Stratford District Council
Municipal Wastewater Treatment Plant
Monitoring Programme
Annual Report
2015-2016

Technical Report 2016-28

ISSN: 1178-1467 (Online)
Document: 1776809 (Word)
Document: 1803556 (Pdf)

Taranaki Regional Council
Private Bag 713
STRATFORD

March 2017

Executive summary

The Stratford District Council (SDC) operates a municipal wastewater treatment plant (WWTP) located on Victoria Road at Stratford, in the Patea catchment. This report for the period July 2015 to June 2016 describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess SDC's environmental performance during the period under review. The report also details the results of the monitoring undertaken and assesses the environmental effects of SDC's activities.

SDC holds one resource consent to discharge treated wastewater to the Patea River, which includes a total of 12 conditions setting out the requirements that they must satisfy.

During the monitoring period, SDC demonstrated an overall good level of environmental performance.

The Council's monitoring programme for the year under review included four inspections, wastewater analyses, and physicochemical and biological surveys of the receiving waters of the Patea River.

In recent years, improvements in the SDC's maintenance programme have generally enhanced the appearance of the plant and effectively controlled any produced odour. No complaints were received in relation to the operation of the WWTP. Regular inspections indicated no immediate problems with the performance of the plant, with no overflows recorded during the monitoring year. Seasonal variability in pond microfloral populations (as indicated by chlorophyll-a populations) was also influenced by preceding wet weather stormwater infiltration. Wastewater quality was good at the time of the very low flow late summer receiving water physicochemical survey, with a moderate algal component. This algal component had a minor impact on turbidity under the very low flow conditions, which was non-compliant with aesthetic consent conditions. A late summer biomonitoring survey found no impacts on the macroinvertebrate fauna as a result of the discharge of treated wastewater.

During the year, SDC demonstrated a good level of environmental and a high level of administrative performance with the resource consents. Effects from the discharge on the receiving waters continue to be recorded, with minor or no effects noted beyond the boundary of the permitted mixing zone.

For reference, in the 2015-2016 year, 71% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 24% demonstrated a good level of environmental performance and compliance with their consents.

In terms of overall environmental and compliance performance by the consent holder over the last several years, this report shows that SDC's performance remains at a good level.

This report includes recommendations for the 2016-2017 year, including continuation of a similar basic monitoring programme and requirements relating to operation and maintenance of the treatment ponds system.

Table of contents

List of tables

List of figures

List of photos

1 Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period July 2015 to June 2016 by the Taranaki Regional Council (the Council) describing the monitoring programme associated with the renewed consent held by Stratford District Council (SDC) for the Stratford municipal oxidation ponds' system.

This report covers the results and findings of the monitoring programme relating to the discharge of treated wastes into the Patea River. This is the twenty-ninth annual report to be prepared by the 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:

- consent compliance monitoring under the RMA and the Council's obligations;
- the Council's approach to monitoring sites though annual programmes;
- the resource consents held by SDC 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.

Sections 2 and 3 present the results of monitoring during the period under review, including scientific and technical data.

Section 4 discusses the results, their interpretations, and their significance for the environment.

Section 5 presents recommendations to be implemented in the 2016-2017 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 RMA primarily addresses environmental 'effects' which are defined as positive or adverse, temporary or permanent, past, present or future, or cumulative. Effects may arise in relation to:

(a) the neighbourhood or the wider community around an activity, and may include cultural and social-economic effects;
(b) physical effects on the locality, including landscape, amenity and visual effects;
(c) ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;

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

In drafting and reviewing conditions on discharge permits, and in implementing monitoring programmes, the Council is recognising the comprehensive meaning of 'effects' inasmuch as is appropriate for each activity. Monitoring programmes are not only based on existing permit conditions, but also on the obligations of the RMA to assess the effects of the exercise of consents. In accordance with Section 35 of the RMA, the Council undertakes compliance monitoring for consents and rules in regional plans, and maintains an overview of the performance of resource users and consent holders. Compliance monitoring, including both activity and impact monitoring, enables the Council to continually re-evaluate its approach and that of consent holders to resource management and, ultimately, through the refinement of methods and considered responsible resource utilisation, to move closer to achieving sustainable development of the region's resources.

1.1.4 Evaluation of environmental and administrative performance

Besides discussing the various details of the performance and extent of compliance by SDC, this report also assigns them a rating for their environmental and administrative performance during the period under review.

Environmental performance is concerned with actual or likely effects on the receiving environment from the activities during the monitoring year. **Administrative performance** is concerned with SDC's approach to demonstrating consent compliance in site operations and management including the timely provision of information to Council (such as contingency plans and water take data) in accordance with consent conditions.

Events that were beyond the control of the consent holder and unforeseeable (that is a defence under the provisions of the RMA can be established) may be excluded with regard to the performance rating applied. For example loss of data due to a flood destroying deployed field equipment.

The categories used by the Council for this monitoring period, and their interpretation, are as follows:

Environmental Performance

- **High:** No or inconsequential (short-term duration, less than minor in severity) breaches of consent or regional plan parameters resulting from the activity; no adverse effects of significance noted or likely in the receiving environment. The Council did not record any verified unauthorised incidents involving significant environmental impacts and was not obliged to issue any abatement notices or infringement notices in relation to such impacts.

- **Good:** Likely or actual adverse effects of activities on the receiving environment were negligible or minor at most. There were some such issues noted during monitoring, from self reports, or in response to unauthorised incident reports, but these items were not critical, and follow-up inspections showed they have been dealt with. These minor issues were resolved positively, co-operatively, and

quickly. The Council was not obliged to issue any abatement notices or infringement notices in relation to the minor non-compliant effects; however abatement notices may have been issued to mitigate an identified potential for an environmental effect to occur.

For example:

- High suspended solid values recorded in discharge samples, however the discharge was to land or to receiving waters that were in high flow at the time;
- Strong odour beyond boundary but no residential properties or other recipient nearby.

- **Improvement required**: Likely or actual adverse effects of activities on the receiving environment were more than minor, but not substantial. There were some issues noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent minor non-compliant activity could elevate a minor issue to this level. Abatement notices and infringement notices may have been issued in respect of effects.

- **Poor:** Likely or actual adverse effects of activities on the receiving environment were significant. There were some items noted during monitoring, from self reports, or in response to unauthorised incident reports. Cumulative adverse effects of a persistent moderate non-compliant activity could elevate an 'improvement required' issue to this level. Typically there were grounds for either a prosecution or an infringement notice in respect of effects.

Administrative performance

- **High:** The administrative requirements of the resource consents were met, or any failure to do this had trivial consequences and were addressed promptly and co-operatively.

- **Good:** Perhaps some administrative requirements of the resource consents were not met at a particular time, however this was addressed without repeated interventions from the Council staff. Alternatively adequate reason was provided for matters such as the no or late provision of information, interpretation of 'best practical option' for avoiding potential effects, etc.

- **Improvement required:** Repeated interventions to meet the administrative requirements of the resource consents were made by Council staff. These matters took some time to resolve, or remained unresolved at the end of the period under review. The Council may have issued an abatement notice to attain compliance.

- **Poor**: Material failings to meet the administrative requirements of the resource consents. Significant intervention by the Council was required. Typically there were grounds for an infringement notice.

For reference, in the 2015-2016 year, 71% of consent holders in Taranaki monitored through tailored compliance monitoring programmes achieved a high level of environmental performance and compliance with their consents, while another 24%

demonstrated a good level of environmental performance and compliance with their consents.

1.2 Treatment plant system

Stratford town sewage is treated by an oxidation pond system and combined successive maturation cell system (2.6 ha and 1.7 ha in area), that was upgraded in 2009. Changes made to the system during the upgrade included:

- flow recorder installation at the inflow structure to the primary pond;
- splitter chamber replaced with an influent chamber (to prevent overflows);
- installation of a step screen system at the influent;
- relocation of the tanker waste disposal area to Esk Road;
- a new trade waste connection from the regional stockyards on Esk Road into the system; and
- improvements to the pond system itself.

A full history of the pond system and upgrade process can be found in the 2014-2015 annual report (TRC, 2015). Some industrial wastes are also discharged into the system, which includes an influent chamber fitted with a permanent flow-recording device.

1.2.1 Inflow and infiltration reduction programme

SDC reported on progress with the implementation of the inflow and infiltration reduction programme to minimise stormwater inflow in mid 2010. This programme includes visual infiltration surveys in winter and summer, followed by CCTV surveys within the reticulation to determine sections requiring repairs or replacement. This work was intended to be prioritised, although SDC advised that the completion of the work could take several years due to financial constraints.

SDC has relined 1,090 m of sewer pipework over the past four year and this work has seen a noticeable reduction in the wet weather flow in the Achilles, Hathaway, and Lysander Street catchments.

1.3 Resource consents

1.3.1 Water discharge permit

Section 15(1) (a) of the RMA 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.

SDC holds water discharge permit **0196** which authorises the discharge of 4,800 cubic metres/day of treated wastewater from the municipal oxidation ponds system into the Patea River.

This consent expired on 1 June 2016, but SDC continues to operate under the consent as per Section 124 of the RMA.

Condition 1 relates to best practice.

Conditions 2 and 3 relate to limits on wastewater volume and infiltration reduction.

Conditions 4, 5, and 6 detail requirements for management plans, maintenance of the ponds, and trade wastes connections.

Conditions 7 to 11 detail requirements of effects on the receiving waters and provisions for the physicochemical and nutrient monitoring programmes.

Condition 12 provides for review of the consent.

The permit is attached to this report in Appendix I.

1.4 Monitoring programme

1.4.1 Introduction

Section 35 of the RMA sets obligations upon the Council to gather information, monitor and conduct research on the exercise of resource consents within the Taranaki region. The Council is also required to assess the effects arising from the exercising of these consents and report upon them.

The 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.

The monitoring programme for the Stratford WWTP consisted of four primary components.

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the 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;
- new consents;
- advice on the Council's environmental management strategies and content of regional plans; and
- consultation on associated matters.

1.4.3 Site inspections

The Stratford oxidation ponds system was visited four times (as 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 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.

1.4.5 Biological survey

The programmed summer macroinvertebrate biological receiving water survey was undertaken on 29 February 2016 at four sites in the Patea River under late summer very low flow conditions, six days prior to the physicochemical survey of the receiving waters. An additional site, added to the survey in March 2009, as necessitated by the relocation of the outfall (a component of the WWTP upgrade), was used in place of one of the original sites, which was no longer appropriate for biomonitoring purposes.

2 Results

2.1 Inspections of treatment system operation

Four regular scheduled inspections were performed during the monitoring period. During regular inspections, physical features of the components of the system were recorded, and dissolved oxygen concentrations were measured in the surface wastes adjacent to the oxidation pond outlet. Results of the dissolved oxygen measurements from scheduled inspections are summarised in Table 1. Chlorophyll-a samples were collected from the final cell of the second pond on three of the four scheduled inspection visits (see Section 4.6) for 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 (%)
20 Aug 2015	0930	9.7	6.3	57
07 Oct 2015	0810	15.8	1.2	12
24 Feb 2016	0830	21.9	0.4	4.8
15 Jun 2016	0915	10.9	1.1	10

The results in Table 1 indicate dissolved oxygen was present at all times in the surface layer of the third cell of the upgraded secondary pond near the outlet, over a moderately wide range of concentrations. The seasonal variation (between 4.8% and 57% saturation) recorded during the period was less variable than in the previous period when supersaturation (114%) was recorded. The variation in saturation levels measured to date has been typical of a biological treatment system in which the photosynthetic contribution of the microfloral population often causes wide dissolved oxygen variations. Mechanical aeration of the primary pond (by up to 4 aerators) was operative on all inspection occasions.

The primary pond varied from relatively clear, pale green to slightly turbid, brown turbid, dark green while the final cell of the secondary pond system varied from relatively clear, pale green to slightly turbid, pale green to turbid, dark 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 occasions coincident with the continual operation of the mechanical aerators which maintained noticeable circulation through this pond. No debris was noted on the outlet structure, which appeared well-maintained through the year.

No localised odours were recorded in the vicinity of the ponds, and no odour complaints were received from nearby residents during the period. Past complaints had been related to scum build-up on the surface of the primary pond necessitating remedial clearance. Very slight odours occurred in the area around the flume shed and step screen during the 7 October 2015 inspection, but management of the solid wastes screening and disposal system minimised these issues.

No sediment was observed rising to the surface in either the primary pond or cells of the secondary pond on any inspection occasion. The primary pond and secondary cells' surfaces were relatively flat on all occasions as inspections coincided with calm to relatively light wind conditions.

Wildlife were present during all inspection visits with ducks (mallard, teal, and paradise) common on the primary pond and secondary pond cells at all times and black swans (up to 20) also present on several occasions (Photo 1). Canadian geese were present in low numbers on the primary pond and secondary pond cells on one occasion where pied stilt and seagulls were noted from time to time. There was a repeat of the large populations (>500) of paradise ducks present on these cells in late summer. These wildlife species are common to the avifauna associated with such treatment ponds (Don, 2004).

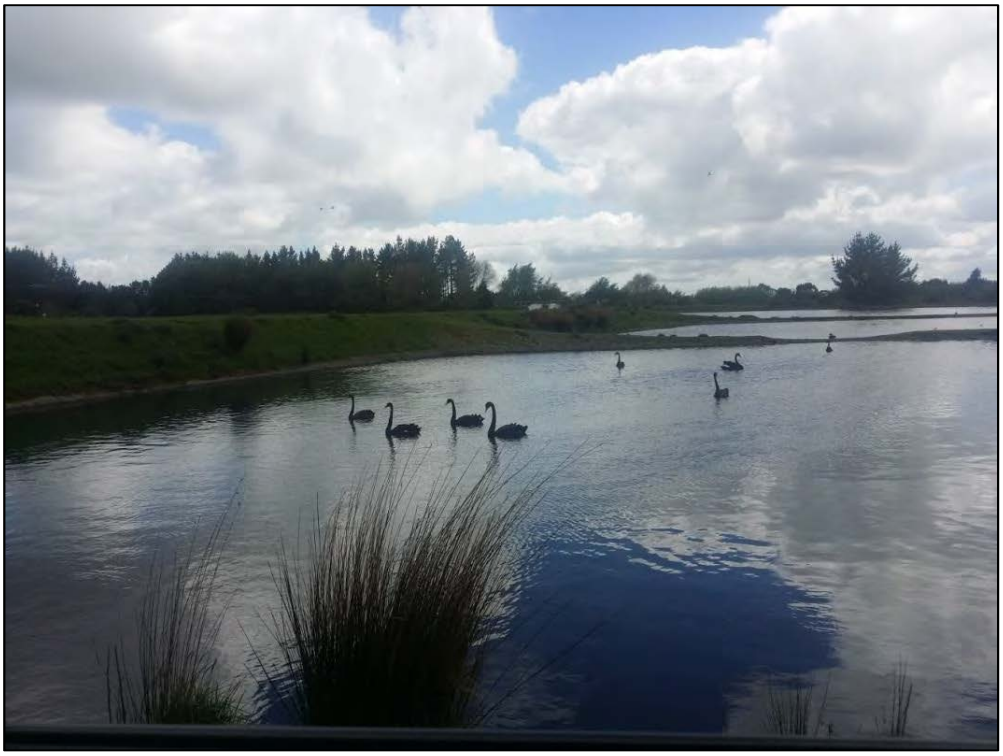


Photo 1 Black swans on the secondary cells at Stratford WWTP

The ponds' surrounds were generally tidy due to grazing throughout the monitoring period. The wavebands continue to be monitored by the consent holder with respect to weed growth, debris entrapment and/or odour problems. Further waveband replacement and repairs had been undertaken by the consent holder as a component of the consented upgrade. There was some evidence of waveband scouring noted in late June 2015, and this continued through the monitoring period.

Maintenance of the primary pond outlet grid was satisfactory during the period, with no accumulations of debris on the grid noted during any inspections.

Effluent discharge estimates ranged from 20 to 75 L/sec, depending upon preceding climatic conditions. These could have been underestimates due to the nature of the rock riprap structure which reduced visibility of the total flow at the outfall. The rock

rip-rap was free of debris. There were no particularly noticeable visual impacts of the effluent discharge under moderate winter flow conditions. However, there was some noticeable visual discolouration beyond the mixing zone under lower river flow conditions on the other three inspection occasions.

The adequacy of the mixing characteristics of the river had been confirmed by a fluorescein dye-tracing exercise undertaken on 28 March 2014. The dye tracer indicated complete mixing across the river at the boundary of the mixing zone; 100 m downstream of the rock riprap outfall (see TRC, 2014).

2.2 Associated infrastrusture and overflows

No overflow incidents were recorded during the 2015-2016 period. Mechanical aeration of the primary pond has resulted in no scum formation or accumulation problems occurring over the current monitoring period.

2.2.1 Step-screen at the inlet

A step-screen and associated overflow by-pass were operated successfully for the 2015-2016 period, with no odour complaints being received. All debris removed by the screen is pressed on site prior to transfer for disposal at the Colson Road, New Plymouth landfill.

Photo 2 Step screen facility at the inlet to the Stratford WWTP.

2.2.2 Esk Road trade waste facility

The Esk Road pump station and industrial trade waste facility provides a waste disposal facility for septic tanker wastes and discharges from the nearby saleyards (Photo 3). The site also includes a separate disposal facility for campervan wastes. A comprehensive history of the Esk Rd facility is contained in the previous annual monitoring report (TRC, 2015).

No complaints concerning this facility were received in the 2015-2016 period, during which inspections indicated that maintenance was adequate and there were no odours in the vicinity of the pump station. No overflows occurred from this facility during the monitoring year.

Photo 3 Esk Road trade waste facility

3 Results of oxidation ponds' system monitoring

3.1 Plant performance

A sample of the oxidation ponds' system effluent discharge was collected for analysis on 24 February 2016 as a component of the late summer assessment of effects on the physicochemical quality of the receiving waters of the Patea River under very low flow conditions. In recognition of the industrial trade wastes component of the sewage inflow to the oxidation ponds' system (e.g. galvanising industry, tanker wastes disposal and saleyards wastes), the ponds' 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 previous surveys' data.

Table 2 Comparison of effluent analysis data from the final cell of the Stratford WWTP (24 February 2015) and final tertiary cell data (for the period mid 2009-2015)

Parameter	Units	Survey of 24 February 2016	Final (tertiary) cell (2009-2015)		
			No. of samples	Range	Median
Time	NZST	0830	-	-	-
Temperature	°C	21.9	41	6.2-21.8	14.8
pH	pH	7.4	29	7.1-8.8	7.5
Chloride	g/m³	27.9	37	11.7-35.2	17.9
Conductivity	mS/m@20 °C	31.4	30	15.6-42.3	25.2
Dissolved oxygen	g/m³	0.41	41	0.7-11	3.5
Dissolved oxygen saturation	%	4.8	41	11-141	36
Faecal coliform bacteria	/100ml	6,300	30	270-14,000	2,300
Suspended solids	g/m³	39	30	5.0-62	23
Turbidity	NTU	32	30	5.7-71	16
BOD_5	g/m³	45	33	25-41.9	38
BOD_5 (filtered)	g/m³	4.5	6	5.1-5.8	9.2
Nutrients					
Ammonia-N	g/m³ N	8.78	30	0.87-25.4	10.0
Nitrate+Nitrite-N	g/m³ N	1.48	6	1.13-4.28	2.6
Total nitrogen	g/m³ N	-	25	7.2-30.8	13.8
Dissolved reactive phosphorus	g/m³ P	2.31	30	0.695-4.97	1.87
Total phosphorus	g/m³ P	-	25	1.02-5.8	2.18
Metals (acid soluble)					
Cadmium	g/m³	<0.005	6	<0.005-<0.005	<0.005
Chromium	g/m³	<0.03	6	<0.03-<0.003	<0.03
Zinc	g/m³	<0.008	6	0.009-0.035	0.029
Appearance		turbid, dark green			

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

The tertiary cell effluent quality (Table 2) was typical of a well treated secondary oxidation pond waste with moderate total BOD_5 and suspended solids levels and faecal coliform bacteria number. Nutrient levels were typical of the secondary oxidation pond treated effluent with the exception of dissolved reactive phosphorus (DRP), turbidity,

and chloride, which remained elevated in comparison to the median concentration levels but within the range recorded since the upgrade.

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.

Comparatively, tertiary cell effluent parameters were within ranges recorded from previous surveys of the secondary pond effluent (Table 2), and in most instances were similar to, or above, median values. Effluent quality was good in terms of BOD_5 concentration, faecal coliform bacteria number, and suspended solids concentration coincident with a moderate late summer microfloral population abundance as also illustrated by the median turbidity.

3.1.1 Microflora of the Stratford ponds' system

Pond microflora are very important for the stability of the symbiotic relation with aerobic bacteria within the facultative pond. These phytoplankton may be used as a bio-indicator of pond conditions, for example cyanobacteria are often present in under-loaded conditions and chlorophyceae are present in overloaded conditions. To maintain facultative conditions in a pond system there must be an algal community present in the surface layer.

The principal function of algae is the production of oxygen which maintains aerobic conditions while the main nutrients are reduced by biomass consumption. Elevated pH (due to algal photosynthetic activity) and solar radiation combine to reduce faecal bacteria numbers significantly.

Samples of the final tertiary cell effluent were collected on all four inspection occasions for chlorophyll-a analyses. Chlorophyll-a concentration can be used as a useful indicator of the algal population present in the system (Note: Pearson (1996) suggested that a minimum in-pond chlorophyll-a concentration of 300 mg/m^3 was necessary to maintain stable facultative conditions). However, seasonal changes in algal populations and also dilution by stormwater infiltration might be expected to occur in any wastewater treatment system which together with fluctuations in waste loadings would result in chlorophyll-a variability.

The results of final cell effluent chlorophyll-a analyses are provided in Table 3 together with field observations of pond appearance.

Table 3 Chlorophyll-a measurements from the surface of the third cell at the perimeter adjacent to the outlet

Date	Time (NZST)	Appearance	Chlorophyll-a (mg/m^3)	Chlorophyll-a (mg/m^3) data for period mid 2014-2015		
20 Aug 2015	0930	light pale green	34	N	Range	Median
07 Oct 2015	0810	pale green	17	4	16-474	366
24 Feb 2016	0830	dark green	-			
15 Jun 2016	0915	pale green	89			

Relatively poor microfloral populations were indicated by low chlorophyll-a concentrations in late winter, spring, and late autumn when dissolved oxygen saturation levels of 57%, 12% and 10.5% were measured respectively. A very low concentration (coincident with a saturation of 12%) followed wet spring weather conditions and stormwater dilution through the WWTP system. Chlorophyll-a analysis was not undertaken during the late summer period, when the lowest saturation (4.8%) was recorded.

3.2 Results of receiving environment monitoring

Two components of the receiving water monitoring programme were operative during the period; the late summer physicochemical receiving water survey, and the receiving water compliance monitoring survey. These assessed the impacts of treated wastes disposal from the upgraded 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 Landfill Annual Report (TRC 2015).

3.2.1 Late summer physicochemical receiving water survey

A late summer assessment of the impact of the upgraded oxidation ponds' system effluent discharge on the receiving waters of the Patea River was performed on 24 February 2016 when flow in the river (at the Skinner Road recorder) was 1.750 m^3/s, during a low recession flow period. Sites were located (Figure 1) as summarised in Table 4.

Table 4 Location of sampling sites

Site	Location	GPS location	Site code
Patea River	at Swansea Road bridge (upstream of landfill and WWTP discharges)	E1711801 N5644382	PAT000315
Patea River	approximately 250 m downstream of the WWTP original discharge (and 350m upstream of the new outfall)	E1712748 N5644549	PAT000345
Secondary oxidation pond tertiary cell effluent	at manhole upstream of rock riprap outfall	E1712834 N5644344	OXP005002

Site	Location	GPS location	Site code
Patea River	approximately 130 m downstream of the WWTP new outfall	E1713033 N5644266	PAT000350
Patea River	approximately 1 km upstream of the Kahouri Stream confluence	E1714497 N5645112	PAT000356

Figure 1 Aerial photo of site and location of sampling sites since the upgrade of the WWTP

This survey was performed seven days after a major river fresh seven times over the median flow. The river flow was above the minimum mean monthly flow recorded for February (0.64 m^3/s) at the Skinner Road recorder site (4.5 km downstream of the new outfall and the Kahouri Stream confluence), and below the monthly mean of 2.73 m^3/s.

The results of the survey are summarised in Table 5. All analyses were performed in the Council's IANZ-registered laboratory using documented standard methods.

Table 5 Patea River physicochemical sampling survey results of 16 February 2015

Site		PAT000315	PAT000345	OXP005002	PAT000350	PAT000356
Site Location		Upstream of landfill and WWTP	Downstream of landfill and 350m upstream of new WWTP outfall	Effluent discharge at new outfall	130m downstream of WWTP new outfall	1km upstream of Kahouri Stm
Parameter	**Unit**					
Temp	°C	15.1	15.0	21.9	15.5	16.3
pH	pH	7.6	7.6	7.4	7.6	7.8
Chloride	g/m³	8	8.3	27.9	8.7	8.8
Conductivity	mS/m@20°C	8.6	8.7	31.4	9.3	9.2
Dissolved oxygen	g/m³	9.58	9.63	0.41	9.7	10.2
Dissolved oxygen saturation	%	98	98	4.8	100	106
Faecal coliform bacteria	/100ml	240	540	6,300	340	270
Suspended solids	g/m³	<2	<2	39	2	<2
Turbidity	NTU	1.1	1	32	2.5	3.6
Black disc	m	2.87	2.74	N/A	2.17	1.83
BOD5	g/m³	<0.5	0.5	45	1.4	1.2
BOD5 (Filtered)	g/m³	<0.5	<0.5	4.5	<0.5	<0.5
Nutrients						
Un-ionized ammonia-N	g/m³ N	0.00024	0.00052	0.12030	0.00366	0.00221
Ammonia-N	g/m³ N	0.018	0.04	8.78	0.271	0.098
Nitrate+Nitrite-N	g/m³ N	0.65	0.64	1.48	0.66	0.74
Dissolved reactive phosphorus	g/m³ P	0.029	0.029	2.31	0.1	0.078
Metals (acid soluble)						
Cadmium	g/m³	<0.005	<0.005	<0.005	<0.005	<0.005
Chromium	g/m³	<0.03	<0.03	<0.03	<0.03	<0.03
Zinc	g/m³	<0.005	0.007	0.008	<0.005	<0.005
Appearance		clear, light green brown	clear, light green brown	turbid, dark green	sl. turbid, green brown	sl. turbid, light green brown

[Note: N/A = not analysed]

A dilution ratio of approximately thirty-one parts river flow to one part effluent discharge at the time of the sampling survey was indicated by reference to selected analytical results assuming complete mixing at the sampling site (PAT000350).

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 good effluent quality in terms of these parameters. There was a 21% decrease in black disc clarity coincidental with an increase in turbidity of 1.5 NTU (representing a 150% increase) but minimal rise in 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 and slight change in colour mainly due to the fine algal component in the oxidation ponds treated effluent. The increased turbidity in the receiving waters was in minor non-compliance with the relevant consent condition (Special Condition 8) under these very low flow conditions. Bacterial numbers showed a decrease of 200 faecal coliforms/100 ml at the site 130 m downstream of the mixing zone.

Increases in total BOD_5 (<0.5 to 1.4 g/m³) recorded at the site downstream of the discharge had no impact on dissolved oxygen level at this site below the mixing zone. Dissolved reactive phosphorus was elevated at the two sites downstream of the discharge point (PAT000350 and PAT000356), while there was a significant increase in ammonia N downstream of the discharge followed by a reduction at the furthest downstream site (Site 4). This 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 widespread at the time of this survey, and nitrification of ammoniacal nitrogen in the receiving waters. Un-ionized ammonia concentrations downstream of the permitted mixing zone were well within the limit required by Special Condition 11 of the consent.

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, very low total BOD_5, and good water clarity) with moderate faecal coliform numbers. Although nutrient levels were also relatively low, an increase in ammonia-N level (but no increase in bacteria number) continued to be recorded between the two sites upstream of the WWTP discharge, possibly due to landfill leachate seepage into the river from the true right bank (TRC, 2015).

3.2.2 Receiving water compliance surveys

Receiving water physicochemical monitoring surveys were performed on 20 August 2015, 7 October 2015, and 15 June 2016 with results discussed beneath. The sampling sites were OXP005002, PAT000345, and PAT000350 as described in Table 4.

3.2.2.1 Survey of 20 August 2015

The wastewater discharge from the outfall was relatively clear and light pale green in appearance with a high flow rate (estimated at 75 L/s). Results are presented in Table 6.

Table 6 Results of the receiving water compliance survey of 20 August 2015

	Site Location	OXP005002 Discharge
Parameter	**Unit**	
Time	NZST	09:30
Temperature	°C	9.7
Chloride	g/m³	15
Appearance		rel. clear, light pale green

Results show a relatively low chloride and temperature, likely the result of wet weather the previous day.

The receiving water sites were not sampled due to the Patea River flowing at 9.82 m³/s, more than three times the median flow, at the time of sampling.

No visual impact of the wastewater discharge was apparent on the Patea River beyond the mixing zone. The river was turbid and brown at both the upstream and

downstream sites, given that it was in fresh at the time. Compliance with Special Conditions 7, 8, and 11 was not able to be assessed given the environmental conditions at the time of the survey.

3.2.2.2 Survey of 7 October 2015

The wastewater was relatively clear and green in appearance with an estimated flow rate of 20 L/s, causing some visual impact (cloudier plume) on the slightly turbid green-grey flow of the Patea River which had a relatively low flow of 2.73 m^3/s (at the Skinner Road recorder), under steady recession five days after the previous fresh (11 m^3/s). Results of the survey are presented in Table 7.

Table 7 Results of the receiving water compliance survey of 7 October 2015

	Site	PAT000345	OXP005002	PAT000350
	Location	Upstream	Discharge	Downstream
Parameter	**Unit**			
Time	NZST	0845	0810	0900
Temperature	˚C	10.3	15.8	10.8
BOD_5 (carbonaceous filtered)	g/m^3	<0.5	-	<0.5
pH	pH	7.5	-	7.6
Chloride	g/m^3	8.6	19.5	8.6
Ammonia-N	g/m^3N	0.0065	-	0.36
Unionised ammonia	g/m^3N	0.0005	-	0.0034
Turbidity	NTU	1.1	-	1.5
Appearance		clear, brackish green	sl. turbid, green	sl. turbid, green grey

This treated wastewater discharge was calculated to have been diluted at a ratio of about 11:1 by the receiving waters at the time of the survey. Both carbonaceous filtered BOD_5 and un-ionised ammonia concentrations in the river at the mixing zone boundary were in compliance with Special Condition 11 of the consent while visual compliance with Special Conditions 7 (a) and (c) was assessed by inspection. The turbidity values in the river were indicative of slightly turbid appearance (>2 NTU), with a downstream increase in turbidity of 36% which was compliant with Special Condition 8.

3.2.2.3 Survey of 15 June 2016

Slightly turbid green-brown wastewater was discharging at a high rate (estimated at 60 L/s) into the clear, uncoloured river which was in recession (6.4 m^3/s at the Skinner Road recorder) two days after the most recent fresh (18 m^3/s). There had been four freshes in the river over the preceding two weeks. Only a slight visual impact of the discharge was noticeable in the river at the mixing zone boundary. The results of the survey are presented in Table 8.

Table 8 Results of the receiving water compliance survey of 15 June 2016

	Site	PAT000345	OXP005002	PAT000350
	Location	Upstream	Discharge	Downstream
Parameter	Unit			
Time	NZST	0945	0915	1000
Temperature	˚C	9.7	10.9	9.7
BOD_5 (carbonaceous filtered)	g/m³	<0.5	-	<0.5
pH	pH	7.5	-	7.4
Chloride	g/m³	9.0	17.5	9.5
Ammonia-N	g/m³N	0.04	-	0.414
Unionised ammonia	g/m³N	0.0003	-	0.0023
Turbidity	NTU	0.87	-	1.1
Appearance		clear, uncoloured	sl. turbid, green brown	clear, uncoloured

The wastewater discharge was calculated to be diluted by about 16:1 by the receiving waters at the time of this survey.

The effects of the discharge were compliant with Special Condition 11 of the consent (carbonaceous filtered BOD_5 and un-ionised ammonia), Special Conditions 7 (a), (b), and (c) (visual assessment), and with Special Condition 8 (with an increase in turbidity of 44%).

3.2.3 Biomonitoring survey

One late-summer biomonitoring survey was performed under moderately low flow conditions at the four sites listed in Table 9 and illustrated in Figure 1, with the full report attached as Appendix II.

Table 9 Location of biomonitoring surveys' sites

Site	Site code	Location
1	PAT 000315	Swansea Road bridge (upstream of landfill and oxidation ponds' discharge
2	PAT 000330	Upstream of WWTP discharge (and downstream of landfill
3a	PAT 000350	Approximately 130 m downstream of the WWTP new outfall
4	PAT 000356	Approximately 1 km upstream of the Kahouri Stream confluence

This late summer biological survey of four sites in the receiving waters of the Patea River was performed on 29 February 2016, five days following the physicochemical survey and during a low recession flow period, 11 days after a fresh in excess of seven times the median flow. Results of this biomonitoring survey are summarised in Table 10.

Table 10 Biomonitoring results summary from the survey of 29 February 2016

Site	Macroinvertebrate fauna	
	Taxa numbers	MCI value
1	21	113
2	17	111
3a	24	113

4	21	93

Typical macroinvertebrate communities' richnesses were found by surveys at the four Patea River sites during a very low flow recession period in the latter part of summer. Periphyton river substrate cover conditions varied from none (Sites 1 & 2) to patchy algal mats and filamentous algae (Site 3a) to patchy periphyton and widespread filamentous algae (Site 4). Very minor discolouration of the river's reach below the WWTP's re-located discharge was apparent and there was no planktonic pond algal deposition on the river bed. Faunal communities upstream of the WWTP discharge had higher percentages of 'sensitive' taxa whereas communities at downstream sites had increased percentages of 'tolerant' taxa. There were some differences in dominant (characteristic) taxa between these four sites' communities with a tendency toward proportionately fewer 'sensitive' and more 'tolerant' dominant taxa in a downstream direction.

MCI scores were relatively similar to scores generally typical of mid-catchment ringplain rivers in Taranaki, particularly those found during summer low flow conditions and showed a moderately wide range (20 units) along the four 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. An increase in number of 'tolerant' taxa, together with fewer 'sensitive' taxa downstream of the WWTP's relocated discharge, resulted in lower MCI scores at these sites, which were significant in the immediate vicinity of the discharge with minimal further deterioration downstream. There were several significant changes in individual taxon abundances including amongst some dominant taxa as reflected in a reduction in $SQMCI_s$ value between sites 2 and 3a of 1.9 units and sites 2 and 4 of 3.6 units. These lower $SQMCI_s$ scores at sites 3a and 4 (2.5 km downstream of the wastewater discharge) reflected lower abundances in certain 'highly sensitive' taxa, particularly some mayfly taxa, and increased numbers within 'tolerant' taxa, particularly chironomid midges. Both downstream sites had 'very abundant' orthoclad midges which feed on streambed algae and are often abundant in unshaded, nutrient enriched streams with substantial algal growths.

Microscopic assessment of material from the riverbed at the four sampling sites indicated that there were no unusual heterotrophic growths present in the river at the two upstream and two downstream sites. This was consistent with the visual absence of such growths noted at all sites at the time of the survey.

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 summer biomonitoring surveys.

3.3 Investigations, interventions, and incidents

The monitoring programme for the year was based on what was considered to be an appropriate level of monitoring, review of data, and liaison with the consent holder. During the year matters may arise which require additional activity by the Council, for example provision of advice and information, or investigation of potential or actual courses of non-compliance or failure to maintain good practices. A pro-active approach that in the first instance avoids issues occurring is favoured.

The 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 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.

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

In the 2015-2016 period, the Council was not required to undertake significant additional investigations and interventions, or record incidents, in association with the Council's conditions in resource consents or provisions in Regional Plans. For the eighth consecutive annual monitoring period, no odour complaints associated with the WWTP were reported. This absence of odour incidents is a result of the major upgrade of the plant completed during the 2008-2009 period.

4 Discussion

4.1 Discussion of plant performance

The Stratford WWTP 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, particularly when diluted during wet weather conditions, with low to very low microfloral densities (as indicated by chlorophyll-a levels).

Screening of the outlet from the secondary oxidation pond was well maintained. The inlet system functioned as designed during the monitoring period, and any overflows from the inlet following heavy rainfall were contained and directed into the primary pond. Longer term remedial work to the reticulation system will provide additional capacity and 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.

Trade wastes controls placed by SDC on the usage of the system by industrial tanker wastes continue to require monitoring by the consent holder, due to the nature and/or source of wastes being discharged to the system. No major problems with this aspect of the waste disposal to the WWTP occurred during the monitoring year. Disposal of treated wastes from the regional stockyard through the pond system had no apparent impact on the system's performance. Capacity remains for additional waste loadings to the system, provided that hydraulic issues associated with the inflow volumes and outflow reticulation can be resolved.

Monitoring of the microfloral component of the tertiary cell of the secondary pond (using chlorophyll-a measurements) indicated that the system had a low algal content, particularly following heavy rainfall events. However, there have been no apparent blooms of blue-green algae, and therefore no repeat of significant aesthetic impacts on the receiving waters of the Patea River. Microfloral populations have not indicated poor performance of the treatment system to date and generally indicate an improvement in conditions in the tertiary cell since the last WWTP upgrade.

4.2 Environmental effects of exercise of consents

Some impacts of the discharge were recorded on the physical and chemical quality of the Patea River, during the more intensive late summer survey, when very low recession flow conditions provided an approximately 31-fold dilution of the effluent in the receiving waters. Localised and moderate increases in nutrients were recorded downstream of the rock riprap outfall, mitigated to a certain extent by the effluent quality which was of a good standard at the time of the survey. Some discolouration of the receiving water occurred downstream of the discharge, but this did not extend beyond the permitted mixing zone. The late summer macroinvertebrate fauna survey showed minor impacts of the discharge beyond the permitted mixing zone under low recession 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.

Increases in benthic periphyton cover continue to be recorded at two sites in the Patea River downstream of the discharge over spring to late summer/autumn in recent receiving water surveys. This data will contribute to the evaluation of options for future upgrades to the WWTP.

Three additional seasonal receiving water monitoring surveys found compliance with most special conditions of the consent in each occasion. Some increases in turbidity in the Patea River were recorded coincident with the fine algal component of the wastewater. This contributed to elevated turbidity levels above the compliance limit on one occasion, under moderate dilution conditions in the relatively low flow of the river.

4.3 Evaluation of performance

A tabular summary of the consent holder's compliance record for the year under review is set out in Table 11.

Table 11 Summary of performance for consent 0196-4

Purpose: ***Discharge of oxidation ponds treated wastes to surface water***		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Best practicable option	Inspections	Yes
2. Limits on wastewater volume	Inspections	Yes
3. Implementation of infiltration reduction programme	Reporting by consent holder	Yes (continuing)
4. Implementation of management plan	Provision by consent holder	Yes
5. Maintenance of aerobic ponds conditions	Inspections and sampling	Yes
6. Trades wastes connections	Liaison with consent holder	Yes
7. Narrative limits on receiving waters	Inspections, physicochemical sampling and biomonitoring	Yes
8. Limit on receiving water turbidity effect	Physicochemical sampling	Partial – minor non-compliance during the summer low flow survey
9. Monitoring provisions	Performance of tailored programme and additional contract work	Yes
10. Nutrient monitoring provisions	Performance of tailored monitoring programme and additional contract work	Yes (completed previously)

Purpose: *Discharge of oxidation ponds treated wastes to surface water*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
11. Numerical limits on receiving water effects (post-upgrade)	Physicochemical sampling	Yes
12. Reporting issues and options	Provided by consent holder in November 2015 (deadline extended following consultation with the Council)	Yes
Overall assessment of consent compliance and environmental performance in respect of this consent Overall assessment of administrative performance in respect of this consent		**Good** **High**

N/A = not applicable

During the year, SDC demonstrated a good level of environmental and high level of administrative performance with the resource consents as defined in Section 1.1.4.

Improvement was recorded with aspects of the WWTP operation, and 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 for the current period. No complaints relating to odour from any of the facilities were received.

Problems that had been experienced with the hydraulic loadings on the system during previous periods were adequately managed by the consent holder during the period. Reduction in secondary pond algal blooms and subsequent discharge impacts have been partially addressed by the most recent upgrade. Issues with aspects of trade wastes disposal to the sewerage reticulation at the Esk Road facility which had been the subject of public complaint were maintained adequately during the period with no further issues.

4.4 Recommendations from the 2014-2015 Annual Report

In the 2014-2015 Annual Report, it was recommended:

1. THAT monitoring be continued for the 2015-2016 period by formulation of a suitable monitoring programme, similar in format to the 2014-2015 programme including the additional inspection of the Esk Road industrial wastewater connection facility;

2. THAT the consent holder advise the 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 Council as required;

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

These conditions were implemented as required during the monitoring period.

4.5 Alterations to monitoring programmes for 2016-2017

In designing and implementing the monitoring programmes for air/water discharges in the region, the Council has taken into account:

- the extent of information made available by previous authorities;
- its relevance under the RMA;
- its obligations to monitor emissions/discharges and effects under the RMA; and
- to report to the regional community.

The Council also takes into account the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki emitting to the atmosphere/discharging to the environment.

It is proposed that for 2016-2017, monitoring at the Stratford WWTP continue at the same level as that in the 2015-2016 period (including the extended inspection component of the Esk Road industrial connection facility).

5 Recommendations

1. THAT monitoring of consented activities at Stratford WWTP in the 2016-2017 year continues at the same level as in 2015-2016.

Glossary of common terms and abbreviations

The following abbreviations and terms may be 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.
Conductivity	Conductivity, an indication of the level of dissolved salts in a sample, usually measured 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 colony forming units per 100 millilitre sample.
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre of sample.
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
g/m^3	Grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.
Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.
Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.
Incident Register	The Incident Register contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
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.
mS/m	Millisiemens per metre.
Mixing zone	The zone below 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	Ammonium, normally expressed in terms of the mass of nitrogen (N).
NH_3	Unionised ammonia, 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 including all subsequent amendments.
SQMCI	Semi quantitative macroinvertebrate community index.
SS	Suspended solids.
Taxa richness	The number of taxa found in the macroinvertebrate community at a site.
Temp	Temperature, measured in °C (degrees Celsius).
Turb	Turbidity, expressed in NTU.

*an abbreviation for a metal or other analyte may be followed by the letters '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.

Bibliography and references

Don, G (2004): *Wastewater treatment plant avifauna*. Water and Wastes in NZ July.

Pearson, HW (1996): *Expanding the horizons of pond technology and application in an environmentally conscious world*; Water Science and Technology 33(7): 1-9.

Taranaki Regional Council (2015): *Stratford District Council Municipal Oxidation Ponds System Monitoring Programme Annual Report 2014-2015;* Technical Report 2015-07.

Taranaki Regional Council (2015): *Stratford District Council Landfills: Huiroa, Pukengahu and Stratford Annual Report 2014-2015;* Technical Report 2015-59.Taranaki Regional Council (2014): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2013-2014*; Technical Report 2014-14.

Taranaki Regional Council (2013): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2012-2013*; Technical Report 2013-32.

Taranaki Regional Council (2012): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2011-2012*; Technical Report 2012-26.

Taranaki Regional Council (2011): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2010-2011*; Technical Report 2011-25.

Taranaki Regional Council (2010): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2009-2010*; Technical Report 2010-24.

Taranaki Regional Council (2009): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2008-2009*; Technical Report 2009-32.

Taranaki Regional Council (2008): *Cleanfill Monitoring Programme Annual Report 2007-2008;* Technical Report 2008-79.

Taranaki Regional Council (2008): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2007-2008*; Technical Report 2008-36.

Taranaki Regional Council (2007): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2006-2007*; Technical Report 2007-39.

Taranaki Regional Council (2006): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2005-2006*; Technical Report 2006-79.

Taranaki Regional Council (2005): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2004-2005*; Technical Report 2005-42.

Taranaki Regional Council (2004): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2003-2004*; Technical Report 2004-56.

Taranaki Regional Council (2003): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2002-2003*; Technical Report 2003-28.

Taranaki Regional Council (2002): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2001-2002*; Technical Report 2002-22.

Taranaki Regional Council (2001): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 2000-2001*; Technical Report 2001-14.

Taranaki Regional Council (2000): *Stratford District Municipal Council Oxidation Ponds System Monitoring Programme Annual Report 1999-2000*; Technical Report 2000-28.

Taranaki Regional Council (1999): *Stratford District Council Municipal Oxidation Ponds System Monitoring Programme Annual Report 1998-99*; Technical Report 99-42.

Taranaki Regional Council (1998): *Stratford District Council Municipal Oxidation Ponds System Monitoring Programme Annual Report 1997-98*; Technical Report 98-24.

Taranaki Regional Council (1997): *Stratford District Council Municipal Oxidation Ponds System Monitoring Programme Annual Report 1996/97*; Technical Report 97-61.

Taranaki Regional Council (1996): *Stratford District Council Municipal Oxidation Ponds System Monitoring Programme Annual Report 1995/96*; Technical Report 9-56.

Taranaki Regional Council (1995): *Stratford District Council Municipal Oxidation Ponds System Monitoring Programme Annual Report 1994/95*; Technical Report 95-15.

Taranaki Regional Council (1994): *Officers' report on applications by ECNZ for resource consents relating to abstraction of water and discharge of used water associated with the proposed Taranaki Combined Cycle Power Station*.

Taranaki Regional Council (1994): *Patea River Catchment Water Management Plan*.

Taranaki Regional Council (1994): *Stratford District Council Municipal Oxidation Ponds System Monitoring Programme Annual Report 1993/94*; Technical Report 94-14.

Taranaki Regional Council (1993): *Stratford District Council Municipal Oxidation Ponds System Monitoring Programme Annual Report 1992/93*; Technical Report 93-32.

Taranaki Regional Council (1991): *Stratford District Council Municipal Oxidation Ponds System Monitoring Programme Annual Report 1990/91;* Technical Report 91-11.

Taranaki Regional Council (1990): *Stratford District Council Oxidation Ponds Monitoring 1989/90*; Technical Report 90-29.

Appendix I

Resource consents held by Stratford District Council

(For a copy of the signed resource consent please contact the TRC Consents department)

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
Decision Date:	23 October 2013
Commencement Date:	14 November 2013

Conditions of Consent

Consent Granted:	To discharge treated wastewater from the Stratford Wastewater Treatment Plant into the Patea River
Expiry Date:	1 June 2016
Site Location:	Victoria Road, Stratford
Legal Description:	Lot 1 DP 9529 Lots 7, 8, 9 & 10 DP 1942 Blk II Ngaere SD (Discharge source & site)
Grid Reference (NZTM)	1712836E-5644349N
Catchment:	Patea

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

General condition

a. The consent holder shall pay to the Taranaki Regional Council all the administration, monitoring and supervision costs of this consent, fixed in accordance with section 36 of the Resource Management Act 1991.

Special conditions

1. The consent holder shall at all times adopt the best practicable option, as defined in section 2 of the Resource Management Act 1991, to prevent or minimise any adverse effects of the discharge on the environment.

2. 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).

3. 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.

4. 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.

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

6. 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.

7. After allowing for reasonable mixing, being a mixing zone extending from the discharge point, to a point 50 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.

8. After allowing for reasonable mixing within a mixing zone extending 50 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.

9. 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 to provide for an assessment of possible further upgrade requirements in relation to potential impacts on the biological communities of the receiving water.

10. The monitoring, evaluation and assessment required by condition 9 shall specifically include monitoring, evaluation and assessment of dissolved reactive phosphorus (DRP) and other nutrient-species.

11. After allowing for reasonable mixing, being a mixing zone extending from the discharge point, to a point 50 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}

12. Before 30 June 2015 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.

Signed at Stratford on 23 October 2013

For and on behalf of
Taranaki Regional Council

_____

Director-Resource Management

Appendix II

Biomonitoring report

To Technical Officer, Rae West
From Scientific Officer, Darin Sutherland
Doc No 1668921
Report No DS045
Date April 2016

Summer biomonitoring of the Patea River in relation to the Stratford District Council's upgraded Wastewater Treatment Plant, February 2016

Introduction

The upgrading of the wastewater treatment plant (WWTP) completed in 2009, required by conditions attached to the renewed consent 0196 (TRC, 2013), has been the subject of an additional investigative assessment of the upgrade's effectiveness in terms of system performance and its impacts on the receiving waters of the Patea River. A component of the assessment included two spring biomonitoring surveys of the river specifically in association with the upgraded treatment system and relocated, improved outfall structure (some 600 m downstream of the sealed-off original outfall). The summer survey (CF486) performed soon after completion of the WWTP upgrade, and the subsequent spring, 2009 (CF491), scheduled summer, 2010 (CF501), spring, 2010 (CF517), and summer, 2011 (CF526) surveys completed the requisite assessments. Subsequently, summer surveys (including the current survey) have been requirements of scheduled monitoring programmes for compliance monitoring purposes.

Methods

The standard '400 ml kick sampling' technique was used to collect streambed (benthic) macroinvertebrates from three established sites and one more recently established site in the Patea River (illustrated in Figures 1 and 2), on 29 February 2016.

These sites were:

Site No	Site code	GPS reference	Location
1	PAT 000315	E1711801 N5644382	Swansea Road bridge (upstream of landfill and oxidation ponds' discharge)
2	PAT 000330	E1712403 N5644580	Upstream of WWTP discharge (and downstream of landfill)
3a	PAT 000350	E1712956 N5644292	Approximately 130 m downstream of the WWTP new outfall
4	PAT 000356	E1714497 N5645112	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 not required for the purpose of the current survey as no discharge from the sealed 'old' outfall was occurring at the time nor had any recent leakages occurred.

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

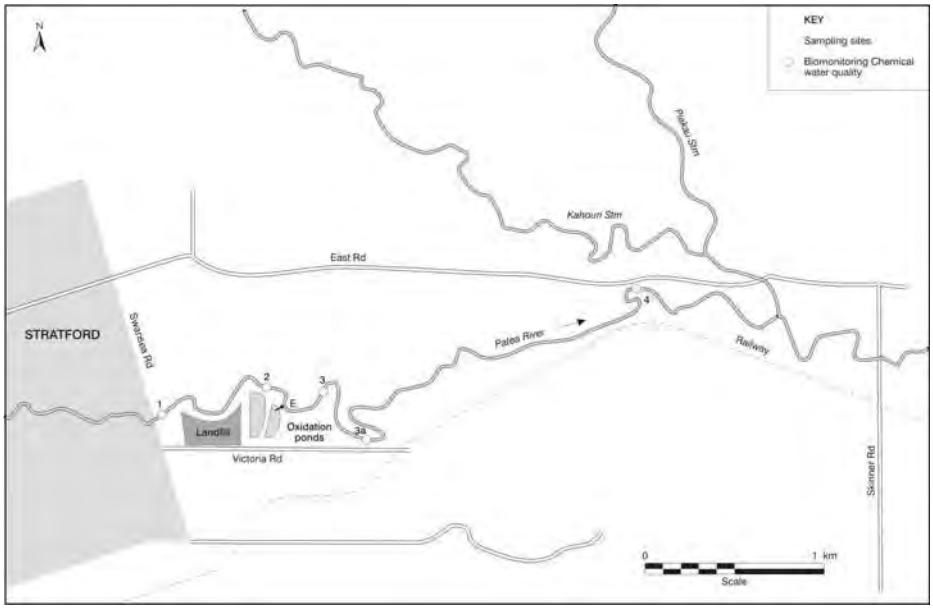


Figure 1 Biomonitoring sites in the Patea River in relation to Stratford landfill and oxidation ponds discharge

Figure 2 Aerial photo of site and location of sampling sites

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly `sensitive' taxa were assigned the highest scores of 9 or 10, while the most `tolerant' forms scored 1. Sensitivity scores for certain taxa have been modified in accordance with Taranaki experience. By averaging the scores obtained from a list of taxa collected from one site and multiplying by a scaling factor of 20, a Macroinvertebrate Community Index (MCI) value was obtained. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. More 'sensitive' communities inhabit less polluted waterways. A difference of 11 units or more in MCI values is considered significantly different (Stark 1998).

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).

Where necessary sub-samples of algal and detrital material taken from the macroinvertebrate samples were scanned 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.

Results

Site habitat characteristics and hydrology
This summer survey was performed under moderately low flow conditions (approximately half median flow), 11 days after a fresh in excess of both 3 times and 7 times median flow in the Patea River (flow gauging site at the Patea River at Skinner Road). The survey followed a relatively dry period where only one extremely large fresh (31 times median flow) was recorded over the preceding month.

The water temperatures during the survey were in the range 17.4-18.0 °C. Water levels were low and water speed was swift. The water was uncoloured and clear. The substrate at all four sites comprised gravel/cobble/boulder.

Site 1 had no periphyton but there was patchy moss, leaves and wood. Site 2 also had no periphyton and there were patchy leaves on the streambed. Site 3a had patchy algal mats and filamentous algae, and there were again patchy leaves on the streambed. Site 4 had patchy periphyton and widespread filamentous algae on the streambed. There was also patchy moss and leaves. Only site 3a did not have partial shading and overhanging vegetation.

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 March 2015

Site No.	N	No of taxa			MCI value			$SQMCI_s$ value		
		Median	Range	Feb 2016	Median	Range	Feb 2016	Median	Range	Feb 2016
1	47	26	20-33	21	110	98-130	113	5.9	3.2-7.6	6.3
2	33	24	11-36	17	105	95-119	111	5.6	3.6-7.8	6.9
3a	10	26	21-29	24	101	95-116	113	5.9	3.4-7.1	5.0
4	42	24	17-31	21	99	82-116	93	4.1	2.3-7.2	3.3

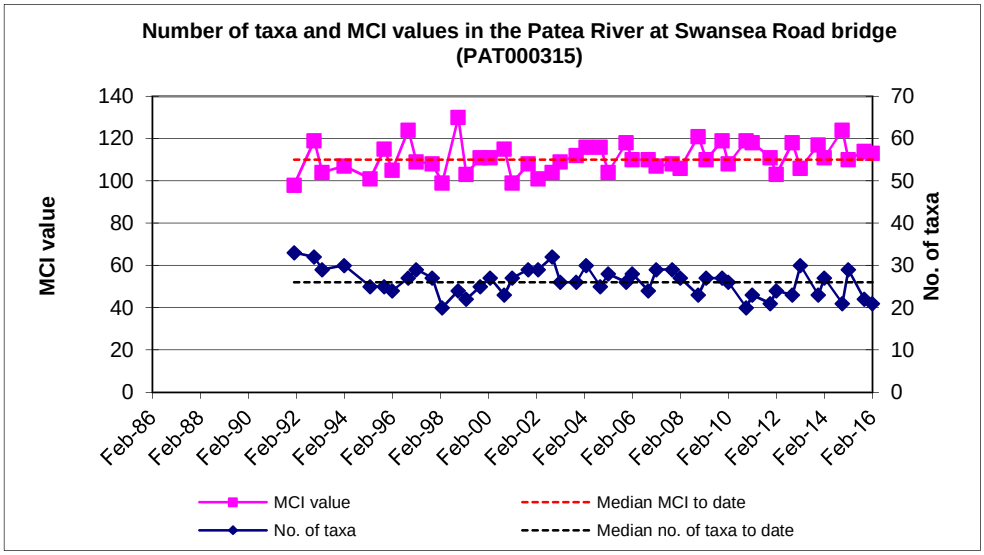
Survey results since February 1986 are illustrated in Figure 2, while the results of the current survey are presented in Table 2 and discussed beneath.

Table 2 Macroinvertebrate fauna of the Patea River in relation to Stratford District Council WWTP discharge and closed landfill leachate discharges sampled on 29 February, 2016

Taxa List	Site Number	MCI score	1	2	3a	4
	Site Code		PAT000315	PAT000330	PAT000350	PAT000356
	Sample Number		FWB16100	FWB16101	FWB16103	FWB16104
ANNELIDA (WORMS)	Oligochaeta	1	R	R	C	C
	Lumbricidae	5	-	-	-	R
MOLLUSCA	*Potamopyrgus*	4	-	R	R	R
CRUSTACEA	*Paracalliope*	5	-	-	-	R
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	-	-	R	-
	Austroclima	7	R	R	R	-
	Coloburiscus	7	VA	A	A	R
	Deleatidium	8	VA	VA	VA	A
	Nesameletus	9	C	R	R	-
	Zephlebia group	7	-	-	R	-
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	-	-	R	-
	Zelandoperla	8	R	R	-	-
COLEOPTERA (BEETLES)	Elmidae	6	A	A	C	C
	Hydraenidae	8	A	C	R	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C	C	R	R
TRICHOPTERA (CADDISFLIES)	*Hydropsyche (Aoteapsyche)*	4	VA	A	A	A
	Costachorema	7	R	R	R	R
	Hydrobiosis	5	R	C	-	R
	Neurochorema	6	R	-	-	-
	Beraeoptera	8	R	-	R	-
	Confluens	5	R	-	-	R
	Oxyethira	2	-	-	R	R
	Pycnocentrodes	5	C	-	R	-
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	C	C	C
	Maoridiamesa	3	R	-	C	C
	Orthocladiinae	2	R	R	VA	VA
	Tanypodinae	5	-	-	R	-
	Tanytarsini	3	-	R	C	C
	Empididae	3	-	-	-	C
	Austrosimulium	3	R	R	C	C
	Stratiomyidae	5	R	-	-	-
ACARINA (MITES)	Acarina	5	-	-	R	R
		No of taxa	21	17	24	21
		MCI	113	111	113	93
		SQMCIs	6.3	6.9	5.0	3.3
		EPT (taxa)	12	8	11	6
		%EPT (taxa)	57	47	46	29

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

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



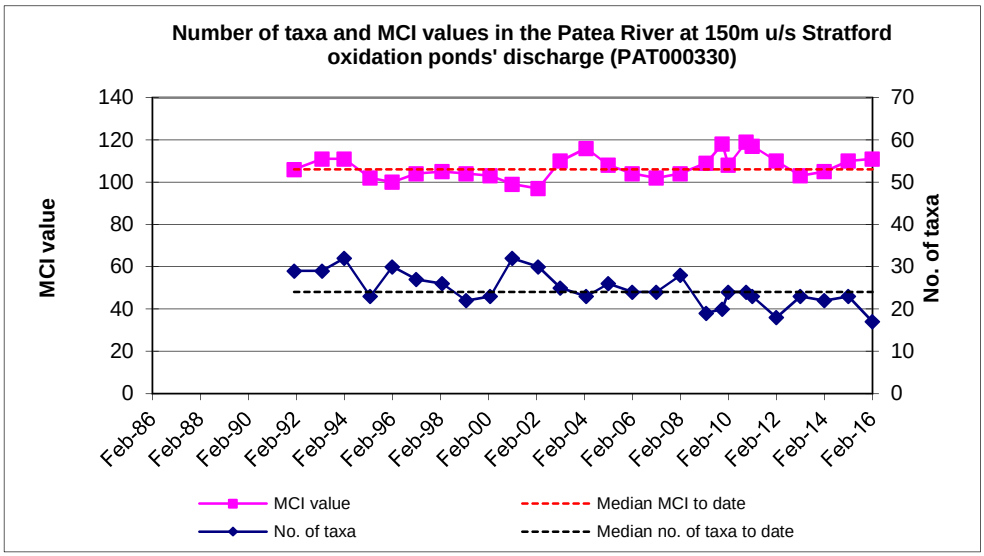
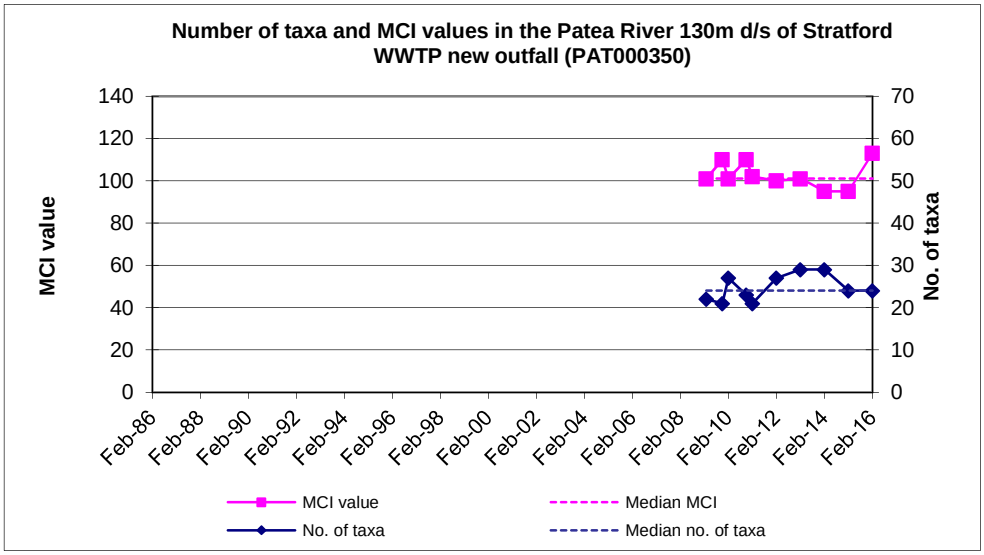


Figure 3 Taxa richness and MCI scores recorded to date at the Patea River sites upstream of the WWTP discharge



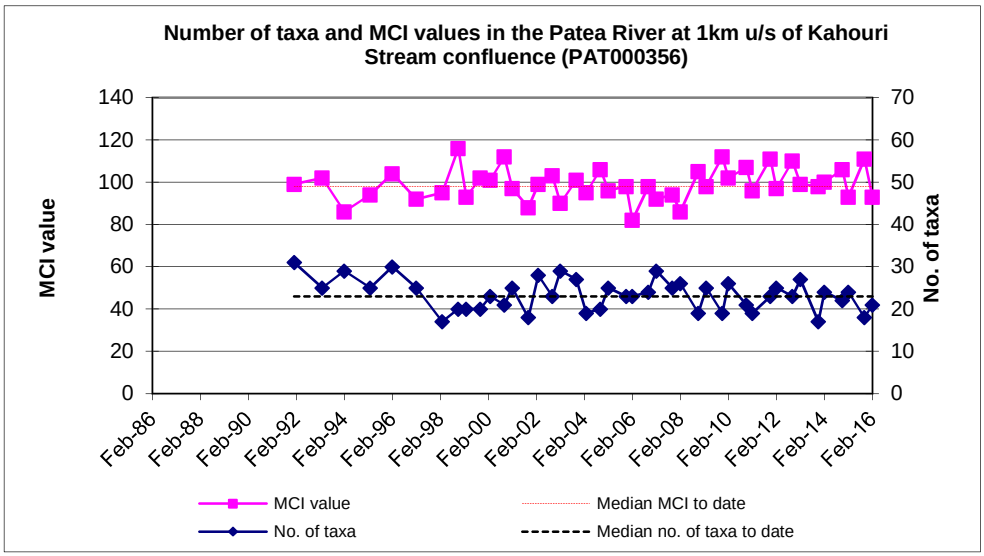


Figure 4 Taxa richness and MCI scores recorded to date at the Patea River sites downstream of the WWTP discharge

Site 1 (Swansea Road)
A moderate macroinvertebrate community richness of 21 taxa was found at site 1 ('primary control' site) at the time of the summer survey (Table 1).

The MCI score of 113 units indicated a community of 'good' biological health which was not significantly different (Stark, 1998) to the median MCI score of 110 units. The MCI score was very similar to the preceding survey on October 2015 (114 units). Predicted score for the site using the equation MCI=130.230 -1.411*D (D= distance from source) was 112 units. The $SQMCI_S$ score of 6.3 units was also similar to the median $SQMCI_S$ score of 5.9 units (Table 1).

The community was dominated by three 'very abundant' taxa which included one 'tolerant' taxon [caddisfly (*Hydropsyche/Aoteapsyche*)], one moderately sensitive taxon [mayfly (*Coloburiscus*)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 2).

Site 2 (upstream of original oxidation ponds outfall)
A moderately low macroinvertebrate community richness of 17 taxa was found at site 2 ('secondary control' site) at the time of the survey (Table 1).

The MCI score of 111 units indicated a community of 'good' biological health which was not significantly different (Stark, 1998) to the median MCI score of 105 units. The MCI score was very similar to the preceding survey on October 2015 (110 units). Predicted score for the site using the equation MCI=130.230 -1.411*D (D= distance from source) was 111 units The SQMCIS score of 6.9 units was higher than the median SQMCIS score of 5.6 units (Table 1).

The community was dominated by one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 2).

Site 3a (130m downstream of new WWTP riprap outfall)
A moderate macroinvertebrate community richness of 24 taxa was found at site 3a ('primary impact' site) at the time of the survey (Table 1).

The MCI score of 113 units indicated a community of 'good' biological health which was significantly higher (Stark, 1998) than the median MCI score of 101 units. The MCI score was significantly higher than the preceding survey on February 2015 (95 units). Predicted score for the site using the equation MCI=130.230 -1.411*D (D= distance from source) was 109 units The $SQMCI_S$ score of 5.0 units was lower than the median $SQMCI_S$ score of 5.9 units (Table 1).

The community was dominated by two 'very abundant' taxa which included one 'tolerant' taxon [midges (Orthocladiinae)] and one 'highly sensitive' taxon [mayfly (*Deleatidium*)] (Table 2).

Site 4 (upstream of discharge at East Road)
A moderate macroinvertebrate community richness of 21 taxa was found at site 4 ('secondary impact' site) at the time of the survey (Table 1).

The MCI score of 93 units indicated a community of 'fair' biological health which was not significantly different (Stark, 1998) to the median MCI score of 99 units. The MCI score was significantly lower than the preceding survey on October 2015 (111 units). Predicted score for the site using the equation MCI=130.230 -1.411*D (D= distance from source) was 106 units

which was significantly more than the observed result. The $SQMCI_S$ score of 3.3 units was lower than the median $SQMCI_S$ score of 4.1 units (Table 1).

The community was dominated by one 'very abundant' 'tolerant' taxon [midges (Orthocladiinae)].

Riverbed heterotrophic growth assessment

Microscopic assessment of material from the riverbed at the four sampling sites indicated that there were no unusual heterotrophic growths present in the river at the two upstream and two downstream sites. This was consistent with the visual absence of such growths noted at all sites at the time of the survey.

Discussion and conclusions

Macroinvertebrate richnesses were slightly lower than historical medians which may have been due to the very large fresh which occurred only 11 days prior to the survey. Differences among sites were not particularly large though there was a seven taxa increase between sites 2 and 3a. Often, nutrient enrichment can raise taxa numbers in rivers with relatively good water quality.

The MCI scores categorised sites 1, 2 and 3a as having 'good' generic river health with the furthest downstream site (site 4) only being of 'fair' health. Considering the considerable distance site 4 is from the discharge (approximately 2.5 km) its use as an 'impact' site is questionable and a new site should be established a short distance downstream of site 3a.

This survey was relatively consistent with river health recorded by previous surveys except that the macroinvertebrate community at the 'primary impact' site was in better health than normal, strongly indicating that there had been no impacts from the Stratford WWTP. MCI scores were relatively consistent with expected values for the Patea River except for the most downstream site which was in significantly worse condition, probably as a result of nutrient enrichment occurring between the WWTP discharge and the site (Stark and Fowles, 2009).

There were several significant changes in individual taxon abundances including amongst some dominant taxa as reflected in a reduction in $SQMCI_s$ value between sites 2 and 3a of 1.9 units and sites 2 and 4 of 3.6 units. These lower $SQMCI_s$ scores at sites 3a and 4 (2.5 km downstream of the wastewater discharge) reflected lower abundances in certain 'highly sensitive' taxa, particularly some mayfly taxa, and increased numbers within 'tolerant' taxa, particularly chironomid midges. Both downstream sites had 'very abundant' orthoclad midges which feed on streambed algae and are often abundant in unshaded, nutrient enriched streams with substantial algal growths.

Microscopic assessment of material from the riverbed at the four sampling sites indicated that there were no unusual heterotrophic growths present in the river at the two upstream and two downstream sites. This was consistent with the visual absence of such growths noted at all sites at the time of the survey.

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 summer biomonitoring surveys.

Overall, the results of this summer macroinvertebrate survey indicated that the discharge from the Stratford wastewater treatment plant and leachate from the closed Stratford landfill site had not had any recent significant detrimental effects on the macroinvertebrate communities of the Patea River. A noticeable deterioration in condition at the most downstream site was likely due to nutrient enrichment from adjacent farmland and unrelated to the discharges, and ideally a 'secondary impact' site should be established closer to the discharge point.

Summary

The Council's standard 'kick-sampling' technique was used at four 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.

Macroinvertebrate richnesses were slightly lower than historical medians which may have been due to a large fresh. The MCI scores categorised sites 1, 2 and 3a as having 'good' generic river health while site 4 only being of 'fair' health. However, all values were not significantly different to historical median or expected values apart from site 3a being higher than normal and site 4 being lower than expected which suggests that there was no impact from the Stratford WWTP discharges and that site 4 is positioned too far away (2.5 km) from the discharge point to be useful as a 'secondary impact' site and should be shifted further upstream. Furthermore, no undesirable heterotrophic growths were found on the substrate of the river at the sites surveyed downstream of the discharge.

Overall, the survey indicated that the discharge from the Stratford wastewater treatment plant and leachate from the closed Stratford landfill site had not had any recent significant detrimental effects on the macroinvertebrate communities of the Patea River.

References

Fowles CR, 2015: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, February 2015 (CF638).

Fowles CR, 2014: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, February 2014 (CF604).

Fowles CR, 2013: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, February 2013 (CF575).

Fowles CR, 2012: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, February 2012 (CF545).

Fowles CR, 2011: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, February 2011 (CF526).

Fowles CR, 2010: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, February 2010 (CF501).

Fowles CR, 2010: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, November 2010 (CF517).

Fowles CR, 2009: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, March 2009 (CF486).

Fowles CR, 2009: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, November 2009 (CF491).

Fowles CR, 2008: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, February 2008 (CF440).

Fowles CR, 2007: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, February 2007 (CF420).

Fowles CR, 2006: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, February 2006 (CF399).

Fowles CR, 2005: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, February 2005 (CF359).

Fowles CR, 2004: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, March 2004 (CF306).

Fowles CR, 2003: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, February 2003 (CF273).

Fowles CR, 2002: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, March 2002 (CF250).

Fowles CR, 2001: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, February 2001 (CF233).

Fowles CR, 2000: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, March 2000 (CF214)

Fowles CR, 1999: Biomonitoring of the Patea River in relation to the Stratford District Council's landfill and oxidation ponds' system, March 1999 (CF188).

Stark JD, Boothroyd IKG, Harding JS, Maxted JR, Scarsbrook MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No 1. Prepared for the Ministry for the Environment. Sustainable Management Fund Project No 5103. 57p.

Stark JD, Fowles CR, 2009: Relationships between MCI, site altitude, and distance from source for Taranaki ring plain streams. Stark Environmental Report 2009-01. 47p.

Stark JD, 1999: An evaluation of Taranaki Regional Council's SQMCI biomonitoring index. Cawthron report No 472. 32pp.

Stark JD, 1985: A macroinvertebrate community index of water quality for stony streams. Water and Soil Miscellaneous Publication No. 87.

TRC, 2015: Some statistics from the Taranaki Regional Council database (Esam) of freshwater macroinvertebrate surveys performed during the period from January 1980 to 30 September 2014, (SEM reference report). TRC Technical Report 2014-105.

TRC, 2014: Stratford District Council municipal oxidation ponds system monitoring programme Annual Report 2013-2014. TRC Technical Report 2014-14.