstream ('Featherston 2') found that the downstream site was significantly higher in:

- faecal coliforms
- *E.coli*
- pH
- conductivity
- suspended solids
- turbidity
- ammonia-nitrogen
- nitrite-nitrogen
- total nitrogen
- soluble reactive phosphorus
- total particulate phosphorus
- BOD₅.

Also the downstream site had significantly lower oxygen saturation. Therefore a difference was detected in all parameters measured except temperature and nitrate-nitrogen. The magnitude of the downstream differences is indicated by Table 6-2.

Table 6-2: Donald's Creek water quality upstream and downstream of Featherston effluent discharge, July 1999 – June 2001.

	Featherston 1 median	Featherston 2 median	Magnitude of downstream change
Faecal coliforms (/100ml)	140	680	386%
<i>E.coli</i> (/100ml)	110	500	355%
pH	6.88	7.02	2%
Conductivity ($\mu\text{S}/\text{cm}$)	128	142	11%
Suspended solids (g/m^3)	4.5	12.0	167%
Turbidity (NTU)	2.5	3.7	48%
$\text{NH}_4\text{-N}$ (g/m^3)	0.02	0.66	3200%
$\text{NO}_2\text{-N}$ (g/m^3)	0.004	0.023	475%
Total nitrogen (g/m^3)	1.22	2.48	103%
SRP (g/m^3)	0.02	0.33	1550%
TPP (g/m^3)	0.03	0.41	1267%
BOD_5 (g/m^3)	0.6	3.7	517%
O_2 saturation (%)	97	92	-5%

The largest degradations were found to be in bacteriological water quality, phosphorus and nitrogen concentrations and BOD_5 . This is in agreement with the 1998 – 1999 results, which found the effluent discharge was having a significant impact on nitrogen, phosphorus and BOD_5 levels in Donald's Creek^[10].

6.3.3 Achieving water quality objectives

The expired consent for effluent discharge to Donald's Creek specifies that oxygen content in the receiving waters must not be reduced below 5 mg/L. Under the Regional Freshwater Plan the water quality of Donald's Creek is to be managed for aquatic ecosystem purposes. The water quality guidelines for minimum water quality standards in the RMA 1991 to be met are²³:

“After reasonable mixing, the contaminant, either by itself or in combination with other contaminants, is not likely to cause any of the following effects:

- (1) *The production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials.*
- (2) *Any conspicuous change in the colour or visual clarity.*
- (3) *Any emission of objectionable odour.*
- (4) *The rendering of freshwater unsuitable for consumption by farm animals.*
- (5) *Any significant adverse effects on aquatic life.”*

The additional guidelines for water to be managed for aquatic ecosystem purposes are that a contaminant must not cause any of the following effects²⁴:

- (6) *The natural temperature of the water shall not be changed by more than 3°C.*
- (7) *The following shall not be allowed if they have an adverse effect on aquatic life:*
 - *Any pH change*
 - *Any increase in the deposition of matter on the bed of the water body or coastal water*

²³ Regional Freshwater Plan Appendix 8, Guidelines A8.1

²⁴ Regional Freshwater Plan Appendix 8, Guidelines A8.2

- Any discharge of a contaminant into the water.
- (8) The concentration of dissolved oxygen to fall below 80% of saturation concentration.
 - (9) There shall be no undesirable biological growths as a result of any discharge of a contaminant into the water

Some of these conditions cannot be assessed with the available data. Following is an assessment of compliance with the Regional Freshwater Plan water quality guidelines where available.

6.3.3.1 Dissolved oxygen

Dissolved oxygen concentrations were consistently above the lower limit specified in the consent of 5 mg/L. The lowest recorded measurement over 1999 – 2001 was 7.6 mg/L. Similarly, compliance with the 80% saturation lower limit in the Regional Freshwater Plan guidelines was achieved.

6.3.3.2 Temperature

On no occasions was the temperature of Donald’s Creek changed by more than 3°C downstream of the outfall. The maximum difference between the two sites was 1.8°C.

6.3.3.3 Water clarity

As water clarity is not directly measured as part of this programme, turbidity measured upstream and downstream of the discharge is used to assess whether a conspicuous change in clarity has occurred. A ‘conspicuous change’ is taken to be the maximum turbidity change of 10% recommended by ANZECC^[2]. As shown by Figure 6-3, the turbidity of Donald’s Creek downstream of the discharge was usually 10% or more greater than the upstream turbidity. As reported in 6.3.2, the median increase was 48%. Therefore it is assumed that the Featherston effluent discharge is causing a conspicuous change in water clarity.

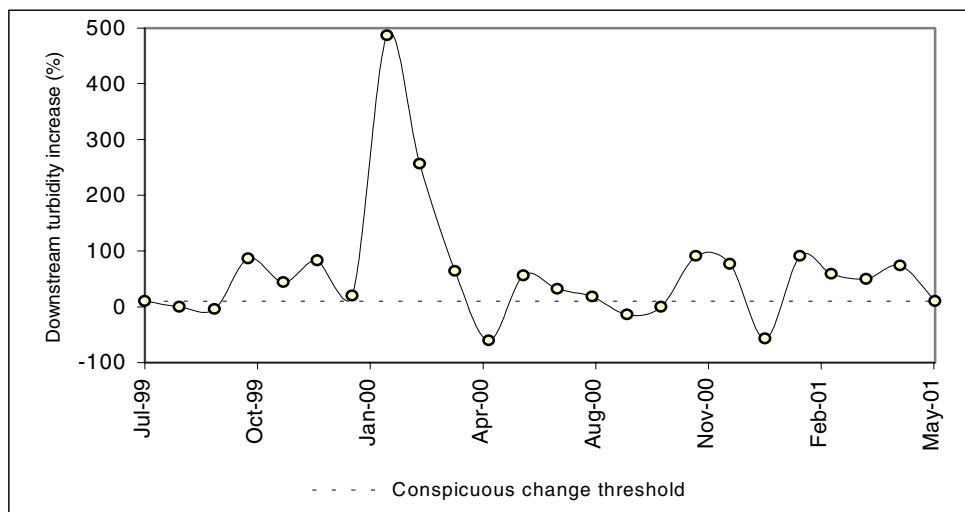


Figure 6-3: Change in Donald’s Creek turbidity downstream of Featherston oxidation ponds, July 1999 – June 2001

6.3.3.4 pH

Donald's Creek pH was significantly higher downstream of the Featherston effluent discharge. The increase (reported in Section 6.3.2) was from a median of 6.88 upstream to 7.02 downstream of the discharge. The time-series of pH at the two sites (Figure 6-4) shows that a difference occurred between the sites on most sampling occasions. Therefore the effluent discharge is causing a change in pH of the water body.

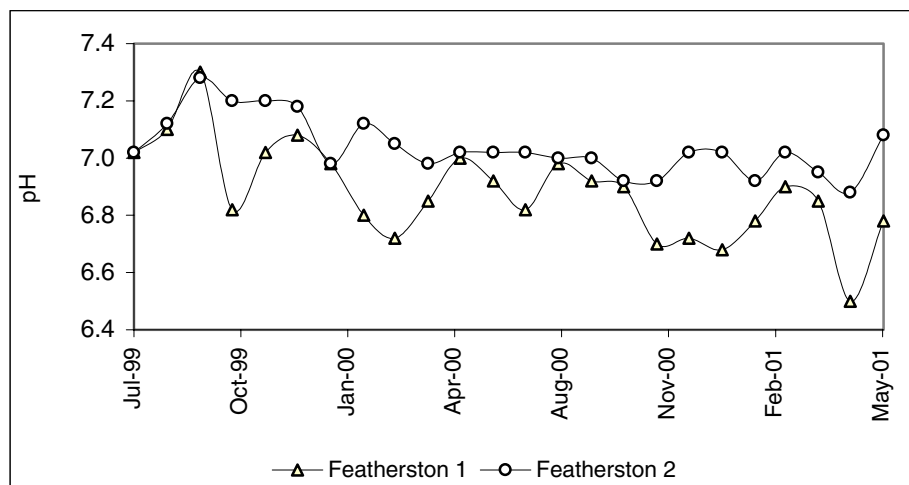


Figure 6-4: Donald's Creek pH upstream (Featherston 1) and downstream (Featherston 2) of Featherston effluent discharge, July 1999 – June 2001

6.3.3.5 Undesirable biological growths

Periphyton cover is not assessed as part of this monitoring programme. However, as the growth of periphyton is promoted by nutrient enrichment, nutrient concentrations can be used to assess compliance with this condition. The New Zealand Periphyton Guideline suggest maximum values of 34 mg/m³ soluble inorganic nitrogen and 2.8 mg/m³ soluble reactive phosphorus, above which growth may be promoted given suitable flow conditions^[5].

Concentrations in Donald's Creek of soluble inorganic nitrogen and soluble reactive phosphorus exceeded the above guideline values on all occasions. Therefore nutrient availability is not a limiting factor for the growth of periphyton. However, as the site upstream of the discharge also exceeded the guidelines, the Featherston oxidation pond discharge is not considered solely responsible for elevating nutrient levels to encourage undesirable biological growths.

6.3.3.6 Water quality for farm animal consumption

Good water quality is essential for farm animal consumption, as poor water quality may reduce production and impair fertility^[1]. Water quality guidelines for livestock watering recommended by ANZECC^[1] are that:

- nitrate-nitrogen should not exceed 400 mg/L
- nitrite-nitrogen should not exceed 30 mg/L
- median faecal coliform count should not exceed 100 cfu/100ml.

Nitrate-nitrogen and nitrite-nitrogen concentrations in Donald's Creek were consistently lower than the recommended limit, at both the upstream and downstream sites on all sampling occasions since July 1999. However, compliance with the faecal coliform guideline value for livestock watering was poor. The median count downstream of the effluent discharge over July 1999 – June 2001 was 680 cfu/100ml. However, the upstream site also exceeded the guideline, with the median count being 155 cfu/100ml. Therefore, although faecal coliform counts are significantly increased downstream, the Featherston oxidation pond discharge is not solely responsible for degrading Donald's Creek to cause the water to be unsuitable for farm animal consumption.

6.3.3.7 Effects on aquatic life

To assess whether the discharge is having a significant adverse effect on aquatic life, macroinvertebrate community structures upstream (Featherston 1) and downstream (Featherston 2) of the discharge are compared. Macroinvertebrate communities were sampled on two occasions, in February 2000 and March 2001. Four replicate samples were taken on each occasion, the median of which is compared to the pollution guidelines of Stark^[12] (Figure 6-4).

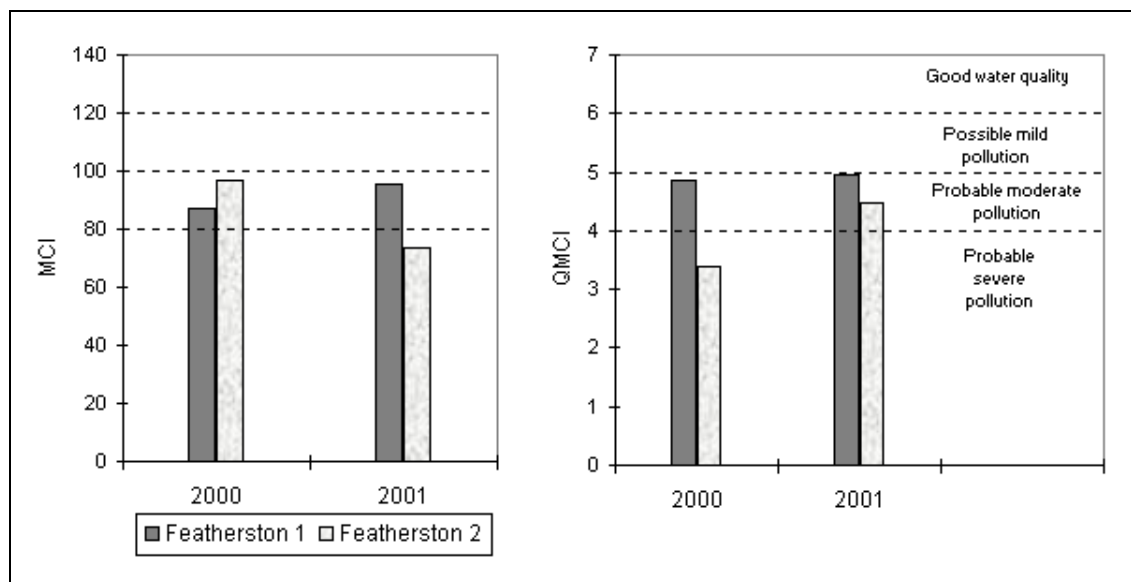


Figure 6-5: MCI and SQMCI for Donald's Creek upstream and downstream of Featherston effluent discharge, 2000 and 2001

The MCI scores for Donald's Creek do not show a consistent effect from the discharge with the degradation to 'probable severe pollution' in 2001, not being identified between the sites in 2000. Stansfield^[10] reported that there was no difference between sites in 1999. At this stage, in relation to MCI, the data does not show a consistent degradation of the macroinvertebrate community.

However, using the SQMCI scores (which use abundance as well as the taxa composition to determine the 'health' of the aquatic environment) a decrease downstream of the outfall during both years is seen. Also on both sampling occasions, *Ephemeroptera* (mayflies) were considerably less abundant in Donald's Creek downstream of the outfall; these are particularly sensitive to organic

enrichment. The number of taxa present was also lower downstream. These results suggest that the effluent discharge may be having an adverse effect on aquatic life.

6.4 Summary

Effluent discharge from Featherston oxidation ponds occurs via a surface flow wetland to Donald's Creek. Trends analysis found water quality of the effluent has degraded between July 1999 and June 2001 (since the previous report), with significant increases in conductivity, nitrite-nitrogen, ammonia-nitrogen, total nitrogen, soluble reactive phosphorus and total particulate phosphorus, and a decrease in dissolved oxygen. These changes occurred since an apparent improvement in effluent water quality in mid-1999.

A similar degradation is observed in the receiving water quality over the same period. Increases in ammonia-nitrogen, BOD₅, conductivity, nitrite-nitrogen, soluble reactive phosphorus and total particulate phosphorus were found, and a decrease in dissolved oxygen and oxygen saturation. This is likely to be linked to the decrease observed in effluent water quality, and low flows over summer 2000-2001.

The Featherston effluent discharge was found to be causing downstream water quality changes in Donald's Creek. Significant downstream changes were observed in all water quality determinants measured, except nitrate-nitrogen and temperature.

Comparison of receiving water quality with Regional Freshwater Plan guidelines showed compliance with conditions for temperature and dissolved oxygen. However, water clarity downstream of the discharge showed a 'conspicuous change' compared with that upstream, and the discharge is causing a change in pH of Donald's Creek. The discharge was not found to be causing undesirable biological growths or livestock drinking water guidelines to be exceeded, because background water quality did not fully comply with the guidelines. However, there is evidence that the Featherston effluent discharge may be having an adverse effect on aquatic life of Donald's Creek.

7. Martinborough Municipal Oxidation Pond

7.1 Background

7.1.1 System description

Martinborough oxidation pond is a single pond system with mechanical aerators (Figure 7-1). It is operated by South Wairarapa District Council, and serves a population of about 1450. Effluent is discharged into the Ruamahanga River under Right 860077, which expired in May 1997. A new consent has been applied for^[15] and is currently being processed. Sampling of the effluent is performed by Wellington Regional Council on a monthly basis, at the end of the outfall pipe.

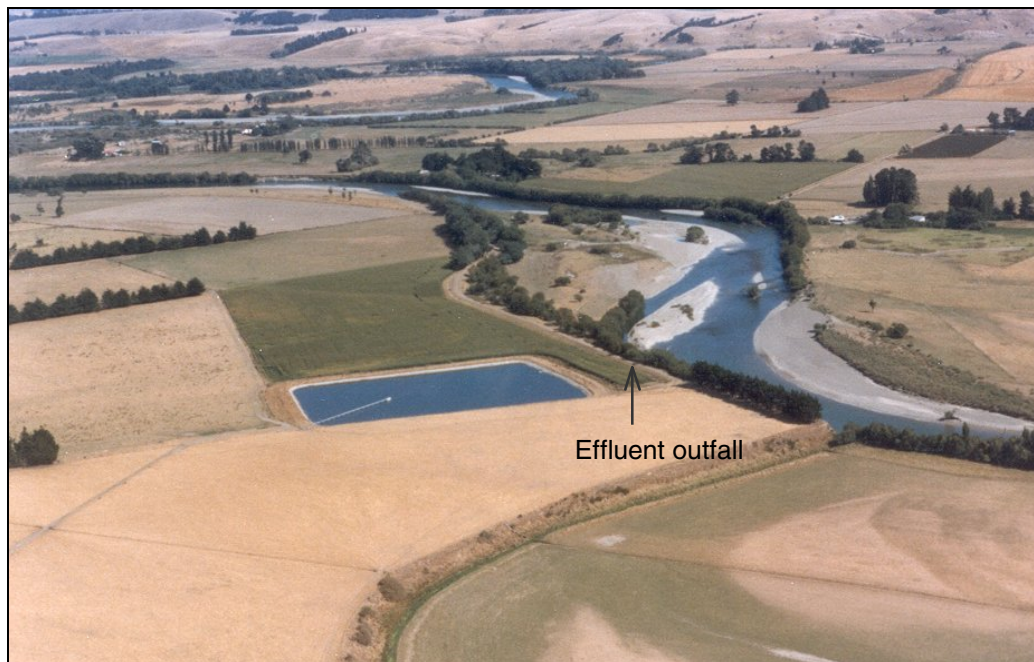


Figure 7-1: Martinborough oxidation pond

7.1.2 Receiving environment

The Ruamahanga River is identified in the Regional Freshwater Plan as having water quality to be managed for contact recreation purposes, particularly for canoeing, kayaking and angling. Effluent from the Martinborough municipal oxidation pond enters the Ruamahanga River in its lower reaches, 2.5km downstream of Waihenga Bridge and about 33km upstream of the confluence with Lake Onoke. At this point the river has also received effluent from Masterton, Carterton and Greytown municipal oxidation ponds. On a monthly basis Wellington Regional Council monitors water quality of the Ruamahanga River upstream and downstream of the Martinborough effluent discharge; data from 1994 are available for analysis²⁵.

²⁵ These results will be referred to as “Ruamahanga River at Martinborough” to avoid confusion with the analysis of results for Masterton oxidation ponds.

7.2 Effluent analysis

7.2.1 Discharge quantity

South Wairarapa District Council uses a Scada system to monitor discharge at the effluent outfall. Results for the reporting period were supplied in graphical format; this allows assessment of flow variability, but not statistical analysis.

Maximum permitted discharge under the consent was 61 m³/hour (17 L/s). Actual discharge quantity was usually less than this. Seasonal variations were identified. Over winter and spring 2000 (April – October) discharge flow varied between 6 and 16 L/s. During summer the flow dropped to about 4 L/s, and from April – June 2001 varied between 4 and 8 L/s. Therefore compliance with the consent condition has been observed.

7.2.2 Effluent water quality: compliance

The consent for discharge to water specifies water quality conditions relating to BOD₅ (influent) and dissolved oxygen (effluent). The BOD₅ condition of less than 84 kg/ha/day is unable to be assessed due to lack of influent water quality data.

Special Condition 2 of the consent specifies that oxygen content in solution should not be consistently below 5 mg/L. The samples for evaluation must be collected between 0800 and 0900 hours and the evaluation should be based on 5 samples collected over a 30-day period. However, the only data available for analysis is collected monthly and usually at about 0900-1000 hours. This data shows general compliance with the condition since July 1999 (Figure 7-2). On three occasions during summer 2000 – 2001 dissolved oxygen dropped below 4 mg/L, but since this time compliance has occurred.

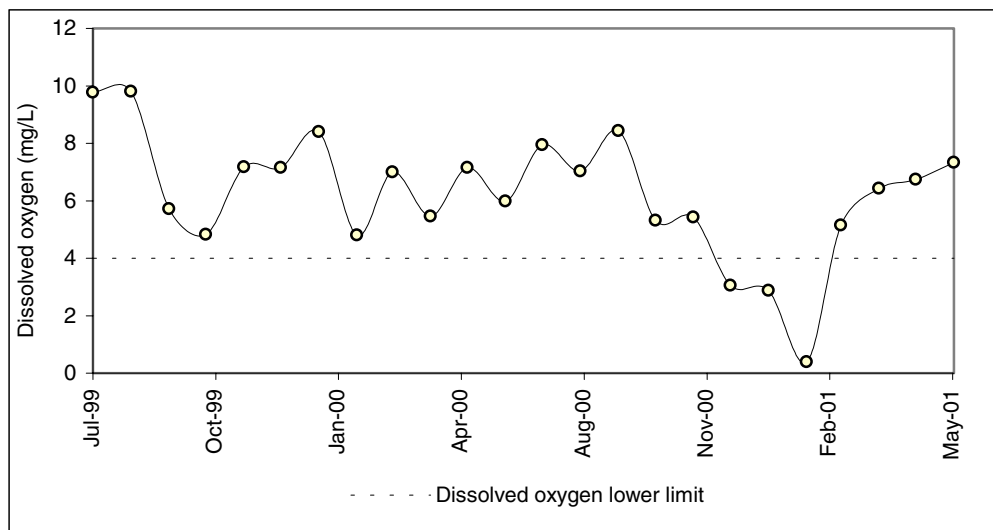


Figure 7-2: Dissolved oxygen in Martinborough oxidation pond effluent (at outfall), July 1999 – June 2001

7.2.3 Effluent water quality: trends

Over the two year period (July 1999 – June 2001) increases in the concentrations nitrite-nitrogen, nitrate-nitrogen, soluble reactive phosphorus and total particulate phosphorus were found to have occurred in the Martinborough effluent. These changes have also been apparent since 1994. Table 7-1 indicates the magnitude of the observed increases.

Table 7-1: Changes in Martinborough oxidation pond effluent, 1994 – 2001

	1994 median	2000-2001 median	Magnitude of increase
NO ₂ -N (g/m ³)	0.13	0.48	269%
NO ₃ -N (g/m ³)	0.08	2.25	2713%
SRP (g/m ³)	5.57	8.00	44%
TPP (g/m ³)	7.91	9.41	19%

This degradation in terms of chemical water quality would suggest that either the influent quality has changed (higher strength influent), or pond performance has diminished. However, an improvement in effluent faecal coliform counts has occurred since 1997.

7.2.4 Effluent chemical loadings

In consideration of this discharge being a point source load to the river system, it is worthwhile to determine the contribution to the receiving environment. Accurate estimation of effluent chemical loadings is not possible for Martinborough oxidation pond, due to lack of exact flow data. However a conservative estimate, for comparison purposes, using the median flow estimate of 6 L/s²⁶ and median chemical concentrations over 1999 – 2001 is:

3.6 tonnes/year of total nitrogen
1.8 tonnes/year of total particulate phosphorus

With regard to the nitrogen loading this would be the equivalent of an aerial application of nitrogenous fertiliser to about 49 hectares (based on 150 kg/ha/year). The background loading of the Ruamahanga River (i.e. the accumulative effect from other landuse practises upstream of the effluent discharge point) is estimated as:

1934 tonnes/year of total nitrogen
98 tonnes/year of total particulate phosphorus.

This is based on the mean flow at Waihenga of 86.27 m³/s^[14] and 1999 – 2001 median nutrient concentrations measured at the Martinborough upstream site²⁷. Based on these figures the load added by the effluent discharge is small, at about 0.2% for total nitrogen and 2% for total particulate phosphorus.

²⁶ This flow estimate is taken from a limited dataset (from April 2000) and is raw data that has not undergone quality assurance procedures. It is also a personal interpretation of data which was supplied in graphical format.

²⁷ Median values: Total nitrogen = 19.2 g/m³; Total particulate phosphorus = 9.3 g/m³

7.3 Receiving water quality analysis

7.3.1 Temporal trends

No significant trends in water quality of the Ruamahanga River were observed downstream of the Martinborough effluent outfall that were not also observed upstream. Therefore the significant increases in nitrate-nitrogen, nitrite-nitrogen, soluble reactive phosphorus and total particulate phosphorus levels in the effluent (see Section 7.2.3) has not caused a similar significant increase over time downstream of the discharge point.

7.3.2 Inter-site comparisons

Water quality of the Ruamahanga River downstream of the Martinborough effluent outfall (Martinborough 2) was compared with that upstream of the outfall (Martinborough 1). The downstream site was found to be significantly higher in:

- faecal coliforms
- *E.coli*
- ammonia-nitrogen
- nitrite-nitrogen
- soluble reactive phosphorus
- total particulate phosphorus.

The magnitude of the observed inter-site differences is indicated by Table 7-2. The largest downstream increases were found to be in bacteriological counts.

Table 7-2: Ruamahanga River water quality upstream and downstream of Martinborough effluent outfall, July 1999 – June 2001

	Martinborough 1 median	Martinborough 2 median	Magnitude of downstream increase
F. coliforms (/100ml)	45	90	100%
<i>E.coli</i> (/100ml)	40	90	125%
NH ₄ -N (g/m ³)	0.019	0.025	32%
NO ₂ -N(g/m ³)	0.004	0.006	50%
SRP (g/m ³)	0.025	0.035	40%
TPP (g/m ³)	0.036	0.051	42%

7.3.3 Achieving water quality objectives

The (expired) consent for discharge to water from Martinborough oxidation pond has one condition relating to receiving water quality following mixing. This specifies that dissolved oxygen content must not fall below 5 mg/L.

Under the Regional Freshwater Plan the Ruamahanga River at Martinborough is to be managed for aquatic ecosystem and contact recreation purposes. The water quality guidelines for minimum water quality standards in the RMA 1991 to be met are²⁸:

²⁸ Regional Freshwater Plan Appendix 8, Guidelines A8.1

“After reasonable mixing, the contaminant, either by itself or in combination with other contaminants, is not likely to cause any of the following effects:

- (1) The production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials.*
- (2) Any conspicuous change in the colour or visual clarity.*
- (3) Any emission of objectionable odour.*
- (4) The rendering of freshwater unsuitable for consumption by farm animals.*
- (5) Any significant adverse effects on aquatic life.”*

The additional guidelines for water to be managed for aquatic ecosystem purposes are that a contaminant must not cause any of the following effects²⁹:

- (6) The natural temperature of the water shall not be changed by more than 3°C.*
- (7) The following shall not be allowed if they have an adverse effect on aquatic life:*
 - Any pH change*
 - Any increase in the deposition of matter on the bed of the water body or coastal water*
 - Any discharge of a contaminant into the water.*
- (8) The concentration of dissolved oxygen to fall below 80% of saturation concentration.*
- (9) There shall be no undesirable biological growths as a result of any discharge of a contaminant into the water.*

As well as the above guidelines, the Ruamahanga River at Martinborough must meet contact recreation guidelines. These state that a contaminant must not cause the following effects³⁰:

- The visual clarity of the water to be so low as to be unsuitable for bathing.*
- The water to be rendered unsuitable for bathing by the presence of contaminants.*

Data is not available to assess compliance with all of these conditions, such as production of oil or grease films, change in colour, odour, and the deposition of material on the bed. The following is an assessment of the compliance where possible.

7.3.3.1 Dissolved oxygen

Compliance with the dissolved oxygen condition in the consent was good, with the lowest measurement being 8.47 mg/L. There was no difference in dissolved oxygen content between the upstream and downstream sites. The oxygen saturation downstream of the discharge was consistently greater than 80%, the lower limit specified in the Regional Freshwater Plan.

²⁹ Regional Freshwater Plan Appendix 8, Guidelines A8.2

³⁰ Regional Freshwater Plan Appendix 8, Guidelines A8.3

7.3.3.2 Temperature

The average temperature difference downstream of the outfall was -0.08°C . On no occasions was the 3°C change threshold exceeded.

7.3.3.3 Water clarity

As water clarity is not directly measured as part of this programme, turbidity measured upstream and downstream of the discharge is used to assess whether a conspicuous change in clarity has occurred. A 'conspicuous change' is taken to be the maximum turbidity change of 10% recommended by ANZECC^[2] for the protection of aquatic ecosystems.

The difference in turbidity between the upstream and downstream sites varied greatly, hence no significant difference was reported in Section 7.2.3. Figure 7-3 shows the percentage increase in turbidity between Martinborough 1 and Martinborough 2. Although the 10% threshold was often exceeded (11 out of 24 occasions), turbidity was sometimes higher upstream. This relatively large variance in results does not allow it to be determined that the discharge is causing a conspicuous change in water clarity.

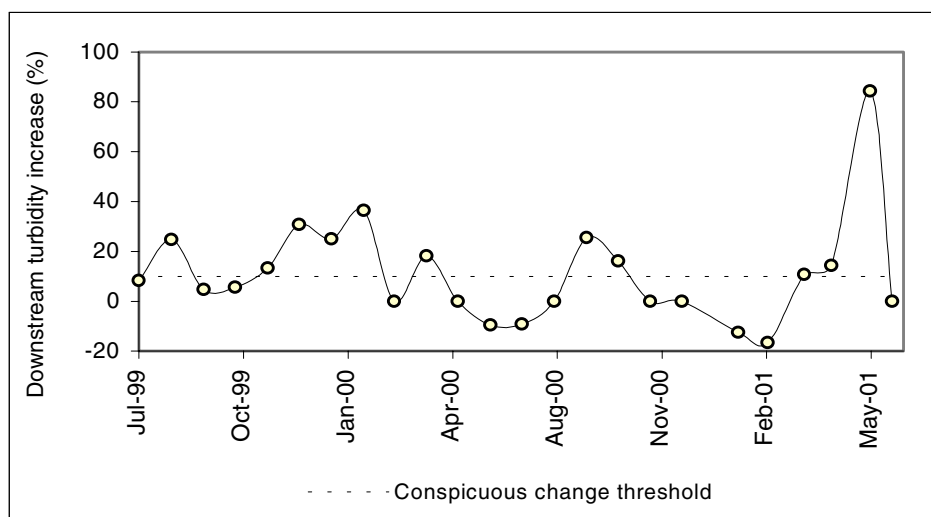


Figure 7-3: Change in Ruamahanga River turbidity downstream of Martinborough effluent outfall, 1999-2001

7.3.3.4 pH

No change in pH of the Ruamahanga River was observed downstream of the Martinborough effluent discharge. Therefore compliance with this condition was achieved.

7.3.3.5 Undesirable biological growths

Periphyton cover is not assessed as part of this monitoring programme. However, as the growth of periphyton is promoted by nutrient enrichment, nutrient concentrations can be used to assess compliance with this condition. The New Zealand Periphyton Guideline suggest maximum values of 34 mg/m^3 soluble inorganic nitrogen and 2.8

mg/m³ soluble reactive phosphorus, above which growth may be promoted given suitable flow conditions^[5].

On all sampling occasions, soluble reactive phosphorus and soluble inorganic nitrogen concentrations exceeded the guidelines, at both Ruamahanga River sites. This means nutrient supply is not a limiting factor for periphyton growth in the Ruamahanga River at Martinborough. However, as the guidelines were exceeded at both sites, factors other than the discharge from Martinborough oxidation pond are causing nutrients to be elevated to levels able to sustain undesirable biological growths given suitable flow conditions.

7.3.3.6 Water quality for farm animal consumption

Good water quality is essential for farm animal consumption, as poor water quality may reduce production and impair fertility^[1]. Water quality guidelines for livestock watering recommended by ANZECC^[1] are that:

- nitrate-nitrogen should not exceed 400 mg/L
- nitrite-nitrogen should not exceed 30 mg/L
- median faecal coliform count should not exceed 100 cfu/100ml.

Nitrate-nitrogen and nitrite-nitrogen levels were consistently below the recommended threshold for stock watering. Similarly, compliance with the faecal coliform guideline was observed with a median count at the downstream site over July 1999 – June 2001 of 90 cfu/100ml. Therefore the Martinborough oxidation pond discharge has not rendered the water unsuitable for consumption by farm animals.

7.3.3.7 Bathing water quality

Guidelines relating to water clarity for contact recreation require black-disk measurements; therefore compliance with the visual clarity condition cannot be assessed. For bacteriological water quality, current contact recreation guidelines^[8] specify a single-sample *E.coli* limit of 410 cfu/100ml. Testing for *E.coli* began in December 1999. Results since this time show general compliance with the guideline value (Figure 7-4).

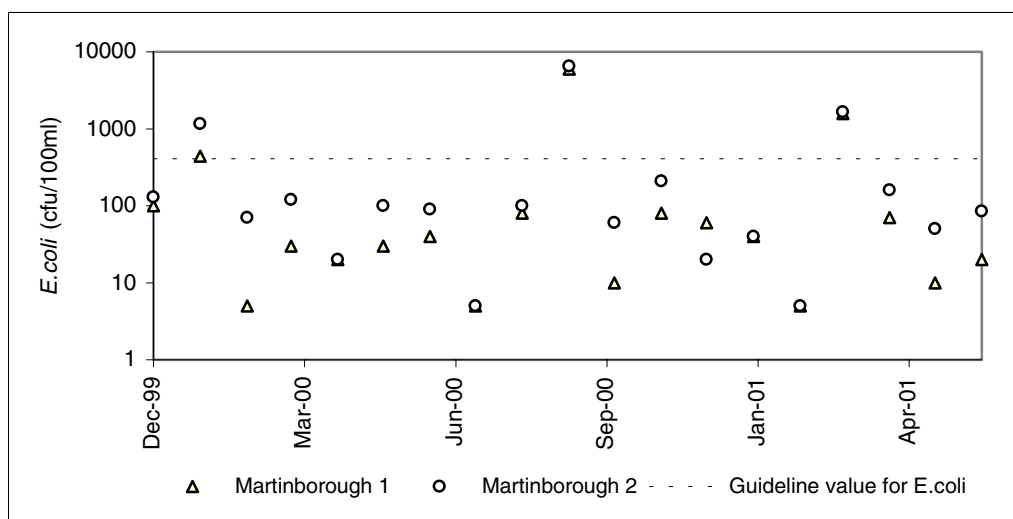


Figure 7-4: Ruamahanga River *E.coli* counts upstream and downstream of Martinborough oxidation ponds, 1999-2001

Exceedances of the threshold have occurred on three occasions at both the upstream and downstream sites. As background *E.coli* values were high, the Martinborough effluent discharge was not considered the factor causing the non-compliance with the contact recreation guidelines on these occasions³¹.

7.3.3.8 Effects on aquatic life

To assess whether the discharge is having a significant adverse effect on aquatic life, macroinvertebrate community structures upstream (Martinborough 1) and downstream (Martinborough 2) of the discharge are compared. Macroinvertebrate communities were sampled on two occasions, in February 2000 and March 2001. Four replicate samples were taken on each occasion, the median of which is compared to the pollution guidelines of Stark^[12] (Figure 7-5).

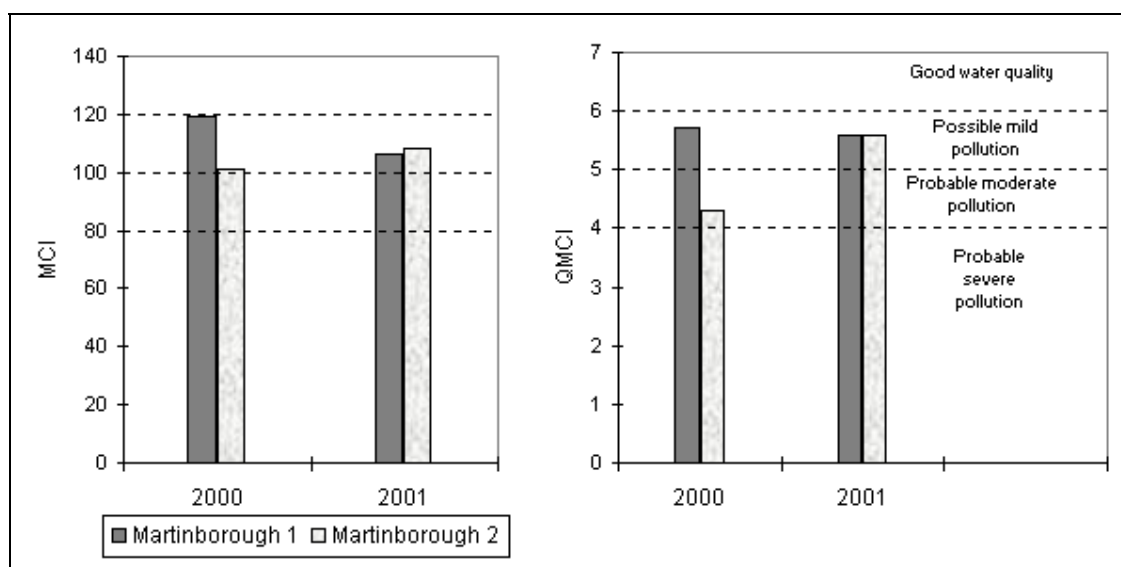


Figure 7-5: Ruamahanga River median MCI and SQMCI scores upstream and downstream of Martinborough oxidation pond outfall, 2000 and 2001

Using the MCI scores, on both occasions samples upstream and downstream fitted into the ‘possible mild pollution’ category. Similarly, using the SQMCI scores, 2001 samples at both sites were categorised as ‘possible mild pollution’. Results for 2000 should be viewed with caution as the upstream site from the 2000 dataset was derived from the site at Waihenga Bridge, approximately 2.5km upstream of the oxidation ponds. Over this distance of 2.5km other pressures, such as agricultural inputs, could have had significant adverse effects on aquatic life.

Using the 2001 data (discounting 2000 data due to lack of a reliable control site) the presence of *Ephemeroptera* (mayflies) was considerably less downstream. Mayflies are particularly sensitive to organic enrichment. The number of taxa present was also lower downstream.

³¹ See Appendix 4

Despite these differences the MCI and SQMCI results from 2001 show Martinborough oxidation pond effluent is not causing significant adverse effects on aquatic life of the Ruamahanga River. Although this conclusion is based on one sampling occasion alone and should be treated with caution, it is in agreement with previous years' results^[11,12].

7.4 Summary

The discharge rate from Martinborough oxidation pond complied with the maximum permitted discharge rate of 17 L/s. The effluent was found to have degraded over time in terms of chemical water quality, with increases in nitrite-nitrogen, nitrate-nitrogen, soluble reactive phosphorus and total particulate phosphorus. However these changes did not result in any temporal trends in receiving water quality. The Ruamahanga River downstream of the Martinborough discharge was significantly higher in bacteria counts, nitrite-nitrogen, ammonia-nitrogen, soluble reactive phosphorus and total particulate phosphorus compared to the upstream site.

Compliance with water quality guidelines in the Regional Freshwater Plan was good for dissolved oxygen, temperature, pH and livestock watering standards. Although exceedances of guidelines for bathing water quality and nutrient levels to promote undesirable biological growths occurred, these were not only caused by the discharge as background water quality also exceeded these guidelines. Also changes in turbidity downstream of the discharge were not consistent and therefore could not be attributed to the presence of the effluent. Therefore the effluent discharge is not causing 'conspicuous change' in water clarity.

MCI and SQMCI results from 2001 did not show that the effluent is causing adverse effects on aquatic life. However, only one sample could be used with confidence.

Acknowledgements

Thanks to Masterton District Council, Carterton District Council and South Wairarapa District Council for data provision.

Thanks to Steve Blakemore (Manager, Planning & Resources) for reviewing this report.

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Appendix 1: Water Quality Determinants

Variable (units)	Use
pH	pH (acidity and alkalinity) will impact upon freshwater ecosystems and may change through the course of a day. Particularly high (alkaline) or low (acidic) pH levels may have an adverse impact on aquatic biota directly. Alkaline conditions may also increase the toxicity of other pollutants such as ammonia-N, which in turn may adversely impact upon the aquatic fauna ^[2] .
Conductivity (µS/cm)	Conductivity is a measure of water's ability to conduct electricity and is affected by the concentration of dissolved ions. Oxidation pond effluents generally have high conductivity's reflecting the high concentration of dissolved ions.
Dissolved Oxygen (g/m ³) / Oxygen Saturation (%)	Dissolved oxygen levels can be limited in aquatic ecosystems by the addition of organic material. The addition of organic material stimulates the activity of aerobic heterotrophs, primarily bacteria, which utilise dissolved oxygen from the water as they mineralise the organic material. The addition of nutrients may influence dissolved oxygen, either through enhancing plant growth and therefore respiration at night, when they cease to photosynthesise, or through the decomposition of the plant material that has grown due to the nutrients. The concentrations of dissolved oxygen in a waterbody may vary enormously in the course of 24 hours, particularly in streams where there is significant organic enrichment ^[2] . Receiving water oxygen saturation should not be reduced below 80% for the protection of aquatic ecosystems ^[13] .
Temperature (°C)	Water temperature has a substantial effect on the functioning of aquatic ecosystems and the physiology of the biota. Physiological processes have thermal optima, and alterations to ambient temperatures may affect the species exposed in a variety of ways. Growth and metabolism, timing and success of reproduction, mobility and migration patterns and production may all be altered by the changes in ambient temperature regimes.

Variable (units)	Use
Turbidity (NTU)	Turbidity is a measurement of the light scattering ability of the solution e.g. water and wastewater. This light scattering ability being dependent on particles in solution. Visually this turbidity is often associated with “cloudiness”. Changes in water clarity may be used to interpret the aesthetic value of waterways, and suitability of the water for contact recreation.
Suspended solids (g/m ³)	This is a measure of the particles in suspension, usually defined further by a filter pore size i.e. particles > 0.45um. A high concentration of suspended solids in receiving waters may irritate or clog the gills of aquatic invertebrates and fish. Once settled these solids may also give rise to poor habitat due to smothering of the streambed.
Biochemical Demand (BOD ₅) (g/m ³)	Oxygen Biochemical oxygen demand gives a measure of the oxygen required by principally bacteria to oxidise carbonaceous organic material into carbon dioxide and water. It is a useful measure of the strength of sewage effluent ^[10] . Within the receiving water body it can be used to assess the effect that this organic material will have e.g. suppression of oxygen within the water giving rise to anoxic conditions detrimental to vertebrates and invertebrates.
Faecal coliforms (/100 mL)	Faecal coliform bacteria are present in the intestines and faeces of warm-blooded animals. Faecal coliforms are "indicator organisms". This means their presence in water is indicative of harmful pathogens. Faecal coliforms are useful for determining the suitability of waters for contact recreation and stock drinking. The most common diseases associated with swimming areas are eye, ear, nose and throat infections, skin diseases and gastrointestinal disorders. A number of pathogens and parasites can be transmitted by contaminated water to livestock which may result in reduced growth, morbidity or mortality.
<i>Escherichia coli</i> (<i>E.coli</i>) (/100 mL)	<i>E.coli</i> bacteria are a subgroup of faecal coliforms. Their presence is a more direct measure of faecal material from warm-blooded animals. <i>E.coli</i> -0157 is a pathogenic organism responsible for a gastroenteric disease. The 2000 New Zealand drinking water standards and 1999 contact recreation guidelines ^[8] use <i>E.coli</i> in preference to faecal coliforms due to this more direct relationship to disease risk.

Variable (units)	Use
Macroinvertebrate Community Index (MCI) and Semi-quantitative Community Index (SQMCI)	The MCI and it's quantitative variant the SQMCI were proposed by Stark (1985) to assess organic enrichment of stony riffles and streams in New Zealand ^[12] . Scores relating to tolerance of organic enrichment have been assigned to macroinvertebrate taxa. The MCI is calculated from these scores. The SQMCI is a more robust measure as it takes into account the <i>abundance</i> of each taxa, rather than presence alone.
Soluble reactive phosphorus (g/m ³)	Soluble reactive phosphorus is a form of phosphate, which is immediately available for plant growth. If this nutrient is not limiting eutrophication of the waterway may occur, subject to other factors being suitable.
Total particulate phosphorus (g/m ³)	This is the sum of the dissolved and complexed fractions of phosphorus in the water. It is an important nutrient to monitor for the eutrophication of water bodies.
Nitrate-nitrogen (g/m ³)	During wastewater treatment reduced nitrogen compounds are oxidised and converted to nitrite and nitrate (a process called nitrification). Nitrate is an important nutrient for the growth of algae and other plants and may be harmful to humans and stock in sufficient concentration ^[2] .
Nitrite-nitrogen (g/m ³)	Nitrite is in an intermediate oxidation state of nitrogen and is unstable in the presence of oxygen, i.e. it will convert to the nitrate state. The presence of high concentrations of nitrite indicates a predominantly anaerobic process. In regards to its effect on the environment, high concentrations may cause potential stock and human health problems e.g. the condition methaemoglobinemia [blue-baby syndrome].
Dissolved Inorganic Nitrogen (g/m ³)	Dissolved Inorganic Nitrogen is a measure of the nitrogen available to plants. Dissolved Inorganic Nitrogen = (ammonia-N + nitrate-N + nitrite-N).
Ammonia-nitrogen (NH ₃) (g/m ³)	The presence of toxic unionised ammonia is often associated with wastes or anaerobic waters. Of the wide range of aquatic organisms tested, invertebrates have proven to be most sensitive to ammonia-N. The toxicity of ammonia is dependent on the concentration of the undissociated form (NH ₃), which is controlled by the pH and temperature of the solution ^[1] . Through denitrification, ammonia-

Variable (units)	Use
Total nitrogen (g/m ³)	nitrogen is an important by-product of wastewater treatment. Total nitrogen is the sum of the organic and inorganic fractions of nitrogen. Decreasing concentrations of total nitrogen in an oxidation pond system may indicate an improvement in its wastewater treatment.

Appendix 2: Analytical Methods and Detection Limits

The following table lists the analytical methods used and their detection limits. This applies to the data collected by Wellington Regional Council, analysed by Wairarapa Laboratory Services.

Parameter	Method	Detection limit
Nitrate-nitrogen	Pearson cadmium reduction method, nitrite finish	2 mg/m ³
Nitrite-nitrogen	APHA Standard Methods 1998 (20 th edition) 4500-NO ₂ ⁻ B, Azo dye colourimetry	2 mg/m ³
Ammonia-nitrogen	APHA Standard Methods 1998 (20 th edition) 4500-NH ₃ F, phenate method	5 mg/m ³
Total nitrogen	Koroleff alkaline persulphate oxidation method followed by cadmium reduction/nitrite finish	10 mg/m ³
Soluble reactive phosphorus	APHA Standard Methods 1998 (20 th edition) 4500-P, B & E Ascorbic Acid method	3 mg/m ³
Total particulate phosphorus	APHA Standard Methods 1998 (20 th edition) 4500-P, B & E Ascorbic Acid finish following acid/persulphate digestion	3 mg/m ³
BOD ₅	APHA Standard Methods 1998 (20 th edition) 5210 B 5-day BOD test	0.1 g/m ³
pH	APHA Standard Methods 1998 (20 th edition) 4500-H ⁺ , B Electronic method	n/a
Conductivity	at 25°C, APHA Standard Methods 1998 (20 th edition) 2510 B, conductivity meter	n/a
Dissolved oxygen	YSI 59 meter, O ₂ probe, NWSCA method No. 38	0.1 g/m ³
Oxygen saturation	YSI 59 meter, O ₂ probe, NWSCA method No. 38	n/a
Temperature	Dissolved oxygen meter	n/a
Turbidity	APHA Standard Methods 1998 (20 th edition) 2130 B, Nephelometric method	0.1 NTU
Suspended solids	APHA Standard Methods 1998 (20 th edition) 2540 D, Total suspended solids dried at 103-105°C	1 g/m ³
Faecal coliforms	at 44°C, APHA Standard Methods 1998 (20 th edition) 9222 D membrane filter on m-FC agar	<1 per 100ml
<i>E.coli</i>	at 44°C, APHA Standard Methods 1998 (20 th edition) 9213 D membrane filter on mTEC agar, urea substrate	<1 per 100ml

Appendix 3: Greytown Effluent Compliance

In the case of Greytown oxidation ponds, it was deemed inappropriate to discuss compliance with the expired consent when a new consent was issued in June 2001. However, it was also inappropriate to assess compliance with new consent conditions when the consent was granted at the end of the reporting period. For interest, an assessment of compliance of effluent water quality from Greytown with conditions in the old consent (Right 870057) is included here; the limits for BOD₅ and suspended solids also apply under the new consent until 1 August 2001. At this time the allowable limits decrease and a condition for faecal coliforms becomes effective.

A3.1 BOD₅

BOD₅ of the effluent consistently complied with the 65 g/m³ limit for the two years ending June 2001 (Figure A3-1). From August 2001 the mean of 40 consecutive BOD₅ samples must not exceed 30 g/m³.

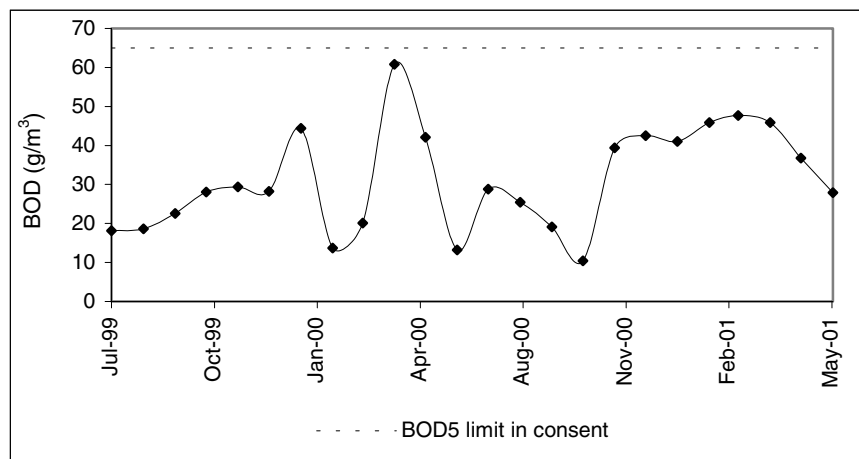


Figure A3-1: BOD₅ of Greytown oxidation pond effluent, July 1999 – June 2001

A3.2 Suspended solids

The condition for suspended solids (80 g/m³) was not complied with on two occasions since July 1999 (Figure A3-2). Both exceedances occurred in January. Beca Steven^[4] found that suspended solids in the Greytown effluent increased in summer due to increased algae growth, which probably is the cause of these exceedances.

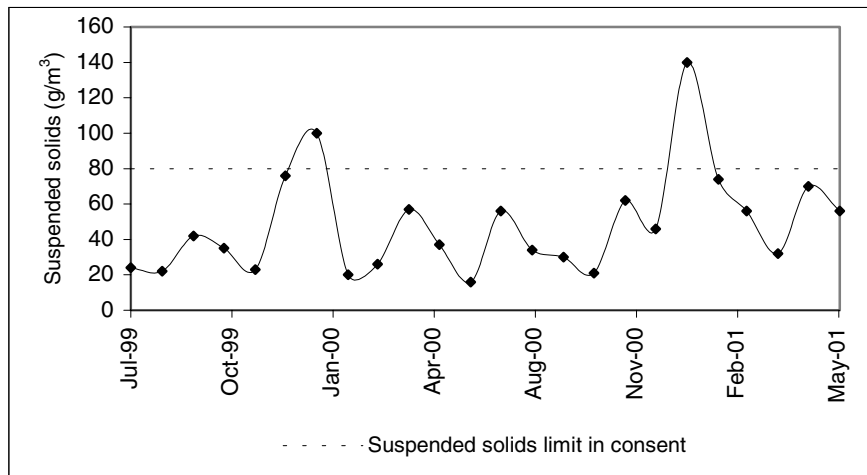


Figure A3-2: Suspended solids in Greytown oxidation pond effluent, July 1999 – June 2001

A3.3 Total phosphorus

Total phosphorus should not exceed 6 g/m³ under the previous consent. As shown by Figure A3-3, the limit was exceeded on most (15 out of 24) occasions. The median concentration over July 1999 – June 2001 was 6.3 g/m³.

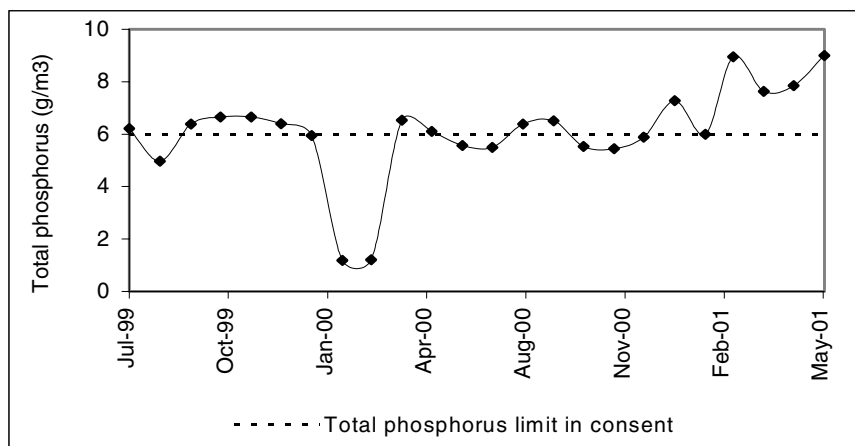


Figure A3-3: Total phosphorus concentrations in Greytown oxidation pond effluent, July 1999 – June 2001

Under the new consent for discharge to Papawai Stream, South Wairarapa District Council must complete a programme of investigation identifying source(s) that contribute to this “anomalous” phosphorus in the effluent discharge.

Appendix 4: Recreational Water Quality Notes

For water bodies to be managed for contact recreation purposes under the Regional Freshwater Plan, a contaminant must not cause the water to be rendered unsuitable for bathing^[13]. The Regional Freshwater Plan specifically requires the numerical criteria for bathing water quality to be that produced by the Ministry of Health and Ministry for the Environment. Therefore the guidelines to be met are the 1999 Recreational Water Quality Guidelines^[8]. These guidelines stipulate that *E.coli* is to be used to indicate the risk of faecal contamination with the potential for the presence of pathogens. However, warnings associated with the Guidelines are:

“These guidelines must not be used as a measure of suitability for bathing when there is a major outbreak of a potentially waterborne disease in the community and that community’s sewage contributes to the microbiological contamination to the water. The guidelines do not apply then because the relationship between indicator organisms (i.e. *E.coli*) and disease was derived when there were no known outbreaks of waterborne diseases in the community. When there is an outbreak of disease in the community, health risks may be increase because of a higher-than-usual ratio of pathogen concentration in the water.” (Recreational Water Quality Guidelines, p 7)

- “Compliance with the guidelines does **not** guarantee that a beach is “safe”. For example, effluent may be treated to a level where the indicator bacterial levels are very low, but other pathogens such as viruses or protozoa may still be present at high levels. It is important that water managers use these guidelines judiciously and carefully consider where they can be applied. Therefore in some circumstances, where for example discharges of highly treated effluent could reduce indicator bacteria levels, these guidelines may not apply and water managers will need to undertake a specific risk assessment.”(Recreational Water Quality Guidelines, p 8)

These points should be taken into account in sections 3.3.3.7 and 7.3.3.7, where compliance of Ruamahanga River *E.coli* counts is compared to the Guidelines. However, it should also be noted that none of the Wairarapa Municipal Oxidation Pond discharges are classed as ‘highly treated’.