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Municipal oxidation ponds system
Monitoring Programme
Annual Report
2008-2009

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Executive summary

The Stratford District Council operates the Stratford municipal oxidation ponds system located to the east of Stratford in the Patea catchment. The Stratford District Council holds a resource consent to allow it to discharge treated wastewater to the Patea River. This report for the period July 2008 to June 2009 describes the monitoring programme implemented by the Taranaki Regional Council to assess the environmental performance during the period under review, and the results and effects of the content holder's activities.

The recently renewed resource consent, which has an expiry date of June 2013, included a total of 16 special conditions setting out the requirements that the Stratford District Council must satisfy. This short term (5 year) renewal of the consent was granted in April 2008 and is conditional upon a staged upgrade of the treatment system and subsequent extensive monitoring of the effectiveness of the upgrade prior to addressing issues and options relating to longer term upgrades to the system. This upgrade involving aeration of the primary pond, division of the second pond into three cells, provision of a sub-surface outlet, and relocation and construction of a new rock riprap outfall, was completed within the requisite time frame. Only minor matters require addressing prior to more intensive monitoring commencing to assess the affects of the significant WWTP upgrade. However, the reduction of stormwater infiltration enter the reticulation, remains an issue to be minimised.

The Council's monitoring programme included four regular inspections, wastewater analyses, and extended physicochemical and biological surveys of the receiving waters of the Patea River.

In recent years improvements in the consent holder's maintenance programme have generally enhanced the appearance of, and controlled odour from, the system. For the first time for many years, no odour complaints were received from neighbouring property owners during the monitoring period coincident with the plant upgrade. Neither were any problems of surface scum accumulation and associated nuisance odours recorded during the period.

Stricter control of industrial waste tanker disposal was instigated by the District Council more than eleven years ago, and although only minor problems with the wastewater treatment system performance were experienced during the monitoring period under review, a more appropriate relocation of the tanker disposal area to provide better control of this activity and fewer operational problems for the treatment system was initiated and completed toward the end of the period. Liaison with the Regional Council has continued whenever uncertainties have existed with respect to proposed additional industrial loadings.

Regular inspections indicated no immediate problems with the oxidation ponds system's performance, with no overflow incidents. Wastewater quality was relatively good at the time of the low flow autumn receiving water physicochemical monitoring survey with a lower than usual algal wastewater component. The survey found minor impacts of the discharge on water quality via the newly located outfall at sites downstream of the permitted mixing zone in the Patea River, mainly related to increases in nutrient loadings under low receiving water flow conditions. The late summer biomonitoring receiving water survey, performed one week after the physicochemical survey, found no significant effects of the discharge on the macroinvertebrate communities of the river, downstream of the new outfall, coincidental with minimal increase in periphyton substrate cover (a consequence of nutrient enrichment) and the absence of significant wastewater-derived microfloral deposition on the riverbed. Regular semi-quantitative pond microfloral assessments indicated some improvement in microfloral community composition and satisfactory long term oxidation pond system performance, with no recurrence of the summer-autumn blue-green algal bloom found from time to time in the past.

Overall, operational performance of the upgraded system and the environmental performance showed improvements equating to a good performance and compliance during the monitoring year. These improvements have been addressed by conditions of the renewed consent, in particular the upgrade of the wastewater treatment system which was completed by mid 2009. Operations will now be the subject of a more intensive two-year monitoring programme (required by specific consent conditions) to ascertain the effectiveness of the upgrade and further assess impacts upon the receiving waters of the Patea River.

Recommendations include continuation of a similar basic monitoring programme over the 2009-2010 period (recognizing the requirement for the more specific additional monitoring of the effectiveness of the WWTP upgrade after its completion), and requirements relating to operation and maintenance of the treatment ponds system and liaison with the Taranaki Regional Council.

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1. Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is the Annual Report for the period July 2008-June 2009 by the Taranaki Regional Council describing the monitoring programme associated with the renewed resource consent held by Stratford District Council for the Stratford municipal oxidation ponds' system (see Appendix I).

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consent held by Stratford District Council relating to the discharge of treated wastes into the Patea River. This is the twenty-second annual report to be prepared by the Taranaki Regional Council to cover this discharge and its effects.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the Resource Management Act and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consents held by Stratford District Council in the Patea catchment, the nature of the monitoring programme in place for the period under review, and a description of the activities and operations conducted in the Patea catchment.

Section 2 presents the results of monitoring during the period under review, including scientific and technical data.

Section 3 discusses the results, their interpretation, and their significance for the environment.

Section 4 presents recommendations to be implemented in the 2007-2008 monitoring year.

A glossary of common abbreviations and scientific terms, and a bibliography, are presented at the end of the report.

1.1.3 The Resource Management Act (1991) and monitoring

The Resource Management Act primarily addresses environment 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

the neighbourhood or the wider community around a discharger and may include cultural and socio-economic effects;
physical effects on the locality, including landscape, amenity and visual effects;
ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;

natural and physical resources having special significance (e.g. recreational, cultural, or aesthetic);
risks to the neighbourhood or environment.

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Taranaki Regional Council is recognizing the comprehensive meaning of 'effects' inasmuch as is appropriate for each discharge source. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the Resource Management Act to asses the effects of the exercise of consents. In accordance with section 35 of the Resource Management Act 1991, the Council undertakes compliance monitoring for consents and rules in regional plans; and maintains an overview of performance of resource users against regional plans and consents. Compliance monitoring, including impact monitoring, also enables the Council to continuously assess its own performance in resource management as well as that of resource users particularly consent holders. It further enables the Council to continually re-evaluate its approach and that of consent holders to resource management, and, ultimately, through the refinement of methods, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental performance

Besides discussing the various details of the performance and extent of compliance by the consent holder during the period under review, this report also assigns an overall rating. The categories used by the Council, and their interpretation, are as follows:

- A **high** level of environmental performance and compliance indicates that essentially there were no adverse environmental effects to be concerned about, and no, or trivial (such as data supplied after a deadline) non-compliance with conditions.
- A **good** level of environmental performance and compliance indicates that adverse environmental effects of activities during the year were negligible or minor at most, items of concern were resolved positively, co-operatively, and quickly, the Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices, there were perhaps some items noted on inspection notices for attention but these items were not urgent nor critical, and follow-up inspections showed they have been dealt with.
- **improvement desirable** indicates that the Council may have been obliged to record a verified unauthorised incident involving significant environmental impacts against the company, and/or abatement notices may have been issued; there were adverse environmental effects arising from activities and intervention by Council staff was required, and there were matters that required urgent intervention, took some time to resolve, or remained unresolved at tend of the period under review.
- **poor** performance is used when there were grounds for prosecution or infringement notice

1.2 Treatment plant system

Stratford town sewage is treated by a twin oxidation ponds system (2.6 ha and 1.7 ha in area), designed and constructed in 1965 for a population of 6300 persons. Some industrial wastes are also discharged into the system, which includes an influent splitter chamber at the end of the main town trunk sewer. This chamber provides for spitting of the raw sewage influent to flow into either, or both ponds, but this provision is only intended for utilisation when excessive stormwater infiltration may cause an overflow directly to the second pond. The final outfall (from the second pond) is to the Patea River. However, the connection between the two ponds and the outlet to the river were originally positioned directly opposite each other, thereby having the potential to short-circuit and reduce retention time in the second pond. The consent holder re-sited the final outlet to the south of the original outlet during 1998-99 to provide improved retention in the secondary pond. Prior to the 2000-2001 monitoring period no significant sludge accumulation had been detected in the pond's system, although only one intensive survey had been performed, fifteen years after commissioning of the treatment system. However, following significant primary pond surface scum problems recorded late in 2000, the consent holder obtained a consultant's report which indicated that considerable sludge accumulation had occurred in the primary pond in particular. Temporary work was necessary to alleviate the immediate surface scum problem, with local burial covering of the sludge. Longer term de-sludging of the pond system required detailed planning by the consent holder with the Taranaki Regional Council and was programmed for the latter part of the 2003-2004 period in accordance with an air emission consent (6262) granted specifically for this purpose. The de-sludging operation was performed during the 2004-2005 period (TRC, 2005 and TRC, 2006), after which the consent was surrendered.

In the 2000-2001 period the consent holder installed influent flow recording at the entrance to the system as the first stage of an assessment of pond loadings and performance, including stormwater infiltration to the system. This information, together with more frequent monitoring of effluent quality (which commenced under contract to the consent holder in the 2001-2002 period) provided the consent holder with data relating to the optimisation of the existing ponds' system and determination of further tertiary treatment options. Further reconstruction of the fluent chamber was undertaken during the 1999-2000 period with the longer-term intention of elimination of the influent splitting facility. A building to house the area was constructed during the 2000-2001 period.

Renewal of the grating system on the original outlet from the second pond was undertaken in late 1999. This outlet was then sealed but was raised and re-opened in 2004 and will continue to be utilised whenever stormwater infiltration volumes increase effluent rates beyond the capacity of the new outlet.

Connection of the new saleyards' partially treated wastes into the sewerage reticulation was approved during the 2002-2003 period and has operated since the saleyards were commissioned.

Construction of a new step screen on the influent line to the ponds system was completed in 2005, as a component of the upgrade but was de-commissioned for a period in 2006-2007 due to blockage problems thought to be linked with industrial waste tanker usage of the system. Waterblasting of the main reticulation upstream of the step-screen was only partially successful in alleviating this problem, necessitating relocation of the waste tanker disposal facility closer to the ponds system. A further relocation of this facility was discussed and implemented in mid 2009. The more suitable location at the Esk Road saleyards provides better facilities and an improved monitoring capability together with a suitable disposal site for campervan wastes.

The consent holder advised in 2001 that $6000,00 had been allocated for improvements to the ponds' system. A pond's influent waste loadings assessment was a component of an upgraded programme. Any further upgrade of ponds' wavebands was to be addressed in the upgrade. An initial meeting between the consent holder, consultant and the Taranaki Regional Council was held in February 2003 to address issues in relation to the 2004 renewal of the consent. This meeting outlined issues of upgrading options for improvements to the treatment system, which formed a component of the assessment of effects accompanying an application for consent renewal received in November 2003. Provision of additional information occurred and the final assessment of effects report was lodged with the Regional Council late in 2007. The renewal of the consent was granted in April 2008 following a further pre-hearing meeting with several submitters.

1.3 Resource consent

1.3.1 Water discharge permit

Section 15(1)(a) of the Resource Management Act stipulates that no person may discharge any contaminant into water, unless the activity is expressly allowed for by a resource consent or a rule in a regional plan, or by national regulations.

Stratford District Council held water discharge permit 0196 which authorised the discharge of 4,800 cubic metres/day of treated wastewater from the municipal oxidation ponds system into the Patea River.

This consent was renewed in late April 2008 and expires on 1 June 2013 with review dates of June 2009 and June 2011. A copy of the renewed consent is attached as Appendix I and was the subject of the monitoring programme. Conditions limit the volume to be discharged, require the timely completion of the WWTP upgrade, reporting progress on the upgrade, provision of a trained operator, proper operation of the system, implementation of an infiltration reduction programme, maintenance of a management plan, limit effects in the receiving waters and provide for review of conditions. Other conditions require monitoring including additional monitoring to evaluate the effectiveness of the upgrade and provision of an assessment for further upgrading of the WWTP leading to a report detailing options and issues for reduction in nutrient discharge loadings.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the Resource Management Act sets out an obligation for the Taranaki Regional Council to gather information, monitor, and conduct research on the exercise of resource consents, and the effects arising, within the Taranaki region.

The Taranaki Regional Council may therefore make and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations, and seek information from consent holders.

An appropriate monitoring programme was established for the system in 1987 and upgraded annual programmes have continued since this date. The 2008-2009 monitoring programme consisted of four primary components.

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Taranaki Regional Council in ongoing liaison with resource consent holders over consent conditions and their interpretation and application, in discussion over monitoring requirements, preparation for any reviews, renewals, or new consents, advice on the Council's environmental management strategies and the content of regional plans, and consultation on associated matters.

1.4.3 Site inspections

The Stratford oxidations ponds system was visited five times (one more than programmed) during the monitoring period. The main points of interest were plant operation, maintenance, upgrades, and performance and the discharges of treated wastewater. These inspections provided for the operation, internal monitoring, and supervision of the plant to be reviewed by the Council.

1.4.4 Wastewater and receiving water quality sampling

The Taranaki Regional Council undertook sampling of wastewater quality and receiving river water physicochemical quality for plant performance and impact assessment purposes. Frequency of sampling and analytical parameters measured varied according to the purpose of monitoring. An additional site was added in the receiving waters due to the relocation of the upgraded outfall.

1.4.5 Biological survey

A macroinvertebrate biological receiving water survey was undertaken on 25 March 2009 at five sites in the Patea River under late summer low flow conditions, one week after the physicochemical survey of the receiving waters. An additional site was added to the survey, necessitated by the relocation of the outfall, a component of the WWTP upgrade.

2. Results

2.1 Inspections of treatment system operation

The four regular scheduled inspections were performed during the monitoring period. Occasional additional inspections were performed in relation to progress with the upgrade of the system documented in Section 2.3. During regular inspections, physical features of the components of the system were recorded, and dissolved oxygen concentrations were measured (by Winkler technique) in the surface wastes adjacent to the repositioned oxidation pond outlet. Results of the dissolved oxygen measurements are summarized in Table 1. Microflora samples were also collected from the second pond on each scheduled inspection visit for comparative on-going assessments of system performance.

Table 1 Dissolved oxygen measurements from the surface of the third cell of the upgraded Stratford secondary oxidation pond at the perimeter adjacent to the outlet

Date	Time (NZST)	Temperature (°C)	Dissolved oxygen	
			Concentration (g/m^3)	Saturation (%)
11 August 2008	0930	8.5	7.8	69
10 November 2008	0830	15.7	0.6	6
18 March 2009	0910	18.6	3.0	33
14 May 2009	0900	9.4	3.2	29

As dissolved oxygen concentrations vary both seasonally and on a daily basis (with minimum concentrations recorded in the early hours of daylight), pond performance has been monitored by standardising sampling times toward mid-morning (0830 to 0930 hrs). Sampling was standardised in this manner for all regular inspection visits. The results in Table 1 indicate dissolved oxygen was present at all times in the surface layer of the secondary pond near the outlet at moderate to low concentrations, with seasonal variation (between 6% and 69% saturation) recorded during the period. Supersaturation was not recorded on any occasion during the monitoring period. The variation in saturation levels measured was typical of a biological treatment system in which the photosynthetic contribution of the microfloral population often causes wide dissolved oxygen variations and may lead to supersaturation at times during daylight hours (particularly later in the day). The lower level (6% saturation) recorded in spring coincided with a very low pond microflora population density. Mechanical aeration of the primary pond (4 aerators) was installed as a component of the system upgrade (required by the renewed consent), late in the previous monitoring period (see Section 2.3) and these aerators were operative on all inspection occasions.

The primary pond varied from relatively clear pale green to pale brown to dark brown while the final cell of the secondary pond system varied from colourless to pale green in appearance on inspection occasions. No surface accumulations of floating scum were noted in the corners or at the edges of the primary pond on any inspection occasion coincident with the continual operation of the four mechanical aerators in this pond.

Localised slight odours were recorded in the vicinity of the ponds on two inspection times, but no odour complaints were received from nearby residents during the period. Past complaints have been related to scum build-up on the surface of the primary pond necessitating remedial clearance. Occasional odours in the area around the flume shed, step screen and tanker wastes disposal point were also the subject of discussions with the consent holder, who undertook improvement in the management of the solid wastes screening and disposal system together with increased surveillance of tanker wastes disposal prior to transfer to a better disposal site undertaken by the consent holder near the end of the period (see Section 2.2.1).

No sediment was observed rising to the surface in either the primary pond or cells of the secondary pond on any inspection occasion, which might be expected after the relatively recent de-sludging operation. The primary and secondary ponds' surfaces were either flat or rippling as inspections coincided with light to moderate wind conditions. Wildlife were present on both ponds during most inspection visits with ducks (brown and paradise) common on both ponds at most times and swans also present on the secondary pond on two occasions. Occasional sightings of cygnets occurred on the secondary pond. These wildlife species are common to the avifauna associated with such treatment ponds (Don, 2004).

Photo 1 Primary pond waveband upgrade, Nov 2008

The ponds' surrounds were generally tidy due to grazing throughout the monitoring period. The waveband repairs of the mid 1990s which used gabion baskets, continue to be monitored by the consent holder with respect to weed growth, debris entrapment and/or odour problems. Further waveband replacement and repairs were undertaken by the consent holder (Photo 1) as a component of the consented upgrade. Some localised subsidence behind the original waveband repairs had previously required remedial backfilling (TRC, 2004).

Photo 2 Primary pond outlet access jetty

Generally, debris was cleared from the primary pond and original second pond outlet grids. New access jetties to the outlet grids had been constructed by the consent holder for cleaning and maintenance purposes (Photo 2).

The new outlet from the final pond was clear of debris on all of the inspection occasions. The septic tanker discharge connection area adjacent to the ponds entrance continued to cause occasional problems (odours and by-passing of the screens) and was relocated to the saleyards area late in the monitoring period. The provision for influent splitting at the entrance to the ponds' system is designed for use only under high (stormwater infiltration) flows. The influent splitter is checked after heavy rainfall and on a regular weekly basis by the consent holder's contractor, and no direct inflow to the secondary pond was noted by any of the four inspections during the monitoring period. A new influent design to prevent inflow directly entering the secondary pond during heavy rainfall events was constructed during the 2000-2001 monitoring period and appears to be effective.

Photo 3 Relocated river riprap outfall

Effluent discharge estimates generally ranged from 6 to 20 L/sec, depending upon preceding climatic conditions, with 100L/sec estimated on one occasion after very heavy winter rainfall. Appearance varied from clearish, very pale green to pale green throughout the period. These discharges were from the newer outfall at the original location until relocation of the outfall with the system upgrade to 600 metres further downstream, where filtration of the wastewater through rock riprap occurs on the true right bank of the river prior to discharge (Photo 3). This outfall was fully operative during the latter half of the period after the overflow outlet in the first cell of the secondary pond was re-routed into the outlet pipeline. The discharge from the old outfall was noted to have a slight visible effect in the river for up to 50 metres downstream. On the initial two inspections occasions there were no noticeable visual impacts under low river flow conditions after relocation of the discharge to the new outfall.

2.2 Comments and incidents

Matters relating to wavebands maintenance, scum formation, primary pond de-sludging (TRC, 2006) and ponds' overflows have been extensively documented in past reports (see references) particularly the report for the 2003-2004 period (TRC, 2004). No overflow incidents were recorded during the 2008-2009 period, but higher than normal levels noted in the first cell of the second pond where to be addresses by the consent holder. Despite expectations that scum formation would be less prevalent following completion of the primary pond de-sludging programme and installation of an inlet pre-screening mechanism, monitoring prior to the current period found that the problem remained. However, subsequent to introduction of mechanical aeration of the primary pond (a component of the system upgrade), no scum formation or accumulation problems occurred.

2.2.1 Step-screen at the inlet

A step-screen and associated overflow by-pass were constructed at the inlet to the ponds' system early in the 2005-2006 monitoring period. Following a complaint in early August 2005 of raw sewage flowing down Victoria Road from the entrance gateway to the ponds' system, it was found that screens in both channels had blocked causing the channels to overflow to the adjacent roadside and drain. Following notification by Regional Council staff, the consent holder immediately manually cleaned both screens which lowered inflow levels and stopped the overflow, and then temporarily removed the step-screen to prevent further blockages.

The problem was linked to significant gravel build-up in the main sewerage reticulation upstream of the inlet. The secondary screen on the bypass line was permanently removed and temporary barriers were installed to contain the spillage. The overflow area was limed for disinfection and tidied. Permanent bunding was constructed, planting and earthworks undertaken, and the system alarmed to provide for immediate contractual response. Monitoring of the system by the consent holder found that gravel build-up in the sewer line continued to cause problems upstream of the step-screen which was removed and re-installed when the blockage was removed. Additional inspections during 2005-2006, particularly following heavy rainfalls, found that no further overflows had occurred and none occurred during the 2006 to 2009 monitoring periods. However, smaller localised spillages were noted in the 2008-2009 period with these directed through an open channel into the primary pond (Photo 4). With relocation of the septic tanks wastes facility this area is currently being tidied up.

Photo 4 Overflow from step-screen area to primary pond, May 2009

In the past several odour complaints during 2006-2007 and 2007-2008 from neighbouring properties (section 2.6) suggested that surface scum build-up (responsible for the odours) had worsened since the de-commissioning of the step-screen. This facility was made operational by March 2007 and, apart from electrical maintenance, remained operative through the remainder of the 2006-2007 period. However operating problems occurred at times in the latter half of 2007, particularly in relation to the solids wastes bin disposal system. This was rectified with the provision of fully enclosed plastic bin liners. All debris removed by the screen is pressed on site prior to transfer for disposal at the Colson Road, New Plymouth landfill. In recognition of the potential for debris build-up in the reticulation (between the tanker discharge site and the step-screen) to affect the step-screen performance, a new tanker wastes disposal facility was constructed adjacent to the entrance to the ponds system. Although this was completed for use during the 2007-2008 monitoring period, various problems at the site required that SDC relocate this facility to a more suitable site (at the Esk Road saleyards) and also that improved quality control measures regulating its usage were instigated.

2.3 Upgrading of the system

During the consent renewal process, the consent holder proposed various upgrades to address various issues which had arisen in the operation and performance of the treatment system. These short, medium and long-term measures included:

- mitigation of the risk to the secondary pond embankment by reducing the pond level by means of the recommissioned original outlet with an overflow riser to take diluted flows in excess of the capability of the newer outlet.
- identification and removal of illegal stormwater connections from properties in the town (30% of properties inspected to date have not fully complied with regulations).
- a step-screen fitted to the inlet to the ponds system.
- investigation and strengthening of the areas of faulty embankment.
- longer term replacement of old pipework to reduce stormwater infiltration into the reticulation (proceeding).

Further, the consent holder has undertaken (as required by conditions of the renewed consent) to upgrade the wastewater treatment system by:

- provision of mechanical aeration of the first pond (which was installed in June 2008)
- refurbishment of ponds' wavebands
- partitioning of the second pond into three cells (Photo 5) and installation of a subsurface outlet to minimise the microfloral component of the treated effluent

Photo 5 Division of second oxidation pond into three cells, November 2008

- relocation and redesign of the piped discharge (further downstream) with passage of the treated effluent through a rock riprap structure prior to river discharge.

These upgrades were required to be completed by 30 June 2009 so that more intensive treated wastewater monitoring could be instigated to assess both the effectiveness of the upgrade and options for further improvements to the wastewater treatment system necessary to address the environmental effects of the discharge on the water quality and the aquatic biota of the Patea River.

The short-term renewed consent has an expiry date of June 2013 and various performance reporting timeframes within this period.

All components of the upgrade were completed and operative by the end of the 2008-2009 period, necessitating certain alterations to the spatial components of the receiving water monitoring programme (see Section 2.5).

An updated report on progress with implementation of the inflow and infiltration reduction programme to minimise stormwater inflow is overdue.

One problem with the original outlet from the second pond remained unresolved at the end of the monitoring period. This outlet in the newly created first cell of this pond was overflowing intermittently to the new diversion pipeline prior to joining the final effluent discharge, thereby partially short-circuiting the full treatment design provided by the upgraded three cell division of the second pond. The need for rectification of this situation has been discussed with the consent holder (and consultant), prior to the implementation of the increased monitoring to assess the upgrade's effectiveness (as required by Special Conditions 12 and 13 of the renewed consent).

2.4 Results of oxidation ponds' system monitoring

2.4.1 Plant performance

A sample of the oxidation ponds' system effluent discharge was collected for analysis on 18 March 2009 as a component of an autumn assessment of effects on the physicochemical quality of the receiving waters of the Patea River under low flow conditions of a summer-autumn recession period. In recognition of the industrial trade wastes component of the sewage inflow to the oxidation ponds' system (eg, tannery, galvanising industry and tanker disposal wastes) and also the design of the system which has incorporated occasional influent waste splitting to each pond, the secondary pond effluent was also analysed for selected metals' components. These metals have the potential to impact on biological aquatic life in the receiving waters if concentrations exceed certain levels of toxicity.

The results of this effluent analysis are provided in Table 2 and compared with past surveys' data.

Table 2 Results of the effluent analysis from the Stratford oxidation ponds' system, 18 March 2009 and past records for the period 1987 to mid 2008

Parameter	Unit	Survey of 18 March 2009	Past data		
			No. of samples	Range	Median
Time	NZST	0810	-	-	-
Temperature	°C	18.6	101	7.4-24.1	14.0
Dissolved oxygen	g/m^3	3.0	94	0.2-15.9	4.7
BOD_5	g/m^3	19	31	9-56	20
BOD_5 filtered	g/m^3	4.2	16	2.0-11	5.4
pH		7.4	23	6.9-8.8	7.5
Conductivity @ 20°C	mS/m	31.0	31	18.0-61.6	32.0
Chloride	g/m^3	23.2	18	22-92	27.9
Dissolved reactive phosphorus	g/m^3P	2.58	24	1.44-11.1	4.68
Ammonia-N	g/m^3N	12.2	36	0.59-24.9	13.7
Turbidity	NTU	17	28	5.6-89	15
Suspended solids	g/m^3	20	34	4-120	39
Faecal coliform bacteria	nos/100/ml	1800	31	70-160000	4000
Metals (acid soluble)					
Cadmium	g/m^3	<0.005	16	<0.005-<0.01	<0.005
Chromium	g/m^3	<0.03	14	<0.03-0.04	<0.03
Zinc	g/m^3	0.020	17	0.009-0.118	0.030
Appearance		lime green			

[Note: with the exception of DO results, data have been recorded mainly from summer surveys]

This effluent quality (Table 2) was typical of a secondary oxidation pond treated waste with moderately low total BOD_5 and suspended solids levels and faecal coliform bacteria number. pH and nutrient levels were also typical of secondary oxidation pond treated effluent. Conductivity, pH and turbidity levels were near previous median levels, with the treated wastewater effluent quality far less influenced by the algal component than has often been recorded in the past, particularly at the time of the summer 2008 survey (TRC, 2008).

Metal concentrations were less than minimum detectable levels, with the exception of zinc, which has consistently remained at low, but detectable, concentrations after a significant increase resulting from the disposal of galvanising wastes during August 1991 (see TRC 92-17). None of these metals' concentrations measured in the effluent at the time of the survey would be expected to exceed toxic levels for aquatic fauna given the dilution provided in the receiving waters of the Patea River.

Effluent parameters were all within ranges recorded from previous surveys (Table 2), and in most instances were below, or very similar to, median values. Effluent quality was good in terms of BOD_5 and suspended solids concentrations and faecal coliform bacteria number, coincident with a lower than usual summer microfloral population abundance and enhanced by the additional secondary pond retention time provided by relocation of the outlet to prevent short-circuiting between the two ponds. It may also have been further improved by the partitioning of the second pond into a three cell system.

2.4.2 Microflora of the Stratford ponds' system

Samples of the secondary pond effluent have continued to be collected at the time of each inspection of the Stratford oxidation ponds system for semi-quantitative microfloral assessment. Table 3 summarises the microflora present in the secondary oxidation pond during the monitoring period together with historical data.

Table 3 Planktonic Microflora found in the Stratford secondary sewage treatment pond since July 1989

Algal Taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	3.7.89	27.7.90	13.12.90	17.1.91	23.8.91	13.9.91	7.11.91	3.6.92	11.9.92	16.10.92	9.12.92	11.3.93	16.6.93	18.8.93	16.11.93	10.2.94	29.3.94	12.5.94	6.9.94	7.12.94	29.3.95	31.5.95	17.7.95	16.8.95	6.11.95	1.2.96	26.4.96	9.5.96	6.8.96	5.11.96
GREEN ALGAE																														
Unidentified Nannoplankton																														
Unidentified colonial																														
Ankistrodesmus	P	P	P	P	P	P	A	A	P	A	P	P	A	VA	A	P	P	A	P	P	P	P	P	P	P	P	P		P	
Closterium	P	A	P	P	P	P	P				P					P		P			P	P				P				
Chlorella		P	A		P			P			P	P	P	P	P	P			P	P	P				P	P	P		P	
Oocystis					P			P				P				P														
Chlorogonium																														
Chlamydomonas				U			U	P	P				P	P	P		P	P				P	P	P	A					P
Selenastrum		P																												
Polyedriopsis				P																										
Diacanthos	P																													
Chodatella																													P	
Eudorina																														
Pandorina																		P			P			P						
Coelastrum								P			P	A				P					P								P	
Botryococcus													U																	
Dictyosphaerium	P	P		P	P	P	A		P	P	A			P	P			P	P	P	P		P		P	P				
Gloeocystis/Planktosphaeria															P						P									
Golenkinia								A	P	P	P	P	P	P	P		A	P	P	A	P		P	P	P					
Micractinium	P	P	P	VA	P	P	P		P	P	P	P		P	A			P	P	A	P	P			A					
Scenedesmus	A	A	A	A	P	A	P	P	P	P	A	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P			P	P
Pediastrum	P		P	P		P		P		P		P	P			P	P				P					P				
Actinastrum		P	P	P				VA	A	A	P	P	P	P	A			P	P	A										
Eudorina																														
Cosmarium																														
Palmellaceae																														
Unidentified unbranched filaments																														
CYANOBACTERIA																														
Oscillatoria										P		P			P		P			P	P					A	P			P
DIATOMS																														
Unidentified																														P
Synedra																														P
Nitzschia										P	P						P				P					P				P
Navicula										P					P		P										P			
Cyclotella			P	A			P			P								P	P			P	P	P					A	
Gomphonema																														P
OTHER																														
Synura																														
Peridinium group	P																													
Trachelomonas																					P									
Euglena	A	P	P		P	P	P	P		P	P	A	P	P	P	P	P	A	A		P	P	A	A	P	P	P	P	A	P
Phacus			P		P																									
Mallomonas																														
Cryptomonas	P		U						P				P					P	P	P					P					
NON-ALGAL GROUPS																														
Non-pigmented bacteria	P		P	A	A	A	P	P	P	P	P	P	A	P	A	P	P	A	A	P	A	A	A	P	A	P	P	P	P	A
Protozoa	P	A	P	P	P	P	P	P	P	P		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
Nematodes											P																			
Rotifers						P					P					P		P		P							P		P	P
Daphnia																														
NUMBER OF TAXA	12	10	13	12	11	10	10	12	10	14	14	13	12	11	14	11	11	15	12	12	17	9	9	9	11	11	8	3	10	11
MfCI	85	74	71	78	67	67	66	62	66	71	67	65	68	58	76	66	69	76	63	67	88	62	58	67	64	71	63	40	62	96

Key : P = Present, A = Abundant, VA = Very Abundant, U= Uncertain ID.

Table 4 Planktonic Microflora found in the Stratford secondary sewage treatment pond since July 1989

Algal Taxa	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
	19.2.97	28.5.97	18.8.97	11.11.97	13.2.98	5.5.98	22.9.98	23.12.98	14.1.99	30.3.99	16.6.99	18.8.99	23.11.99	1.3.00	23.5.00	21.8.00	15.11.00	28.2.01	8.6.01	22.8.01	29.11.01	14.3.02	29.5.02	10.9.02	20.11.02	26.02.03	08.05.03	03.09.03	16.12.03	01.04.04
GREEN ALGAE																														
Unidentified Nannoplankton				**VA**				P																						
Unidentified colonial																														
Ankistrodesmus	P	A	P	P	P	P	P	**A**	P			P	P	P			P	P	P	P				P			P		P	
Closterium										**P**				P				P						P		P	P		P	
Chlorella	**A**	**A**	**A**	P	P	P	P		P	P				P						P	P						P		P	
Oocystis	P									P				**A**																
Chlorogonium																														
Chlamydomonas	P		P							P									P											
Selenastrum						P														P										
Polyedriopsis									**P**					P																
Diacanthos																														
Chodatella			P																											
Eudorina										P																				
Pandorina																				P		A	P							
Coelastrum	P	P			P					P				A				P								P	P	P	P	
Botryococcus																														
Dictyosphaerium	P	P		A			P						P	P			P			P						P	P		P	
Gloeocystis/Planktosphaeria																														
Golenkinia			P		P	P	P													P	A					P				
Micractinium				A		P	**P**	P		P		P	A	P			P										P		**A**	
Scenedesmus	P	P	P	P	P	P	P		P	P			A	A			P	P	P	P			P			P	**P**		**A**	
Pediastrum																											P		P	
Actinastrum																														
Eudorina														P															**A**	
Cosmarium																				P			P							
Palmellaceae																						P								
Unidentified unbranched filaments																														
CYANOBACTERIA																														
Oscillatoria	P				**A**				P	P			P	P				**A**								**VA**				
DIATOMS																														
Unidentified																														
Synedra									P																					
Nitzschia																														
Navicula																														
Cyclotella		P					P	P	P			P	**A**	P										P						
Gomphonema								P																						
OTHER																														
Synura													P	P																
Peridinium group														P																
Trachelomonas																						A								
Euglena	P	P		P	P	P	P		P	P	**P**	P	P	P		P	P	P	P	P			P	P	P	P	P	**P**	P	P
Phacus																			P							P				
Mallomonas																														
Cryptomonas					P																	P	P				P			
NON-ALGAL GROUPS																														
Non-pigmented bacteria	A	A	A	A	P	**A**	P	A	P	P	P	**A**	A	A	**A**	**A**	**A**	P	**A**	**P**	**A**	**A**	**P**	**P**	**A**	P	P	P	P	P
Protozoa		P		P	P	P	P	P	P	P			P	P			P	P	P	P			P	P	P		P	P	P	P
Nematodes	P																													
Rotifers								P	P			P		P													P		P	
Daphnia						A																					P			
NUMBER OF TAXA	11	9	7	9	10	10	10	8	11	12	2	6	10	18	1	2	7	8	7	11	3	5	7	6	3	9	14	4	13	3
MfCI	68	62	57	58	64	54	58	77	82	80	30	52	74	95	20	30	57	65	57	85	40	108	97	57	40	73	73	55	78	40

Key : P = Present, A = Abundant, VA = Very Abundant, U= Uncertain ID.

Table 5 Planktonic Microflora found in the Stratford secondary sewage treatment pond since July 1989

Algal Taxa	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	76	77	78	79	80	90
	21.6.04	17.8.04	2.11.04	16.3.05	31.3.05	16.6.05	24.11.05	30.3.06	26.5.06	28.7.06	25.10.06	28.03.07	15.06.07	17.9.07	11.12.07	7.1.08	26.3.8	23.6.8	11.8.08	10.11.08	18.3.09	14.5.09
	Jun	Aug	Nov	Mar	Mar	Jun	Nov	Mar	May	Jul	Oct	Mar	Apr	Sep	Dec	Jan	Mar	Jun	Aug	Nov	Mar	May
GREEN ALGAE																						
Unidentified Nannoplankton	P		P	P	**A**	P	P	P	**A**	P	P	P	P	P	P					P		P
Unidentified colonial								P														
Ankistrodesmus				P	P	P	P	**A**	P	P	A			**P**					P	**P**		
Closterium										P	P		P		P	P		**P**			P	P
Chlorella											P						P	P	P		P	P
Oocystis														P	P			P				
Chlorogonium											P					P						
Chlamydomonas									P							P						
Selenastrum																						
Polyedriopsis																						
Diacanthos						P																
Chodatella																						
Eudorina																						
Pandorina																					P	
Coelastrum				P		P	P	P			P		P	P		P				P	P	P
Botryococcus																						
Dictyosphaerium							**A**		P	P	P				U	P						P
Gloeocystis/Planktosphaeria																			P	P		
Golenkinia									P	P	P			P	P							
Micractinium			P			P	**A**	P		A	P			P	P	P		P				
Scenedesmus			P	P	P	P	P				P		P	P							P	P
Pediastrum					P																P	P
Actinastrum																						
Eudorina					P																	
Cosmarium													P									
Palmellaceae																						
Unidentified unbranched filaments																P					**A**	**A**
CYANOBACTERIA																						
Oscillatoria				P	P							**P**				**A**	A				P	
DIATOMS																						
Unidentified																						
Synedra	P																					
Nitzschia														P								
Navicula							P															
Cyclotella																		P	**A**	P	P	P
Gomphonema																						
OTHER																						
Synura																						
Peridinium group																						
Trachelomonas									P	P								P				
Euglena	**A**	**P**		**P**	**A**			P	P		P		**P**	P	**P**	P	P	P		P	P	
Phacus	P		P						P					P			**A**	P				
Mallomonas																P						
Cryptomonas				P	P		P	P													P	
NON-ALGAL GROUPS																						
Non-pigmented bacteria	P	P	P	P	P	**A**	P	P	P	P	P	P	P	**A**	P	P	P	P				
Protozoa	P	P	P	P	P	P	P	P	P	P	P		P		P	P			P	P	P	
Nematodes														A								
Rotifers		P	**P**		P	P	P		P		P										P	P
Daphnia												**A**										
NUMBER OF TAXA	6	4	7	9	11	9	11	9	11	9	14	4	8	12	9	12	5	9	5	7	13	10
MfCI	80	40	63	67	78	65	76	64	66	69	65	60	80	65	64	85	64	76	88	83	92	84

Key : P = Present, A = Abundant, VA = Very Abundant, U= Uncertain ID.

Samples of effluent were collected from the outlet of the second oxidation pond and analysed under a binocular microscope to identify phytoplankton present in the sample including algal and non-algal groups. The presence and estimated abundance (present (P), abundant (A) or very abundant (VA)) of these are recorded and the dominant taxa highlighted (in bold). Taxa richness (number of taxa) and the Microfloral Community Index (MfCI) were calculated. The MfCI was designed by Taranaki Regional Council biologists as a measure of sewage pond performance using phytoplankton and some heterotrophic groups. This MfCI uses 'sensitivity' scores from 1 to 10 assigned to each taxon, depending on their occurrence in poorly-performing (overloaded) or well-performing ponds. Higher MfCI values are indicative of better pond performance.

2.4.2.1 Secondary oxidation pond

During the 2008-2009 monitoring period, the Stratford oxidation pond phytoplankton community was characterised generally by moderate numbers of taxa (Table 3 and Figure 1), with a moderate range (5 to 13 taxa) and numbers ranging from four taxa below to four taxa more than the average number (9) taxa found to date.

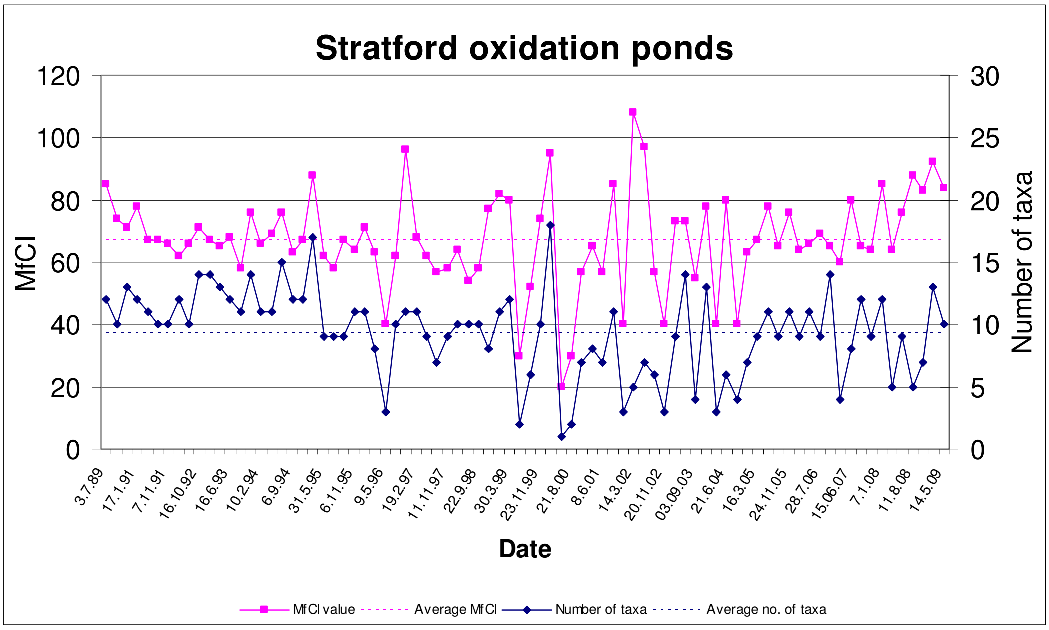

Figure 1 Numbers of taxa and MfCI values for phytoplankton monitoring of the Stratford secondary oxidation pond since 1989

There has been a greater variability in community composition in the Stratford secondary pond than in most sewage treatment ponds in Taranaki. This is the only oxidation pond in the region to date that has been dominated on occasions by the colonial green *Coelastrum*, and one of the few ponds dominated by *Actinastrum* or *Scenedesmus* (although not in recent years), also colonial greens. The blue-green cyanobacteria, *Oscillatoria* often abundant under summer bloom conditions in the past was very seldom found in 2008-2009 and not in abundance.

The average microfloral community index (MfCI) value for the Stratford pond has been 67 units. During the current monitoring year MfCI scores were well above average on all occasions (Figure 1). The lowest pond MfCI value recorded to date (20) was recorded in May 2000 coincident with an absence of algal taxa and the presence of non-pigmented bacteria. Low algal taxa richness has often been the result of zooplankton grazing (by rotifers and/or cladocerans), as was the case in March 2007 when large populations of water fleas (cladocerans) were present in the second pond coincidental with a microfloral richness of only 3 taxa, none of which was abundant. All scores during the monitoring period were indicative of improved pond microfloral conditions despite the variability in taxa richnesses.

2.5 Results of receiving environment monitoring

Two components of the receiving water monitoring programme were operative during the period. These assessed the impacts of treated wastes disposal from the system specifically upon the physicochemical quality and biological communities of the receiving waters of the Patea river. These surveys were also designed to assess any impacts of the adjacent and recently closed Stratford municipal landfill on the receiving waters of the river and are also discussed in this respect in the appropriate Annual Report (TRC 2009 (in prep)).

2.5.1 Physicochemical receiving water survey

An autumn assessment of the impact of the oxidation ponds' system effluent discharge on the receiving waters of the Patea River was performed on 18 March 2009 when flow in the river (at the Skinner Road recorder) was 0.98 m^3/sec, during a moderately low recession flow period (but not as extreme as the very low, lengthy recession flow surveyed in the previous summer). Sites were located (Figures 2 and 3) as summarised in Table 6.

Table 6 Location of sampling sites

No	Site	Location	Map reference	Site code
1	Patea River	at Swansea Road bridge (upstream of landfill and WWTP discharges)	Q20:219062	PAT000315
2	Patea River	upstream of WWTP discharge and downstream of landfill	Q20:254063	PAT000330
E	Secondary oxidation pond effluent	at perimeter adjacent to outlet	Q20:226062	OXP002003
3	Patea River	approximately 250 m downstream of the WWTP original discharge (and now 350m u/s of the new outfall)	Q20:228063	PAT000345
3a	Patea River	approximately 130 m downstream of the WWTP new outfall	Q20:231060	PAT000350
4	Patea River	approximately 1 km upstream of the Kahouri Stream confluence	Q20:246068	PAT000356

Figure 2 Aerial photo of site and location of sampling sites

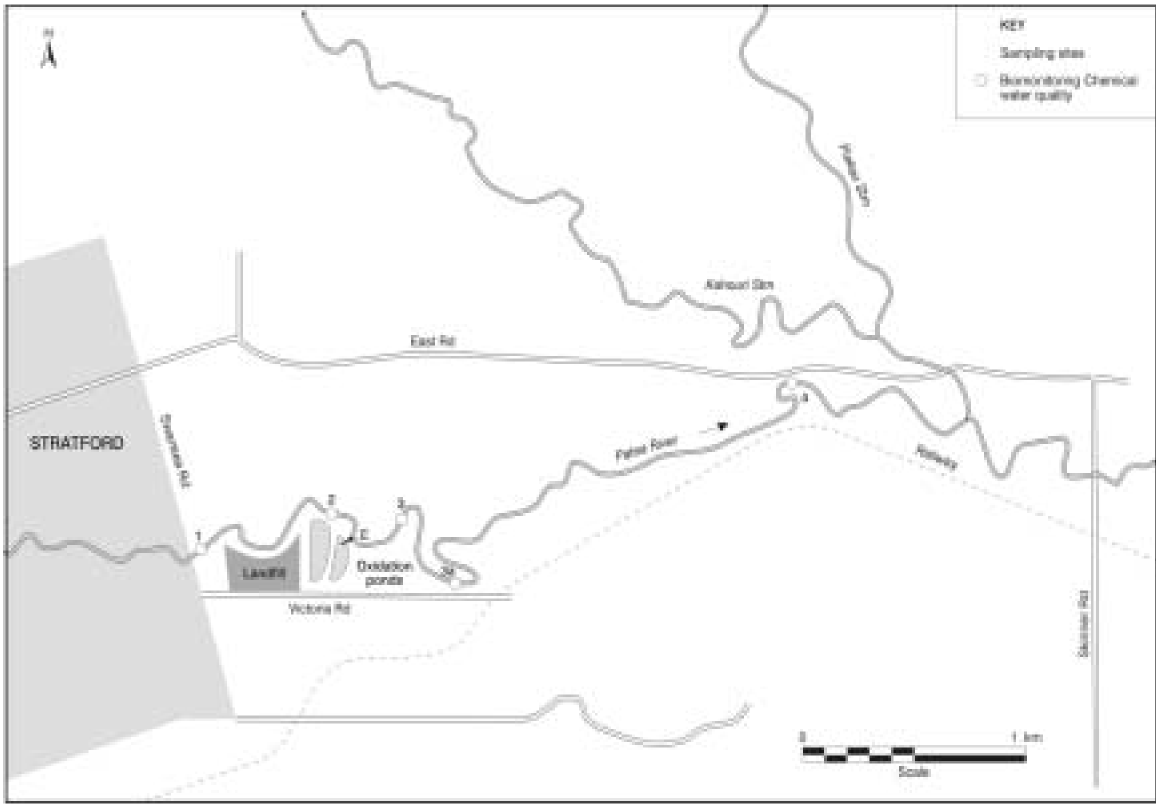

Figure 3 Sampling sites for Stratford landfill and oxidation ponds receiving water monitoring

This survey was performed twenty-six days after a significant river fresh. The river flow was above the minimum mean monthly flow recorded for March (0.63 m^3/s) at the Skinner Road recorder site, and well below the monthly mean of 2.99 m^3/s. This receiving water flow was approximately 170% of the river flow recorded at the time of the previous autumn (2008) survey. An estimated river flow in the vicinity of the oxidation ponds discharge was 0.67 m^3/s.

The results of the survey are summarised in Table 7. All analyses were performed in the Taranaki Regional Council IANZ-registered laboratory using documented standard methods.

Table 7 Patea River physicochemical sampling survey results of 18 March 2009

Site		1	2	3	E	3a	4
Location		Upstream of landfill and WWTP	upstream of WWTP & downstream of landfill	350m upstream of new WWTP outfall	effluent discharge	130m downstream of WWTP new outfall	1km upstream of Kahouri Stream
Parameter	Unit						
Time	NZST	0730	0755	0840	0810	0905	0935
Temperature	^oC	11.9	12.1	12.2	18.6	12.6	13.4
Dissolved oxygen	g/m^3	10.2	10.2	10.4	3.0	10.2	11.0
DO Saturation	%	98	98	100	33	99	109
BOD_5	g/m^3	0.7	0.5	0.5	19	1.7	1.9
pH		7.6	7.5	7.6	7.4	7.6	8.1
Conductivity @ 20^oC	mS/m	9.2	9.3	9.3	31.0	10.0	9.8
Chloride	g/m^3	8.7	8.6	8.7	28.2	9.2	9.7
Zinc (dissolved)	g/m^3	<0.005	0.005	0.005	0.020	<0.005	<0.005
Cadmium (dissolved)	g/m^3	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium (dissolved)	g/m^3	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Dissolved reactive phosphorus	g/m^3P	0.020	0.019	0.017	2.58	0.093	0.072
Ammonia-N	g/m^3N	0.005	0.050	0.050	12.2	0.313	0.061
Un-ionized ammonia-N	g/m^3N	0.00005	0.00042	0.00053	-	0.00341	0.00219
Nitrate + nitrite-N	g/m^3	0.75	0.80	0.70	0.50	0.80	0.93
Turbidity	NTU	2.9	0.8	1.6	17	1.0	1.3
Black disc	m	3.20	3.06	2.98	-	1.72	1.67
Suspended solids	g/m^3	7	<2	<2	20	<2	<2
Faecal coliform bacteria	nos/100ml	66	160	110	1800	170	250
Appearance		rel. clear, uncoloured	rel. clear, uncoloured	rel. clear, uncoloured	sl. turbid, light green	slightly turbid, rel. uncoloured	slightly turbid, uncoloured

A dilution ratio of approximately thirty parts river flow to one part effluent discharge at the time of the sampling survey was indicated by reference to selected analytical results, effluent discharge rate assessment and extrapolation of river flow (from the Skinner Road recorder site).

The effluent discharge had minimal impacts on the receiving waters of the Patea River in terms of temperature, dissolved oxygen, pH, dissolved metals and suspended solids. This was consistent with moderate dilution of the effluent by river flow and a relatively high effluent quality in terms of these parameters. Despite a 42% decrease in black disc clarity there was no coincidental increase in the turbidity or suspended solids levels in the receiving waters. This decrease in black disc clarity measured at the periphery of the new mixing zone, represented a minor change in visual clarity but no change in colour due to the relatively low algal density in the oxidation ponds treated effluent. It remained in compliance with consent conditions. Bacterial numbers increased by 60 faecal coliforms (per 100 ml) at site 3 and a further 80 per 100 ml at site 4 nearly 3 km further downstream.

Increases in total BOD_5 (of 1.2 to 1.4 g/m^3) recorded at the two sites downstream of the discharge had minimal impact on dissolved oxygen levels at these sites below the mixing zone. Although nutrient levels (ammonia-N and dissolved reactive phosphorus) were significantly elevated at site 3 below the discharge, a marked reduction in ammonia-N at the furthest downstream site 4 was consistent with results in most previous summer-autumn periods under low flow conditions. This was due in part to uptake by riverbed periphyton (mats and filamentous algae) which was patchy at the time of this survey, and nitrification of ammoniacal nitrogen (as evidenced by an increase in nitrate nitrogen level at the furthest downstream site) in the receiving waters. Un-ionized ammonia concentrations downstream of the permitted mixing zone were well within the consent condition limit.

In general terms, Patea River water quality upstream of the oxidation ponds' outfall (and downstream of the municipal landfill) was relatively high (98% dissolved oxygen saturation, slightly alkaline pH, low total BOD5 and good water clarity) with moderate faecal coliform numbers. Although nutrient levels were also relatively low, an increase in ammonia-N level was recorded between sites 1 and 2, possibly due to landfill leachate seepage into the river from the true right bank (TRC 2009 (in prep)).

2.5.2 Biomonitoring survey

An autumn biological survey of five sites in the receiving waters of the Patea River (Figure 1) was performed on 25 March 2009, one week after the physicochemical survey and during a lengthy, extremely low flow period. Results of this biomonitoring survey are summarised in Table 8.

Table 8 Biomonitoring results summary from the survey of 25 March 2009

Site	Macroinvertebrate fauna	
	Taxa numbers	MCI value
1	27	110
2	19	109
3	23	104
3a	22	101
4	25	98

Typical macroinvertebrate communities' richnesses (taxa numbers) were surveyed at the four established and one additional Patea River sites during low recession flow period in autumn and under conditions varying from thin to patchy periphyton river substrate cover (mats and filamentous algae). No discolouration of the rivers' reach below the WWTP's newly located discharge was apparent and there was no algal deposition on the river bed, as a result of the low algal concentration in the newly divided second oxidation pond. Faunal communities upstream of the WWTP discharge had slightly higher percentages of 'sensitive' taxa whereas communities at downstream sites had small increases in percentages of 'tolerant' taxa.

MCI scores, relatively typical of mid-catchment ringplain rivers in Taranaki, particularly under summer low flow conditions, showed a moderate range (12 units) along the five sites through the 4.5 km reach of the Patea River. No impacts of seepage from the Stratford landfill (situated between sites 1 and 2) were indicated by the faunal composition at these sites. A small increase in number of 'tolerant' taxa, together with slightly fewer 'highly sensitive' taxa downstream of the WWTP's newly relocated discharge, resulted in insignificantly lower MCI scores. There were few significant changes in individual taxon abundances (as reflected in lower $SQMCI_S$ values) 2.4km downstream of the wastewater discharge.

No 'undesirable' heterotrophic growths were found on the substrate of the river at the sites surveyed downstream of the discharge under these low recession flow conditions and there were no deposition of oxidation ponds' algae on the river bed.

Effects of discharges on the macroinvertebrate communities of the Patea River vary in relation to the treatment provided by the WWTP, dilution available in the receiving waters, preceding climatic conditions and the microfloral component of the wastewaters. Such variations in effects have been documented by previous biomonitoring surveys with this survey illustrating no significant effects during a lengthy recession flow period either form the old outfall or from the recently relocated rock riprap outfall following WWTP upgrade.

2.6 Register of incidents

The Taranaki Regional Council operates and maintains a register of all complaints or reported and discovered excursions from acceptable limits and practices, including non-compliance with consents, which may damage the environment. The register ('unauthorised incident register') includes events where the consent-holder concerned has itself notified the Council. The register contains details of any investigation and corrective action taken.

Incidents may be alleged to be associated with a particular site. If there is an issue of legal liability, the Council must be able to prove by investigation that the identified consent holder is indeed the source of the incident (or that the allegation cannot be proven).

In the 2008-2009 year, there were no incidents recorded by the Council that were associated with the consent holder. For the first time for many years no odour complaints were received nor other incidents reported to the Council. This absence of incidents was coincident with the major upgrade of the WWTP which was completed during the period and particularly the introduction of aerators in the primary pond.

3. Discussion

3.1 Discussion of plant performance

The Stratford oxidation ponds' sewage treatment system has continued to perform satisfactorily with aerobic conditions maintained and a generally high standard of treated wastewater discharged, throughout the twelve month monitoring period. Effluent quality was of a good standard, with a low microfloral density, typical of a twin-pond system when sampled during autumn. Throughout the past, management has attempted to regularly maintain the ponds' system, but surface debris and scum accumulation have occurred, accentuated by certain prevailing wind conditions, despite the completion of the primary pond de-sludging operation in autumn 2005. There have been occasions when climatic conditions and inadequate dispersal have contributed to scum accumulation requiring additional maintenance. This has been emphasised by several odour complains received from neighbouring property owners. However, continuous usage of the influent step-screen system, aeration of the primary pond, and appropriate relocation of the tanker disposal site appear to have alleviated this problem during 2008-2009 when no odour complaints were received and no incidents reported.

The adequacy of waveband repairs (performed during earlier monitoring periods to a stage where no further immediate replacements were considered necessary), has been monitored by the consent holder and further waveband repairs were performed as a component of the WWTP upgrade programme by the consent holder. Screening of the new outlet from the secondary oxidation pond, which has been constructed to provide for increased retention time, was well maintained. The reconstructed inlet system, in order to direct all raw wastes to the primary oxidation pond, functioned as designed during the monitoring period.

The ponds system experienced no further hydraulic problems following intensive rainfall events, as a result of a generally drier period and the provision made for usage of the raised original outfall from the secondary pond. Longer term remedial work in the reticulation has continued to provide additional capacity and will be necessary to markedly reduce stormwater reticulation infiltration. These measures have been identified and planned by the consent holder in conjunction with the system upgrades required by the renewed consent. All aspects of the WWTP upgrade were completed within the period as required by the consent conditions although minor remedial works are being addressed prior to increased monitoring of the upgrade's effectiveness commences.

Trade waste control placed on the usage of the system by industrial tanker wastes by the Stratford District Council (during 1991-92), although resulting in no major problems with this aspect of waste disposal to the ponds' system performance during the monitoring period, may require more intensive monitoring (by the consent-holder) particularly the nature of wastes being discharged to the system. A further relocation of the facility to the saleyards site has provided a more appropriate positioning of this facility in the reticulation system. Disposal of treated wastes from the relatively new regional stockyards through the pond system, actioned six years previously, had no apparent impact on the system's performance.

Regular semi-quantitative biomonitoring of the microfloral component of the secondary pond indicated that the system was characterised by a moderate range of numbers of algal taxa with no summer-autumn intensive bloom of blue-green algae, or aesthetic impacts on the receiving waters of the Patea River unlike the blooms which had occurred on several occasions in past summer–autumn dry, warm periods. Microfloral populations have given no indication of poor performance of the treatment system to date.

3.2 Environment effects of exercise of water permits

Minimal impacts of the discharge were recorded on the physical and chemical quality of the Patea River, during the autumn survey, when low recession flow conditions provided an approximate thirty-fold dilution of the effluent in the receiving waters. Only localised and minor increases in nutrients and bacterial numbers were recorded downstream of the newly re-located rock riprap outfall, mitigated to a certain extent by the effluent quality which was of a good standard at the time of this survey. Minimal discolouration of the receiving waters occurred downstream of the discharge (beyond the permitted mixing zone) in early autumn due to the low algal component of the effluent despite low river flow conditions. The autumn macroinvertebrate fauna showed no significant impacts of the discharge beyond the permitted mixing zone under these low flow conditions.

No significant 'heterotrophic growths' were found on the substrate of the riverbed and all effluent metal concentrations were low with levels unlikely to cause problems to the biota, under the receiving waters low flow conditions experienced in autumn.

3.3 Evaluation of performance

A tabular summary of the Stratford District Council's compliance record for the year under review is set out in Table 9 (in terms of renewed consent 0196).

During the year, the Stratford District Council demonstrated good environmental performance and compliance with the resource consents. Requirements for improvements to wastewater treatment had been addressed by considering upgrades of the system to meet RMA requirements coincident with the short-term renewed consent granted late in the previous period. Although no problems were experienced with hydraulic loadings on the system during the period, such problems were addressed by the consent holder in association with the system upgrade. Past odour complaints resulted in the reappraisal of methods to control surface scum and its disposal including relocation of the tanker wastes disposal facility and improved pond circulation as a component of the upgrade. These facets of the upgrade appear to have alleviated odour problems/scum formation over the 2008-2009 period. Reduction in secondary pond algal blooms and subsequent discharge impacts in part have been addressed by components of the WWTP upgrade relating to the partitioning of the secondary pond and outfall re-design. These were successful in the 2008-2009 period but seasonal variability will be assessed by increased monitoring of microfloral communities associated with the upgrade evaluation.

Table 9 Summary of performance for consent 0196: discharge of oxidation ponds treated wastes to surface water

Condition requirement	Means of monitoring during period under review	Compliance achieved?
1. Upgrade components	Reporting by consent-holder & inspections of system	Yes(by requisite date)
2. Upgrade reporting	Consent-holder supply of reports	Yes (in part)
3. Best practicable option	Inspections	Yes
4. Limits on wastewater volume	Inspections	Yes
5. Implementation of infiltration reduction programme	Reporting by consent-holder	**In part, but update overdue**
6. Implementation of management plan	Provision by consent holder (after plant upgrade)	N/A
7. Provision of operator	Liaison with consent holder	Yes (contractual)
8. Maintenance of aerobic ponds conditions	Inspections & sampling	Yes
9. Trade wastes connections	Liaison with consent holder	Yes
10. Narrative limits on receiving water effects	Inspections, physicochemical sampling and biomonitoring	Yes
12. Limit on receiving water turbidity effect	Physicochemical sampling	Yes
13. Monitoring provisions	Performance of tailored programme and additional contract work	**Yes (latter to commence after upgrade completion)**
14. Numerical limits on receiving water effects (after upgrade)	Physicochemical sampling	N/A
15. Reporting issues & options	Provision by consent holder prior to June 2012	N/A
16. Optional review provision re environmental effects	Not necessary at June 2009	Yes

3.4 Recommendations from the 2007-2008 Annual Report

The previous Annual Report (TRC2008-36) contained the following recommendations in relation to consents monitoring of the operation of the municipal oxidation ponds' system:

1. That monitoring be continued for the 2008-2009 period by formulation of a suitable monitoring programme, similar in format to the 2007-2008 programme; but noting that this programme will be adjusted to include components required by conditions of the recently renewed consent upon completion of the staged upgrade of the WWTP;

2. That the consent holder advise the Taranaki Regional Council whenever additional industrial waste connections are made to the sewerage reticulation system;

3. That regular maintenance of the oxidation ponds' system continue to be performed by the consent holder with particular emphasis on regular removal of accumulated floating debris and clearance of the outlet grids on both ponds. Suitable records are to be kept and made available to the Regional Council as required.

4. That the consent holder liaise with the Taranaki Regional Council with respect to waveband refurbishment monitoring, matters relating to the consent renewal process, and alleviation of the excessive hydraulic loading upon the system.

Recommendations 1, 2, 3 and 4 have been achieved. All monitoring was performed as scheduled with the necessary adjustments. The consent holder has agreed to a more intensive monitoring programme to assess the effectiveness of the completed WWTP upgrade.

3.5 Alterations to the monitoring programme for 2009-2010

In designing and implementing the monitoring programmes for water discharges in the region, the Taranaki Regional Council has taken into account the extent of information made available by previous authorities, its relevance under the Resource Management Act, the obligations of the Act in terms of monitoring discharges and effects, and subsequently reporting to the regional community, the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of municipal treatment processes within Taranaki discharging to the environment.

In the case of the monitoring programme for the Stratford oxidation system it is proposed that for the 2009-2010 period monitoring continue at the same level as that in the 2008-2009 period. However, following the completion of the renewed consent's requirements for the staged upgrade of the WWTP, and as further conditioned by this consent, separate (but integrated) additional monitoring of wastewater quality and impacts upon the receiving waters has been programmed for the 2009-2010 and 2010-2011 periods. A recommendation to this effect is attached to this report.

3.6 Exercise of optional review of consent

The recently renewed resource consent 0196 provides for an optional review of the consent in June 2009 but as this coincided with the completion of the upgrade it is not considered necessary to review the consent at this stage.

4. Recommendations

As a result of the 2008-2009 Monitoring Programme for consent 0196, the following recommendations are made:

1. THAT monitoring be continued for the 2009-2010 period by formulation of a suitable monitoring programme, similar in format to the 2008-2009 programme, and an additional programme performed to include components required by conditions of the recently renewed consent now that the staged upgrade of the WWTP has been completed;

2. THAT the consent holder advise the Taranaki Regional Council whenever additional industrial waste connections are made to the sewerage reticulation system;

3. THAT regular maintenance of the oxidation ponds' system continue to be performed by the consent holder with particular emphasis given to appropriate monitoring and operation of the system immediately following high intensity rainfall events. Suitable records are to be kept and made available to the Regional Council as required; and

4. THAT the consent holder liaise with the Taranaki Regional Council with respect to matters relating to the staged WWTP upgrade and additional monitoring assessment investigations as required by conditions of the renewed consent.

Glossary of common terms and abbreviations

The following abbreviations and terms are used within this report:

biomonitoring	assessing the health of the environment using aquatic organisms
BOD	biochemical oxygen demand. A measure of the presence of degradable organic matter, taking into account the biological conversion of ammonia to nitrate
BODF	biochemical oxygen demand of a filtered sample
bund	a wall around a tank to contain its contents in the case of a leak
condy	Conductivity, an indication of the level of dissolved salts in a sample, usually measure at 20˚C and expressed in mS/m
DO	dissolved oxygen
DRP	dissolved reactive phosphorus
E.coli	*Escherichia coli,* an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as the number of colonies per 100 ml
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological mico-organisms. Usually expressed as the number of colonies per 100 ml
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as the number of colonies per 100 ml
fresh	elevated flow in a stream such as after heavy rainfall
g/m^3	grammes per cubic metre, and equivalent to milligrammes per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures
l/s	litres per second
MCI	macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats
MfCI	microfloral community index: a numerical indication of the state of treatment pond biological life which takes into account the sensitivity of floral taxa to wastewater quality
mS/m	millisiemens per metre
mixing zone	the zone below is a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point
NH_4	ammoniacal nitrogen, normally expressed in terms of the mass of nitrogen (N)
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water
pH	a numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5
physicochemical	measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment

resource consent	refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15)
RMA	Resource Management Act 1991 and subsequent amendments
$SQMCI_S$	semiquantitative macroinvertebrate community index (see MCI) but taking into account each taxon's abundance
SS	suspended solids
taxa richness	number of taxa found in the macroinvertebrate community at a site
temp	temperature, measured in °C
turb	turbidity, expressed in NTU
UIR	Unauthorised Incident Register entry-an event recorded by the Council on the basis that it had potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan

* an abbreviation for a metal or other analyte may be followed by the letter 'As', to denote the amount of metal recoverable in acidic conditions. This is taken as indicating the total amount of metal that might be solubilised under extreme environmental conditions. The abbreviation may alternatively be followed by the letter 'D', denoting the amount of the metal present in dissolved form rather than in particulate or solid form. For further information on analytical methods, contact the Council's laboratory

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Appendix I

Resource consent held by Stratford District Council

Consent 0196-3

TARANAKI
REGIONAL
COUNCIL

CHIEF EXECUTIVE
PRIVATE BAG 713
47 CLOTEN ROAD
STRATFORD
NEW ZEALAND
PHONE: 06-765 7127
FAX: 06-765 5097
www.trc.govt.nz

Please quote our file number
on all correspondence

Discharge Permit

Pursuant to the Resource Management Act 1991
a resource consent is hereby granted by the
Taranaki Regional Council

Name of Consent Holder:	Stratford District Council P O Box 320 STRATFORD 4352
Consent Granted Date:	29 April 2008

Conditions of Consent

Consent Granted:	To discharge treated wastewater from the Stratford wastewater treatment system into the Patea River at or about 2622604E-6206176N
Expiry Date:	1 June 2013
Review Date(s):	June 2009, June 2011
Site Location:	Victoria Road, Stratford
Legal Description:	Lot 1 DP 9529 Blk II Ngaere SD
Catchment:	Patea

For General, Standard and Special conditions
pertaining to this consent please see reverse side of this document

Consent 0196-3

General conditions

a) On receipt of a requirement from the Chief Executive, Taranaki Regional Council the consent holder shall, within the time specified in the requirement, supply the information required relating to the exercise of this consent.

b) Unless it is otherwise specified in the conditions of this consent, compliance with any monitoring requirement imposed by this consent must be at the consent holder's own expense.

c) The consent holder shall pay to the Council all required administrative charges fixed by the Council pursuant to section 36 in relation to:

   i) the administration, monitoring and supervision of this consent; and
   ii) charges authorised by regulations.

Special conditions

1. Before 30 June 2009 the wastewater treatment system shall be upgraded by:

   a) continuous operation of an appropriate influent pre-screening structure;

   b) installation and operation of appropriate mechanical aeration of the first oxidation pond;

   c) refurbishment of the ponds' wavebands;

   d) partitioning of the final ponds into a minimum of three cells by way of rock barriers, and installation of a subsurface outlet to minimise the loading of microflora in the final discharge; and

   e) relocation of the piped discharge and passage of the treated effluent through an appropriately designed rock riprap structure prior to discharge to the river;

   substantially in accordance with drawing no. 14940-SC900 contained in the document supporting the application entitled "Stratford Wastewater Treatment System Resource Consent Application and Assessment of Environmental Effects", [Harrison Grierson July 2007].

2. The consent holder shall supply progress reports on implementation of the upgrade referenced in Special Condition 1, by 30 June 2008 and 30 June 2009 to the Chief Executive, Taranaki Regional Council.

3. Notwithstanding any conditions within this consent, the consent holder shall at all times adopt the best practicable option or options, as defined in section 2 of the Resource Management Act 1991, to prevent or minimize any actual or potential effect on the environment arising from the exercise of this consent.

4. The volume of treated wastewater discharge shall not exceed 4,800 cubic metres per day, unless there has been a total of more than 10 mm of rain over the previous three days [as measured by the Taranaki Regional Council rain gauge at Stratford].

5. The consent holder shall implement an inflow and infiltration reduction programme to minimise the stormwater inflow to the ponds. The programme shall include taking all practicable actions to ensure that all unauthorised stormwater connections to the sewage reticulation system are removed and remain disconnected. The consent holder shall report on progress under this condition to the Chief Executive, Taranaki Regional Council, by 30 June each year.

6. The consent holder shall implement and maintain a Management Plan which shall include operating procedures to avoid, remedy or mitigate against potential adverse effects arising from:

   a) the operation of the wastewater treatment plant;

   b) the build up of sludge in the ponds; and

   c) stormwater and groundwater infiltration into the sewerage system.

7. The consent holder shall ensure that the operation and maintenance of the wastewater treatment system is under the direct control of a suitably trained operator.

8. The oxidation ponds shall be maintained in aerobic conditions at all times during daylight hours.

9. The consent holder shall consult with the Taranaki Regional Council prior to accepting new trade wastes, which may contain toxic or hazardous wastes, into the consent holder's wastewater system.

10. From 30 June 2009, after allowing for reasonable mixing, being a mixing zone extending from the discharge point, to a point 100 metres downstream of the discharge point, the discharge shall not give rise to any of the following effects in the receiving waters of the Patea River:

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

    b) any conspicuous change in the colour or visual clarity;

    c) any emission of objectionable odour;

    d) any significant adverse effect on aquatic ecosystems.

11. From 30 June 2009, after allowing for reasonable mixing within a mixing zone extending 100 metres downstream of the discharge point, the discharge shall not give rise to an increase in turbidity of more than 50% [as determined using NTU (nephelometric turbidity units)] in the Patea River.

12. The consent holder shall, in conjunction with the Taranaki Regional Council, undertake chemical, bacteriological and ecological monitoring of the oxidation pond system and Patea River as deemed reasonably necessary by the Chief Executive, Taranaki Regional Council subject to Section 36 of the Resource Management Act 1991. That monitoring shall include wastewater quality monitoring following the upgrade of the treatment system, sufficient to provide data necessary for an evaluation of the effectiveness of the upgrade and to provide for an assessment of possible further upgrade requirements in relation to potential impacts on the biological communities of the receiving water.

13. The monitoring, evaluation and assessment required by condition 12 shall specifically include monitoring, evaluation and assessment of dissolved reactive phosphorus (DRP) and other nutrient-species.

14. From 30 June 2009, after allowing for reasonable mixing, being a mixing zone extending from the discharge point, to a point 100 metres downstream of the discharge point, the discharge shall not cause the receiving waters of the Patea River to exceed the following concentrations:

Contaminant	Concentration
Unionised ammonia	0.025 gm^{-3}
Filtered carbonaceous BOD_5	2.0 gm^{-3}

15. Before 30 June 2012 the consent holder shall provide to the Chief Executive, Taranaki Regional Council a report detailing issues and options for the Stratford Wastewater Treatment Plant.

The report shall document the environmental effects of the discharge from the Stratford Wastewater Treatment Plant, and set out the options available to address the effects on the receiving environment resulting from the discharge.

The report shall be to the reasonable satisfaction of the Chief Executive, Taranaki Regional Council and shall, as a minimum, address the following:

a) the environmental effects of discharge on the Patea River, including water quality, periphyton growth and aquatic biota;

b) options available for further treatment of wastewater from Stratford, giving particular emphasis to the reduction of nutrients in the discharge; and

c) detail the: costs; expected levels of reduction in adverse effects; and practical implications of introducing each option to the Stratford wastewater treatment system.

16. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2009 and/or June 2011, for the purposes:

a) of addressing the adverse effects of dissolved reactive phosphorus [DRP] and options for reducing those effects; and

b) ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 29 April 2008

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Appendix II

Biomonitoring report

To	Monitoring Manager-Environmental Quality, K Brodie Scientific Officer, S Cowperthwaite
From	Scientific Officer, C R Fowles
File	0196 & 3889
Doc No	627351
Report No	CF486
Date	6 July 2008

Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and Wastewater Treatment Plant, March 2009

1. Methods

The standard '400 ml kick sampling' technique was used to collect streambed (benthic) macroinvertebrates from four established sites and one newly established site in the Patea River (illustrated in Figures 1 and 2), on 25 March 2009.

These sites were:

Site No	Site code	Map reference	Location
1	PAT 000315	Q20: 219 062	Swansea Road bridge (upstream of landfill and oxidation ponds' discharge)
2	PAT 000330	Q20: 224 063	Upstream of WWTP discharge (and downstream of landfill)
3	PAT 000345	Q20: 228 063	Approximately 250 m downstream of the WWTP original discharge (and now 350m u/s of the new outfall)
3a	PAT 000350	Q20: 231 060	Approximately 130m downstream of the WWTP new outfall
4	PAT 000356	Q20: 246 068	Approximately 1 km upstream of the Kahouri Stream confluence

The upgrade to the WWTP system had included a new outfall (via rock rip-rap) to the river located a further 600m downstream of the original discharge point. The original site 3 was retained for the purpose of the current survey to establish that no effects of intermittent usage of the old outfall (which had continued to leak to the river prior to plugging and diversion to the new outfall) had occurred on the biological communities at this site. No discharge from the 'old' outfall was occurring at the time of this survey.

This 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001).

Samples were preserved with Kahle's Fluid for later sorting and identification under a stereomicroscope according to Taranaki Regional Council methodology using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al, 2001). Macroinvertebrate taxa found in each sample were recorded as:

R (rare)	=	less than 5 individuals;
C (common)	=	5-19 individuals;
A (abundant)	=	20-99 individuals;
VA (very abundant)	=	100-499 individuals;
XA (extremely abundant)	=	500 or more individuals.

Macroinvertebrate Community Index (MCI) values were calculated for taxa present at each site (Stark 1985) with certain taxa scores modified in accordance with Taranaki experience.

A semi-quantitative MCI value, SQMCIs (Stark 1999) has also been calculated for the taxa present at each site by multiplying each taxon score by a loading factor (related to its abundance), totalling these scores, and dividing by the sum of the loading factors. The loading factors were 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA), and 500 for extremely abundant (XA).

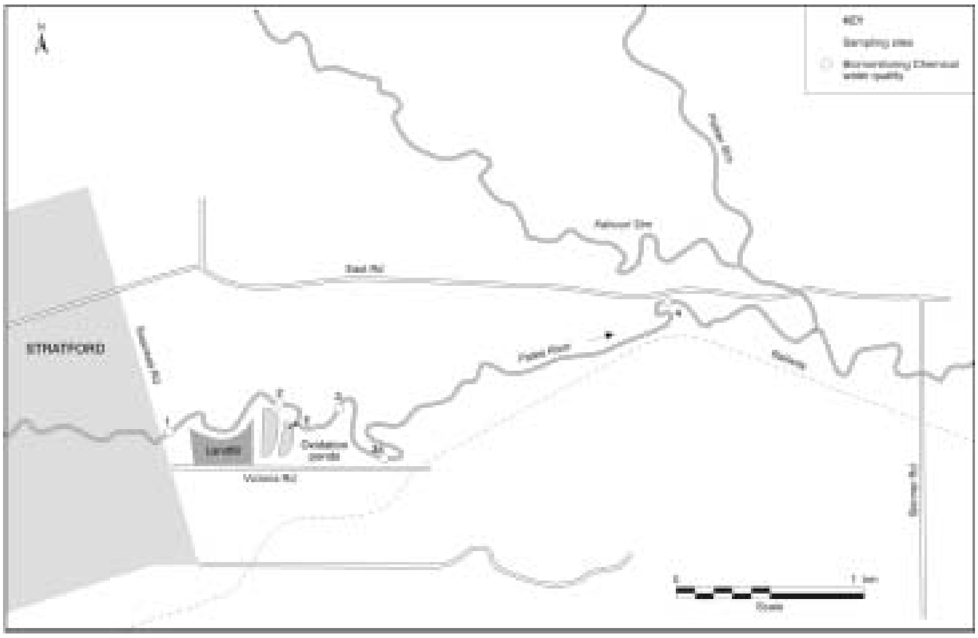


Figure 1 Biomonitoring sites in the Patea River in relation to Stratford landfill and oxidation ponds discharge

Figure 2 Aerial photo of site and location of sampling sites

Sub-samples of algal and detrital material taken from the macroinvertebrate samples were scanned under 40-400x magnification to determine the presence or absence of any mats, plumes or dense growths of bacteria, fungi or protozoa ('undesirable biological growths') at a microscopic level. The presence of these organisms is an indicator of organic enrichment within a stream or river.

2. Results and discussion

This survey was performed during a low recession flow, 18 days after a fresh in excess of 3x median flow and 33 days after a fresh in excess of 7x median flow and during a lengthy dry period. River flow at Skinner Road was 1.51 m^3/sec representing a flow well below the average monthly mean March flow (2.99m^3/sec) but above the minimum mean monthly flow for March (0.63m^3/sec) recorded for the period 1978-2008. This flow was higher by about 0.98 m^3/sec than the flow at the time of the summer 2008 biomonitoring survey.

Periphyton mats were patchy at all sites except site 3 where mats were relatively thin, while filamentous algal growth was patchy at sites 2 and 3. The algal component of the oxidation pond discharge was minimal and none were noticeably trapped amongst the substrate at either of the downstream sites. Patchy moss was recorded on the stony substrates at all of the sites. All sites were partially shaded. Water temperatures ranged from 10.4°C to 12.9°C at the five sites at the time of this late morning – early afternoon survey. The discharge via the rock rip-rap at the new outfall was pale greenish and relatively clear in appearance and caused no obvious increase in turbidity in the river at sites 3a or 4 downstream of the outfall.

2.1 Macroinvertebrate communities

A summary of the results of previous surveys is presented in Table 1.

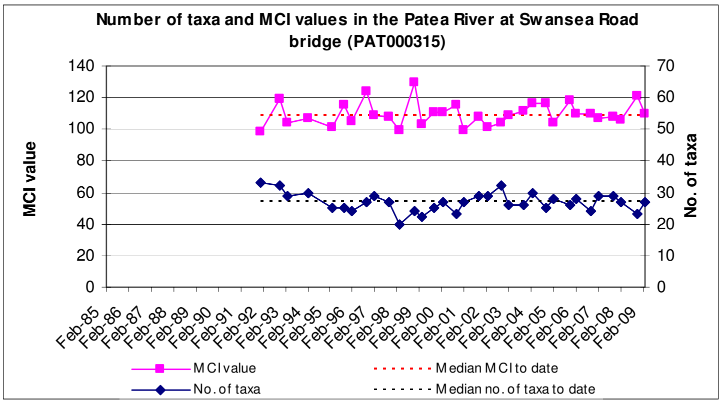
Table 1 Summary of macroinvertebrate taxa numbers and MCI values for previous surveys performed between February 1985 and November 2008

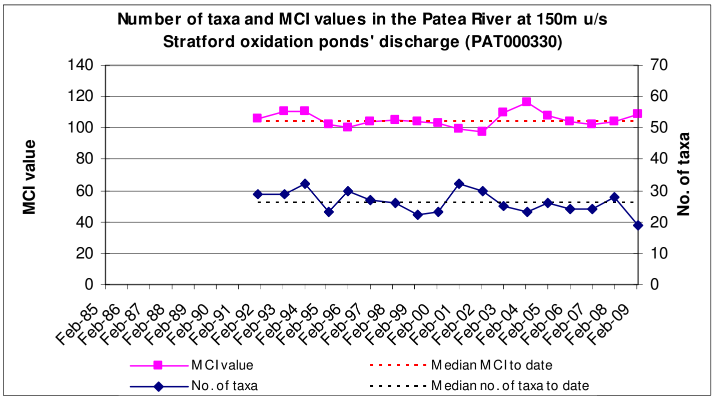
Site	No of surveys	Taxa numbers		MCI Values	
		Range	Median	Range	Median
1	33	20-33	27	98-130	110
2	24	11-36	26	96-116	104
3	24	12-34	29	86-123	99
3a	0	-	-	-	-
4	28	17-31	25	82-116	98

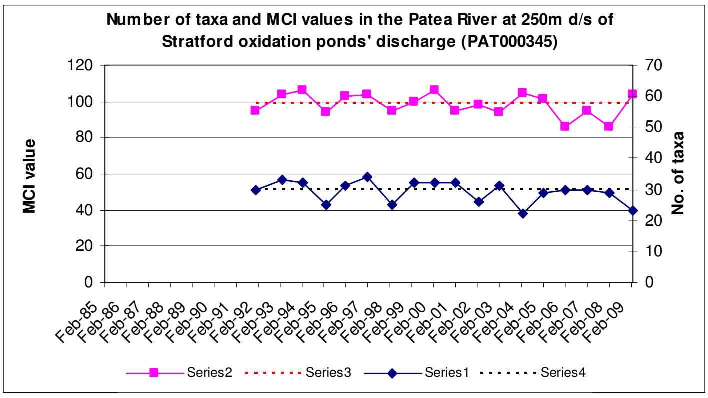
Survey results since February 1985 are illustrated in Figure 2, while the results of the current survey are presented in Table 2 and discussed beneath.

The results from the current survey (Table 2) indicated near or below median faunal richnesses (ranging from 19 to 27 taxa) present at each of the four established river sites. These taxa numbers were within ranges previously recorded (Table 1) at all sites with the richnesses ranging from median to up to 7 taxa below the median values of previous surveys. The richness at the newly established site was also 7 taxa below the historical median at the nearest site.

The range of taxa richnesses was generally typical of most richnesses recorded by previous summer surveys which have been recorded under widespread periphyton cover and varying flow conditions. An exception was the impacts of the frequent and high flood flows recorded during the very wet month of February 2004 which impacted on the macroinvertebrate communities throughout the river to varying degrees, reducing taxa richness and/or abundances within taxa.







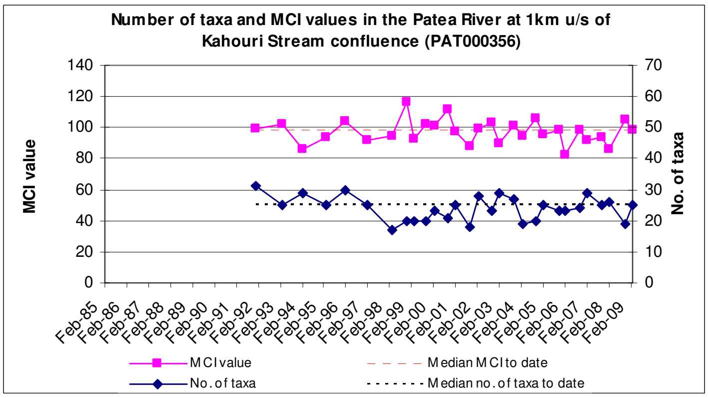


Figure 3 Taxa richness and MCI scores recorded to date at the four established Patea River sites

Table 2 Macroinvertebrate fauna of the Patea River in relation to Stratford District Council WWTP discharge and closed landfill leachate discharges sampled on 25 March 2009

Taxa List	Site Number	MCI score	1	2	3	3a	4
	Site Code		PAT000315	PAT000330	PAT000345	PAT000350	PAT000356
	Sample Number		FWB09182	FWB09183	FWB09184	FWB09185	FWB09186
PLATYHELMINTHES	*Cura*	3	-	-	-	R	-
NEMATODA	Nematoda	3	-	-	-	R	-
ANNELIDA	Oligochaeta	1	C	R	C	A	VA
	Lumbricidae	5	-	-	-	-	R
MOLLUSCA	*Potamopyrgus*	4	-	-	R	-	R
EPHEMEROPTERA	*Austroclima*	7	C	-	C	C	R
	Coloburiscus	7	VA	VA	VA	A	C
	Deleatidium	8	XA	VA	VA	VA	A
	Nesameletus	9	A	A	VA	A	-
PLECOPTERA	*Zelandoperla*	8	R	C	R	R	R
COLEOPTERA	Elmidae	6	VA	A	VA	A	A
	Hydraenidae	8	C	R	C	R	R
	Hydrophilidae	5	-	-	-	-	R
	Ptilodactylidae	8	R	-	-	-	-
	Staphylinidae	5	-	-	-	-	R
MEGALOPTERA	*Archichauliodes*	7	A	A	A	C	A
TRICHOPTERA	*Aoteapsyche*	4	VA	VA	XA	VA	VA
	Costachorema	7	C	C	C	A	C
	Hydrobiosis	5	R	R	R	C	C
	Neurochorema	6	R	-	-	-	-
	Beraeoptera	8	C	R	C	-	-
	Confluens	5	C	C	C	R	-
	Olinga	9	R	-	-	-	-
	Oxyethira	2	R	-	R	-	A
	Pycnocentrodes	5	C	-	-	-	R
	Zelolessica	7	-	-	-	-	R
DIPTERA	*Aphrophila*	5	A	C	A	A	VA
	Eriopterini	5	R	R	R	-	-
	Maoridiamesa	3	R	A	R	A	VA
	Orthocladiinae	2	A	A	C	A	VA
	Tanytarsini	3	A	C	R	C	A
	Empididae	3	-	-	-	-	R
	Ephydridae	4	R	-	-	R	-
	Muscidae	3	R	-	R	R	C
	Austrosimulium	3	R	C	R	R	C
		No of taxa	27	19	23	22	25
		MCI	110	109	104	101	98
		SQMCIs	6.9	6	5.6	5.5	3.5
		EPT (taxa)	13	9	10	9	9
		%EPT (taxa)	48	47	43	41	36

'Tolerant' taxa | 'Moderately sensitive' taxa | 'Highly sensitive' taxa

R = Rare C = Common A = Abundant VA = Very Abundant XA = Extremely Abundant

2.1.1 Sites upstream of WWTP discharge (sites 1 and 2)

The macroinvertebrate communities of this reach of the river upstream of the WWTP discharge (and adjacent to the landfill) were characterised by two 'highly sensitive' taxa (mayflies (extremely abundant, *Deleatidium*; and *Nesameletus*)); up to four 'moderately sensitive' taxa (mayfly (*Coloburiscus*), dobsonfly (*Archichauliodes*), elmid beetles, and cranefly (*Aphrophila*)); and up to four 'tolerant' taxa (net-building caddisfly (*Aoteapsyche*) and midges (orthoclads, tanytarsids, and *Maoridiamesa*)). These dominant taxa were similar to those characteristic of these sites at the times of past summer low flow surveys although slightly fewer in number. Most of the more 'tolerant' taxa are commonly associated with the extensive periphyton assemblages typical of the mid and lower reaches of Taranaki rivers and streams during periods of low recession flows. The presence of five to seven 'highly sensitive' taxa at each of the sites within this surveyed reach of the river, was indicative of relatively good preceding physicochemical water quality upstream and adjacent to the Stratford landfill and WWTP despite the low recession flow period preceding this survey. MCI scores (109 to 110) reflected the moderate proportion of 'tolerant' taxa (32 to 33%) comprising the fauna at these sites, with these scores up to 5 units above medians of previously recorded scores (Table 1). These scores were within 6 units of scores predicted for sites at these altitudes (280 to 300m asl) and an insignificant 7 units higher than predicted for sites this distance from the National Park (12.9 to 13.6 km) in ringplain rivers (Stark & Fowles, 2009). These scores categorised these sites as having 'good' river health (TRC, 2008) at the time of this summer survey, and typical of scores recorded to date under summer low flow conditions at these two sites (Figure 2). The virtual absence of significant differences in individual taxon abundances between sites, together with a statistically insignificant (Stark 1998) downstream decrease of 1 MCI unit, were indicative of no impacts on the macroinvertebrate communities.

2.1.2 Site downstream of 'old' outfall and upstream of 'new' upgraded outfall (site 3)

Taxa richness (23 taxa) was below the historical median richness but well within the range for this site. The community was characterised by the two 'highly sensitive' taxa (mayfly (*Nesameletus* and *Deleatidium*)); four 'moderately sensitive' taxa (mayfly (*Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*), and cranefly (*Aphrophila*)); and one 'tolerant' taxon (net-building caddisfly (*Aoteapsyche*) which was extremely abundant). These dominant taxa were similar to those characteristic of the two upstream sites' communities with the exception of fewer 'tolerant' taxa. The presence of five 'highly sensitive' taxa was indicative of good preceding physicochemical waster quality and moderate periphyton substrate cover at this site below the closed landfill and original Stratford oxidation ponds outfall, and more recently upstream of the relocated WWTP rock riprap outfall to the river.

The MCI score (104 units) reflected the relatively high proportion of 'sensitive' taxa (61%) comprising the fauna at this site, with this score 5 units above the historical median of previously recorded scores (Table 1 and Figure 3) and insignificantly lower than the scores recorded at the two upstream sites 1 and 2. The score categorised this site as having 'good' river health at the time of this summer survey (TRC, 2008). It was also an insignificant 8 units lower than the predicted MCI score for a National Park sourced ringplain river site at an altitude of 280m asl and an insignificant 2 units above the predicted score for this site, 14.2km downstream of the National Park boundary (Stark and Fowles, 2009). The similarity in scores between sites 2 and 3 and virtual absence of significant differences in individual taxon abundances between these adjacent sites were indicative of no impacts on these macroinvertebrate communities due to recent overflows from the original Stratford oxidation ponds outfall.

2.1.3 Sites downstream of WWTP new discharge outfall (sites 3a and 4)

These sites' macroinvertebrate communities differed in taxa richnesses by only three taxa and there were only a few significant differences in characteristic taxa compared with those at the upstream sites 1 and 2. One 'sensitive' mayfly taxon (*Nesameletus*) was less abundant, while 'tolerant' oligochaete worms and midges in particular, increased in abundance. These relatively minor changes in community composition and a small increase in the proportion of 'tolerant' taxa (58% and 59% of faunal numbers) resulted in insignificant decreases in the MCI scores at sites 3a and 4 (101 and 98 units) which were statistically insignificantly lower than scores obtained in the river reach immediately upstream of the discharge from the WWTP. These differences in scores were indicative of no recent impacts of the upgraded WWTP wastes discharge on the macroinvertebrate fauna in the surveyed reach of the Patea River, with the downstream sites' scores 0 to 2 units higher than the relevant medians of past scores. There was minimal difference in MCI scores (3 units) between the two adjacent downstream sites (3a and 4) and the overall fall in MCI scores (12 units) over a distance of 4.3 km between the 'control' site (1) and furthest downstream site (4) was insignificant given the distance between these two sites. There was an insignificant drop in $SQMCI_s$ score immediately downstream of the new outfall (site 3a) but a further drop in $SQMCI_s$ score of 2.0 units at site 4 resulted principally from decreased abundances of the 'highly sensitive' mayflies, *Deleatidium* and *Nesameletus* and increased abundances of very 'tolerant' oligochaete worms and two midge taxa.

The MCI scores categorised sites 3a and 4 as having 'good' and 'fair' river health respectively (TRC, 2008) at the time of this summer survey. These scores (101 and 98 units) were an insignificant 10 units to a significant 12 units lower than predicted for sites at these altitudes (265 and 250m asl) in ringplain rivers and an insignificant 0 to 2 units below predicted scores for these sites 14.8 km and 17.2 km downstream of the National Park boundary (Stark and Fowles, 2009).

The 12 unit difference in MCI scores between sites 1 ('control') and site 4 over a river distance of 4.3km represented an insignificantly 9 unit larger difference than predicted for this reach of the Patea River some 13 to 17 km below the National Park boundary (Stark and Fowles, 2009), indicative of minor impacts of point source discharges and landfill leachate under summer low flow conditions.

2.2 Riverbed heterotrophic growth assessment

Microscopic assessment of material from the riverbed at the five sampling sites indicated that there were no unusual heterotrophic growths present in the river at the three upstream and two downstream sites during a period of summer low recession flow conditions. This was consistent with the visual absence of such growths noted at all sites at the time of the survey. Also there was no increase in algal deposition at the site immediately downstream of the old discharge outfall or downstream of the new relocated outfall.

3. Conclusions

Typical macroinvertebrate communities richnesses were surveyed at the five Patea River sites during a low flow recession period in the latter part of summer and under conditions varying from thin to patchy periphyton river substrate cover (mats and filamentous algae). No discolouration of the river's reach below the WWTP's newly located discharge was apparent and there was no algal deposition on the river bed, as a result of the low algal concentration in the newly divided second oxidation pond. Faunal communities upstream of the WWTP discharge had slightly higher percentages of 'sensitive' taxa whereas communities at downstream sites had small increases in percentages of 'tolerant' taxa.

MCI scores, relatively typical of mid-catchment ringplain rivers in Taranaki, particularly under summer low flow conditions, showed a moderate range (12 units) along the five sites through the 4.5 km reach of the Patea River. No impacts of seepage from the Stratford landfill (situated between sites 1 and 2) were indicated by the faunal composition at these sites. A small increase in number of 'tolerant' taxa, together with slightly fewer 'highly sensitive' taxa downstream of the WWTP's newly relocated discharge, resulted in insignificantly lower MCI scores. There were few significant changes in individual taxon abundances (as reflected in lower $SQMCI_s$ values) 2.4 km downstream of the wastewater discharge.

No 'undesirable heterotrophic growths were found on the substrate of the river at the sites surveyed downstream of the discharge under these summer low recession flow conditions and there was no deposition of oxidation ponds' algae on the river bed.

Effects of discharges on the macroinvertebrate communities of the Patea River vary in relation to the treatment provided by the WWTP, dilution available in the receiving waters, preceding climatic conditions and the microfloral component of the wastewaters. Such variations in effects have been documented by previous biomonitoring surveys with this survey illustrating no significant effects during a lengthy recession flow period either from the old outfall or from the recently relocated rock riprap outfall following WWTP upgrade.

4. Summary

The Council's standard 'kick-sampling' technique was used at four established and one newly established sites to collect streambed macroinvertebrates from the Patea River. Samples were sorted and identified and the number of taxa (richness), MCI score and $SQMCI_S$ score were calculated for each site.

The MCI is a measure of the overall sensitivity of the macroinvertebrate community to the effects of organic pollution in stony streams. It is based on the presence/absence of taxa with varying degrees of sensitivity to environmental conditions. The $SQMCI_S$ takes into account taxa abundance as well as sensitivity to pollution, and may reveal more subtle changes in communities, particularly if non-organic impacts are occurring. Significant differences in either the MCI or the $SQMCI_S$ between sites indicate the degree of adverse effects (if any) of the discharges being monitored.

This March 2009 macroinvertebrate survey indicated that the discharge of treated oxidation ponds wastes from the recently upgraded Stratford WWTP system had had no significant effects on the macroinvertebrate communities of the Patea River under low river flow conditions and moderate microfloral population of the final oxidation pond. No significant changes in macroinvertebrate communities' compositions were recorded between the upstream 'control' site and sites downstream of the original oxidation ponds discharge or the newly relocated outfall. There were also no significant effects associated with seepages from the closed landfill site.

The macroinvertebrate communities of the Patea River contained slightly higher proportions of 'sensitive' taxa at upstream sites and the communities were generally dominated by more 'sensitive' than 'tolerant' taxa at these (two) sites. 'Tolerant' taxa were slightly more predominant proportionately and numerically at the two sites downstream of the newly located WWTP discharge where slightly fewer 'highly sensitive' taxa were present. Taxonomic richnesses (numbers of taxa) were relatively lower in this summer survey compared to the previous survey conducted in late summer, coincident with a reduction in periphyton growth on the river bed at the time of the latest survey

MCI and $SQMCI_S$ scores indicated that the upstream stream communities were of 'good' health (TRC, 2008) and generally typical of conditions recorded in the mid reaches of similar Taranaki ringplain rivers. Stream communities downstream of the WWTP discharge were of 'good' to 'fair' health and were better than those documented by the previous summer survey, due to a marked decrease in the degree of algal deposition (as a result of a lower algal population in the upgraded final oxidation pond) during the latest summer recession flow conditions.

5. References

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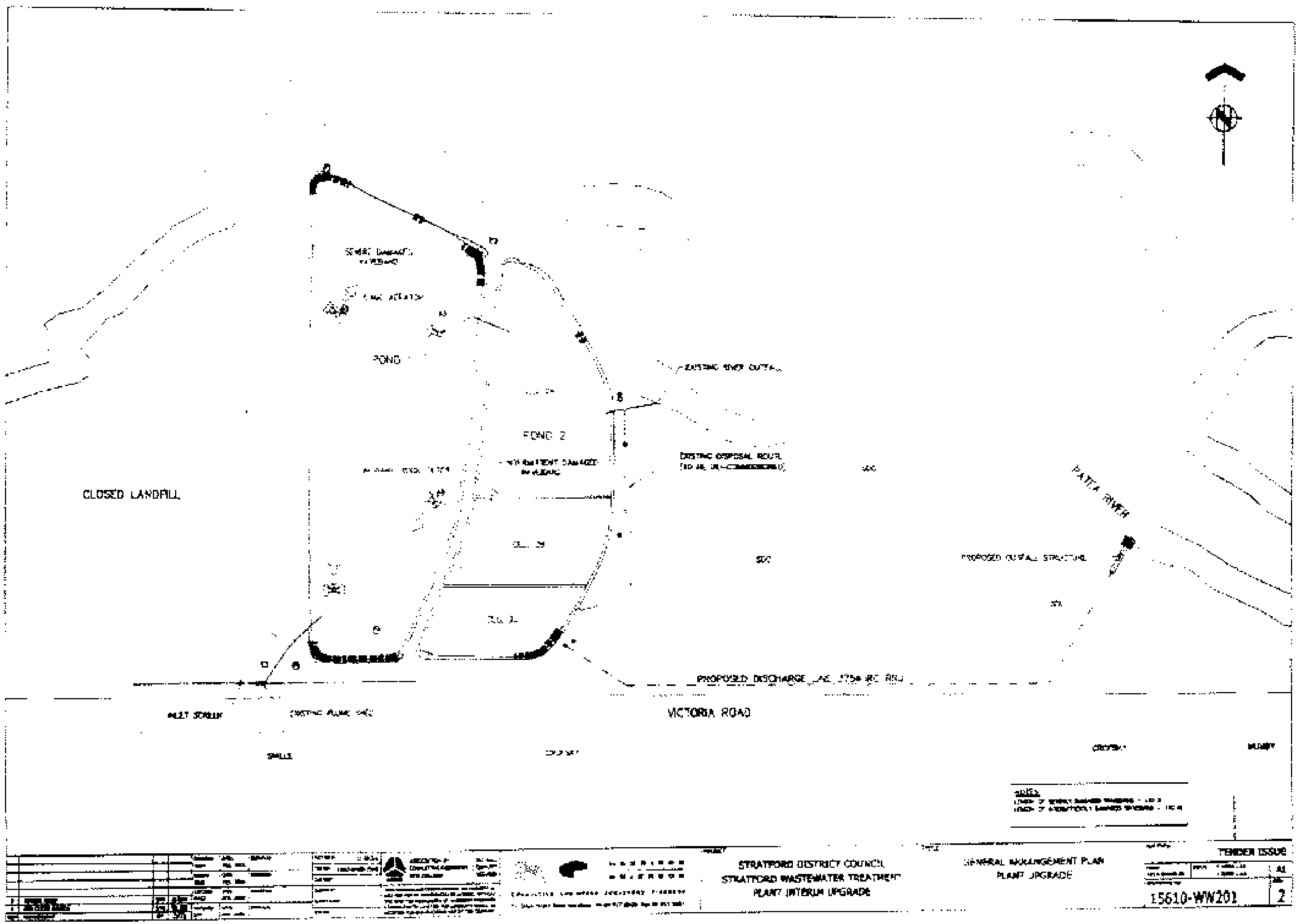
Appendix III

Upgrade of the Stratford Wastewater Treatment Plant



CLOSED LANDFILL
POND
POND 2
PATEA RIVER
EXISTING RIVER OUTFALL
EXISTING DISPOSAL ROUTE
PROPOSED OUTFALL STRUCTURE
PROPOSED DISCHARGE LINE
VICTORIA ROAD
INLET SCREEN
SWALE
TENDER ISSUE
STRATFORD DISTRICT COUNCIL
STRATFORD WASTEWATER TREATMENT
PLANT INTERIM UPGRADE
GENERAL ARRANGEMENT PLAN
PLANT UPGRADE
15610-WW201
2