South Taranaki District Council
Eltham Wastewater Treatment Plant
Monitoring Programme
Annual Report 2013-2014

Technical Report 2014-05

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Executive summary

The South Taranaki District Council, which operates the Eltham municipal wastewater treatment system located to the east of Eltham in the Mangawhero catchment, holds a resource consent to allow it to discharge treated wastewater to the Mangawhero Stream under high rainfall conditions only. The consent for the discharge of emissions into the air expired in mid 2011 when it was no longer considered necessary as the nature of the biological processes at the plant met a 'permitted' category in the Regional Air Quality Plan, the monitored operation of the plant had found no odour issues, and very few complaints had occurred in recent years. This report for the period July 2013 to June 2014 describes the monitoring programme implemented by the Taranaki Regional Council to assess the environmental performance during the period under review, and the results and effects of the consent holder's activities, particularly the environmental improvements associated with recent major modifications to the disposal system. It also records the state of riparian planting and channel improvement initiatives in the lower Mangawhero catchment. Good progress has been made in terms of riparian fencing and vegetation within both the Mangawhero and Mangawharawhara Streams' catchments in recent years.

The pipeline transfer of the treated wastewater out of the Mangawhero Stream catchment to the Hawera WWTP system and then to the Tasman Sea through the ocean outfall involved construction of a new pipeline system and associated pumping and screening facilities (at the WWTP), which were completed in June 2010 and the holding pond (conversion of the wetland) in early 2011. A consent to discharge treated wastewater to the Mangawhero Stream under very high rainfall conditions was granted during the 2009-2010 period to provide for hydraulic overloading of the pumping capacity of the system should such situations eventuate. The consent holder was issued with a Taranaki Regional Council Environmental Award in 2012 in recognition of this upgrade project and its mitigation of previous impacts on the receiving waters of the Waingongoro catchment.

The new overflow water resource consent, replacing the original wastewater discharge consent, included a total of nine special conditions setting out the requirements that the South Taranaki District Council must satisfy.

The Council's monitoring programme included inspections, odour surveys, and limited biological surveys of the receiving waters of the Mangawhero Stream and Waingongoro River. These latter surveys were a means of documenting anticipated improvements in receiving water conditions in the absence of continuous wastewater discharges, these wastes having been diverted by pipeline to the Hawera WWTP in mid 2010.

The upgraded treatment system, although previously identified as extensively overloaded (with industrial dairy wastes), was well maintained and operated during the monitoring year in terms of its general performance. Mechanical aeration of the primary pond (with some aerators replaced and additional aerators installed) was successful in maintaining aerobic conditions throughout the majority of the period although additional industrial loadings at times placed the system under pressure in terms of maintaining positive dissolved oxygen levels. Although slight localised pond odours were noted on occasions, there were no noticeable odours offsite or complaints received during the monitoring year in relation to normal operating conditions in the ponds. A high level of compliance was achieved with the discharge consent in terms of general conditions, with no usage of the converted holding basin, and therefore no overflow discharges at any time.

Final effluent quality assessments were not required as this wastewater quality is no longer an issue because it is diverted to the Hawera WWTP via the recently constructed pipeline for additional treatment prior to disposal.

Relatively low dissolved oxygen levels were recorded in the primary oxidation pond during the monitoring period. This pond has had a high bacterial component of its microflora and average algal taxa richness, although certain of these taxa had been indicative of high wastes loadings on the system.

However, a confounding issue with the normal operation of the WWTP, was the consent holder's decision in September 2013 to provide for the disposal of a significant volume of surplus buttermilk and contaminated milk within the (redundant) EADER, an original anaerobic digester pond component at the WWTP site. Numerous odour complaints to both Councils (the majority justifiable) ensued over several months (with breaches of the Regional Air Quality Plan) resulting in Abatement and Infringement Notices and an Enforcement Order being issued. Further enforcement actions were under consideration at the conclusion of the monitoring period under review. The incident was compounded by a period of overloading of the primary aerobic pond with untreated industrial dairy wastes (in contradiction of a District Council trade waste agreement). Subsequent treatment of the EADER wastes by gradual controlled loadings on the primary pond necessitated a marked increase in mechanical aeration and control of gas emissions prior to diversion of these treated wastes by pipeline to the Hawera WWTP. The transfer of the contents of the EADER was almost completed by 30 June 2014.

Overall, while performance in terms of adherence to the Regional Air Quality Plan was very poor, receiving water environmental performance was high as spring and late summer biological monitoring surveys conducted under low flow conditions to assess receiving water recovery in the absence of a continuous wastewater discharge continued to confirm significant improvements in the biological 'health' of the Mangawhero Stream and further downstream in the mid-reaches of the Waingongoro River. Aspects of biological water quality 'health' under low flow conditions were much improved compared with pre-wastes diversion monitoring periods, through the Mangawhero Stream and extending into the Waingongoro River downstream of their confluence. The state of the environment longer term (eighteen-year) trends of statistically and ecologically significant improvement in biological river/stream 'health' can be expected to be maintained now that wastes are completely diverted to the Hawera WWTP via the pipeline which became operative in June 2010 and functioned very well throughout the 2013-2014 period.

Components of a suitable monitoring programme for 2014-2015 have been identified and included in recommendations. This programme which was reduced in complexity in 2012-2013 in recognition of the significant upgrade to the system, should continue to document marked improvements in the water quality (physicochemical and biological) of the Mangawhero Stream and extending into the mid and lower reaches of the Waingongoro River.

Recommendations relating to on-going monitoring of the WWTP and the consented overflow discharge include no requirement for an optional review of this consent in June 2015 given the high standard of performance of this component of the consented activity since diversion of the wastewater to the Hawera WWTP. However, recommendations relating to more appropriate consideration of trade wastes monitoring and additional wastes loadings on the WWTP by the consent holder are also provided.

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1. Introduction

1.1 Compliance monitoring programme reports and Resource Management Act 1991

1.1.1 Introduction

This report is the Annual Report for the period July 2013 to June 2014 by the Taranaki Regional Council describing the monitoring programme associated with the resource consent held by South Taranaki District Council for the Eltham wastewater treatment plant system.

This report covers the results and findings of the monitoring programme implemented by the Council in respect of the consent held by South Taranaki District Council related to the discharge of treated wastes into the Mangawhero Stream only under conditions of heavy rainfall. While this is the twenty-seventh Annual Report to be prepared by the Taranaki Regional Council to cover discharges and their effects, it is the fourth to report upon performance since the diversion of the treated wastes discharge out of the Mangawhero Stream, to the Hawera WWTP system.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about compliance monitoring under the *Resource Management Act 1991* (RMA) and the Council's obligations and general approach to monitoring sites through annual programmes, the resource consents held by South Taranaki District Council in the Mangawhero catchment (a sub catchment of the Waingongoro 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 Mangawhero and Waingongoro catchments.

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

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

Section 4 presents recommendations to be implemented in the 2014-2015 monitoring year.

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

1.1.3 The Resource Management Act 1991 and monitoring

The *Resource Management Act 1991* (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 a discharger, and may include cultural and socio-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 (e.g. recreational, cultural, or aesthetic);
(e) risks to the neighbourhood or environment.

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

1.1.4 Evaluation of environmental performance

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

- A **high** level of environmental performance and compliance indicates that essentially there were no adverse environmental effects to be concerned about, and no, or inconsequential non-compliance with conditions.

- A **good** level of environmental performance and compliance indicates that adverse environmental effects of activities during the monitoring period were negligible or minor at most, or, 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, or, there were perhaps some items noted on inspection notices for attention but these items were not urgent nor critical, and follow-up inspections showed they have been dealt with, and any inconsequential non compliances with conditions were resolved positively, co-operatively, and quickly.

- **Improvement required (environmental)** or **improvement required (administrative compliance)** (as appropriate) indicates that the Council may have been obliged to record a verified unauthorised incident involving measurable environmental impacts, and/or, there were measurable environmental effects arising from activities and intervention by Council staff was required and there were matters that required urgent intervention, took some time to resolve, or remained unresolved at the end of the period under review, and/or, there were on-going issues around meeting resource consent conditions even in the absence of environmental effects. Abatement notices may have been issued.

- **Poor performance (environmental)** or **poor performance (administrative compliance)** indicates generally that the Council was obliged to record a verified unauthorised incident involving significant environmental impacts, or there were material failings to comply with resource consent conditions that required significant intervention by the Council even in the absence of environmental effects. Typically there were grounds for either a prosecution or an infringement notice.

1.2 Treatment plant system

1.2.1 Background

Eltham township sewage treatment has been provided historically by a two oxidation pond system. Various industrial wastes have also been accepted for treatment by this system. Mechanical aeration of the primary oxidation pond was introduced because of overloading of the two pond system as a consequence of the incorporation of these industrial wastes.

Investigations of individual industrial and total waste loadings being discharged into the treatment system were undertaken by NZ Dairy Research Institute in August 1992 with a follow-up survey performed in March/April 1993. Although some problems were experienced with these surveys, the wastewater loadings entering the ponds system were found to approach, and possibly exceed, the 1000 kg/day BOD_5 treatment capacity. These loadings probably accounted for the increase in mechanical aerator operating times recorded during this period.

Further investigations of wastes influent loadings to the treatment system, undertaken by the South Taranaki District Council in conjunction with its consultants during 1993-94, concluded that the Eltham sewage treatment plant was receiving a peak organic waste load equivalent to a population of 22 000 persons. The original design was based on a population of 5500 persons, prior to the installation of mechanical aeration. The consultant's report (Royds Garden, 1994a) also concluded that while 50% of the flow to the treatment system was contributed by Eltham's domestic sewage, more than 80% of the organic load was of industrial origin (which had large fluctuations in flow, pH, BOD_5 and suspended solids). This report also concluded that in order to obtain a new resource consent, significant upgrading of both the treatment and disposal of Eltham's industrial and domestic wastewater would be necessary. Although this upgrade would be required simply to cope with the existing sewage load, it would be essential to provide some reserve capacity for peak loads and probably further industrial expansion. It recommended planned establishment for a final plant capacity of approximately 30 000 population equivalent.

The consultant's companion report (Royds Garden, 1994b) provided options for treatment plant design and concluded that the best option for disposal was into the Mangawhero Stream despite the requirement for the highest standard of treatment.

Twin aerators had been installed in the primary pond in January 1988 with automatic control by rises/falls in the dissolved oxygen level of the primary pond (as measured by a probe situated at a depth of 700 mm toward the opposite perimeter of the pond). A computerised monitoring record of the aerator's operation and associated pond dissolved oxygen concentrations was maintained by the South Taranaki District

Council and interrogated by South Taranaki District Council staff. However, calibration and problems associated with the dissolved oxygen probe performance caused complications with the aerators' performance, to the extent that the probe became inoperative and was replaced during a system upgrade.

Although the addition of the twin aerators to the pond system increased treatment capacity from 235 kg to more than 1000 kg of BOD_5 (Biochemical Oxygen Demand) per day, the system was not capable of coping with the waste loadings.
From time to time complaints were received by STDC and the Taranaki Regional Council concerning objectionable odours emanating from the ponds system. These odours generally occurred at times of calm weather (early morning and evening) and/or following aerator breakdown/maintenance, and these incidents were usually of short duration.

Despite the operation of the aerators, dissolved oxygen levels in the primary pond from time to time have fallen to levels lower than recommended for efficient pond operation. A combination of high pond loadings, low dissolved oxygen levels, and marked changes in weather conditions, contributed to a major deterioration in primary pond performance (with associated odour problems) over a relatively lengthy period in April/May 1993. The lack of dissolved oxygen at this time indicated that the pond had effectively become anaerobic and generated strong pungent odours. Depending on weather conditions, the smell was discernible throughout much of Eltham and caused considerable distress to residents near the ponds in Castle Street. STDC (in liaison with TRC staff) and industry took various measures to restore aerobic conditions and improve the ponds' performance, including chemical dosing, providing extra aeration (jet-boat and mechanical aerators), pumping effluent from the second pond back into the first pond, and reducing waste loadings. By mid-May the ponds had recovered to normal performance, with only occasional odours being reported since then. Restorative work, with associated monitoring, fortunately confined the problem to the primary pond, thereby maintaining normal ranges of quality in the effluent discharged into the receiving waters. However, despite the addition of further mechanical aeration which was maintained throughout the most recent monitoring periods (up to nine aeration units in operation), primary pond- monitored dissolved oxygen concentrations have often fallen below the minimum level considered necessary for effective operation. Additional aeration also produced increased amounts of bacteria (ie biomass, suspended solids) which remained in suspension and were transferred through into the secondary pond where the pond's appearance altered markedly, often with an associated reduction in the dissolved oxygen concentration of this pond. Deterioration in effluent appearance and quality, with increased impacts on the receiving waters, was the ultimate consequence of additional aeration of the primary oxidation pond.

Previous monitoring reports have highlighted the following problems with the system from time to time:

(i) milky, turbid appearance of the primary pond;
(ii) abundance/domination of filamentous bacteria in the microflora of the pond(s);
(iii) intermittent odour problems associated with the primary pond;
(iv) absence of dissolved oxygen in the primary pond;
(v) marked detrimental impacts on the physicochemical water quality and biological communities of the Mangawhero Stream.

These matters were addressed by the consent holder's consultant as required by conditions attached to the previous short-term consent.

Poor stream water quality conditions had been identified from time to time in the past upstream of the oxidation ponds' discharge. Agricultural waste disposal practices on various farms were more intensively surveyed in this area of the catchment during the Taranaki Regional Council's annual 1994-95 round of dairy shed inspections and follow-up re-inspections performed where necessary to ensure compliance with consents and the RMA. Annual inspections continued during subsequent monitoring periods, with only isolated short-term problems identified and these were rectified. No continuous major waste disposal problems were found, although the potential for contamination of receiving waters was identified should poor effluent disposal system management occur. These systems will continue to be monitored in future Regional Council dairy shed inspection rounds.

No usage of the Eltham wastewater treatment plant for disposal of industrial tanker wastes (e.g. septic tank wastes etc.) now occurs as there are purpose-built facilities in place to accept these wastes at the nearby Stratford oxidation ponds and more appropriately, the Hawera system. Monitoring of waste influent in the ponds is performed by South Taranaki District Council (by way of continuous recording of volume and pH), ensuring that stricter control of such usage now occurs.

1.2.2 Initial proposal for upgrade to the system

A working party was established by the South Taranaki District Council, and consultants were commissioned to identify the standard of wastewater treatment required together with options for treatment and disposal. The most suitable option for upgrading the existing facilities without causing significant adverse environmental effects on the Mangawhero Stream was selected by the working party and formed the basis of an application for renewal of the existing short-term consent. An air discharge consent application was also lodged for the proposed upgrade to the treatment system. These applications were processed in the latter part of 1994 without the need for a formal hearing, although a total of five submissions were received. The proposed upgraded system, when completed, was intended to produce a final effluent quality of:

BOD_5:	20 g/m^3
Suspended solids:	20 g/m^3
Faecal coliform bacteria:	<10 000 per 100 ml

and the components of the proposed upgrade included:

- a new pipeline to take wastewater from the Dairy Meats and Mainland Products Companies to the site;
- a new 0.43 ha covered anaerobic lagoon at the site to provide primary treatment of the Dairy Meats Company and Mainland Products Ltd wastewater. Biogas from the lagoon will be collected and either flared at the site or piped to Mainland Products Ltd for use in boilers. [This design of the anaerobic lagoon (EADER) was subsequently adjusted, by way of an approved 40% increase in volume, to provide greater capacity and increased retention time];

- a new activated sludge treatment plant or an equivalent process to provide further treatment of effluent from the anaerobic lagoon;
- a belt press for sludge removal (with an appropriate building) and off-site disposal (instead of sludge drying beds);
- the existing 3 ha oxidation pond, without a need for mechanical aeration, which would treat domestic sewage from Eltham and pre-treated wastewater from NZ Pastoral Foods;
- a new clarifier to remove sludge from the activated sludge plant effluent and suspended solids from the oxidation pond effluent. (A review of the location and size of the clarifier to the extent that it would treat only the activated sludge plant and anaerobic lagoon effluents was approved); and,
- a constructed wetland, converted from the existing secondary oxidation pond.

1.2.2.1 Progress with upgrade and subsequent alternative disposal method

A comprehensive history of progress is contained in the 2003-2004 annual report (TRC 2004-52). During the 2004-2005 monitoring period investigation and reviews relating to the pipeline diversion of wastes (out of the Mangawhero Stream) to the Hawera oxidation pond system were completed. An application was lodged for a variation of the appropriate ocean outfall coastal permit. This was delayed by requirements for several pre-hearing meetings as a result of submissions received to the application. A formal hearing was held in October 2006 and the recommendation to the Minister of Conservation (to vary the permit) was subsequently appealed by two submitters. These appeals were withdrawn in the latter part of the period.

The pipeline diversion, which had been delayed as a result of the appeals, was completed in June, 2010 with pipeline and pump station construction following a review of costings undertaken by the Eltham dairying industries involved in the joint usage of the system.

The layout of the wastewater plant as it existed prior to the new pipeline diversion is illustrated in Figure 1, with wetlands vegetation remaining stable, while the wastewater levels were generally maintained at a suitable depth to provide for plant development. No use of the clarification component of the system was made during the pre-pipeline diversion period. However, reconfiguration of the wetland to act as a storage pond was due to be undertaken following full diversion of wastes from the primary pond into the Hawera pipeline which was completed in June, 2010.

The primary pond was de-sludged during the 2006-2007 monitoring year with the de-watered sludge contained in geo-textile bags in an excavated, bunded area adjacent to the EADER (Figure 2). De-waterings and stormwater from this area continued to be returned to the primary pond through the clarifier during 2007 to 2010 and no odour problems were associated with this operation. However, STDC water treatment plant sludge was placed over the geotextile bags during 2008-2009 without consultation, resulting in neighbours' concerns with respect to future sludge disposal at this site. The original intention had been to dispose of the Eltham WWTP pond sludge to the Patea landfill which, however, was subsequently closed. A consent to discharge sludge from the WWTP and STDC water treatment plants ((7571), Appendix I) to land at the Eltham WWTP site was granted in December, 2009.

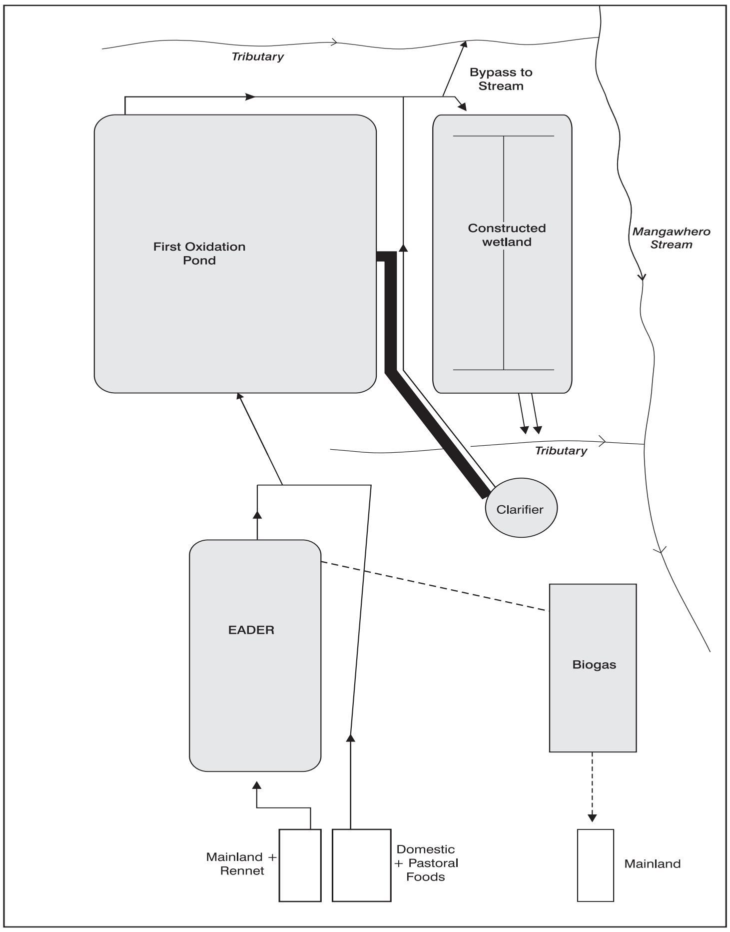

Figure 1 Schematic layout of Eltham wastewater treatment plant as operational prior to the diversion of wastewater to the Hawera WWTP in the 2010-2011 period

Figure 2 Aerial view of the Eltham WWTP showing the sludge geo-textile bags disposal area (lower LH corner) near the plant entrance [Note: the wetland (lower, centre) was converted to a holding pond in early 2011])

After meetings with interested parties STDC was advised that there were no specific issues preventing the consented burial of this sludge on site as chemical testing indicated that it was suitable for land disposal. Although STDC was planning to provide a sludge disposal facility at Whareroa (to take both water and wastewater treatment plant sludges), it was considered that rather than transport the Eltham sludge to that site, a one-off on-site disposal event was appropriate. The vegetation from the cleared converted wetland was also to be deposited in this site and covered with cleanfill.

Work commenced on the pipeline connection to the Hawera WWTP during the latter half of the 2008-2009 monitoring period. A step screen and new inlet to the primary pond were constructed on the raw wastewater reticulation and a new stormwater pipe from this area was directed to the wetland. The wetland was converted to a holding pond in early 2011 to provide high stormwater ingress containment in excess of the pumping capacity of the new pipeline connection. This system is anticipated to have an overflow frequency of one to two occasions in any five year period necessitating a new consent for this discharge which was granted in November, 2009 (consent 7521). Monitoring of overflows from the pond will be provided and incorporated within the consent holder's telemetry system. The upgraded scheme was formally opened in December, 2010.

The new pipeline was operational by June 2010 (see Photos 1-8 in TRC, 2011) and the full upgrade (e.g. conversion of the wetland to a storage pond) was completed in early 2011 with the vegetation removed and buried with the sludge. This was covered, levelled, and replanted by the consent holder in the latter part of the 2011-2012 monitoring period. Discharges to the stream ceased completely in late June 2010.

STDC advised that the EADER would be abandoned by removal of the cover and filling with clean fill. The piped watercourse at the base of the EADER was to be re-lined to provide increased integrity as additional fill would cover this line. Various water treatment plant sludges were to be used to complete the in-filling of the EADER. However, this did not eventuate and liquid sludge was pumped out of the EADER and into the Hawera line in an effort to dewater and remove residual sludge from the EADER. Bacteria and enzymes were added in March 2013 for further breakdown and liquefying of the sludge for pumping purposes (STDC pers.comm, July 2014). Some sludge remained in the EADER when the buttermilk and milk waste was discharged in September 2013.

Stormwater infiltration investigative work has been continued by STDC particularly in relation to illegal connections to the sewerage reticulation. Some re-lining of sewerage pipelines was performed in the 2011-2012, 2012-2013, and 2013-2014 periods and a continuation of this work is programmed for 2014-2015.

Some use was made of the overflow retention pond in mid July 2011 due to surcharging of the Hawera town reticulation. This pond reached about 33% of its retention capacity (Photo 1) before increased pumping to the Hawera WWTP returned this holding facility to its normal, very low level.

Photo 1 Overflow retention pond, 21 July 2011

An issue with a partial collapse of the Hawera western trunk reticulation in early January, 2012 caused a brief (two-day) usage of the emergency storage pond before this was pumped down.

No usage of the retention pond was necessary during the period 1 July 2012 to 30 June 2013 nor in the 2013-2014 period and therefore, no authorised overflows (consent 7521) to the Mangawhero Stream were necessary at any time during the 2013-2014 monitoring periods.

In recognition of the successful completion of the diversion of treated wastewater by pipeline to the upgraded Hawera WWTP, thereby reducing wastes loadings in the Waingongoro River catchment, STDC was presented with a TRC Environmental Award (see Appendix II: TRC, 2012).

1.3 Receiving water riparian management

In recognition of the effectiveness of riparian vegetation as a management technique contributing to water quality improvement, and Special Condition 10 of consent 0160, Regional Council land management staff prepared a riparian management plan for the Mangawhero catchment (TRC, 1998b). This plan identified the 6.6 km reach of the Mangawhero Stream extending from about 2 km upstream of the wastewater treatment plant to the stream's confluence with the Waingongoro River, as the reach requiring a combination of riparian planting and fencing, and willow removal. Design and costs were assessed and progress with implementation of the plan was dependent on landowner agreements integrated with funding from various sources, including a consent holder contribution.

A comprehensive history of progress with willow removal and riparian planting and fencing has been provided in the 2003-2004 annual report (TRC 2004-52).

During the 2004-2005 period no new works were implemented due mainly to funding being exhausted. However, the Taranaki Regional Council employed a contractor to undertake the spraying of willow regrowth along the reach of the Mangawhero Stream from SH3 to the Mangawharawhara Stream confluence. It was considered vitally important that willows do not become re-established along the stream.

In addition to this, the true left bank immediately below the SH3 culvert was sprayed for bindweed and periwinkle. It was resprayed in the 2005-2006 period, with replanting of this area performed in the 2006 planting season along with some minor blanking (planting of the gaps) in this reach.

Several years of concern expressed by affected landowners in regard to ongoing problems with ponding and sediment build-up, resulted in a further 150 m of willow removal undertaken from the Mangawhero/Mangawharawhara confluence downstream towards the railway bridge during the 2005-2006 period. Material removed from the streambed and stream margin was stockpiled on the adjoining properties and dried out before burning and burying. This was implemented by the landowners.

The stream margin from above the Eltham WWTP, downstream to the confluence of the Mangawharawhara Stream has continued to be monitored over the 2007 to 2014 period for willow regrowth, assessment of previous plantings and the impact of willow removal. Particular attention continues to be paid to the area adjacent to the old Eltham landfill, downstream of the Castle Street bridge.

For the period ending 30 June 2014, there is a total of 133 km of the 138 km of Mangawhero Stream banks (upstream of the Mangawharawhara Stream confluence) adequately fenced and 18 km with riparian vegetation. A further 5 km (fencing) and 10 km (vegetation) have been recommended within riparian farm plans for completion.

Correspondingly, 53 km (fencing) and 28 km (vegetated) of the 75 km of Mangawharawhara Stream banks (to the Waingongoro River confluence) are adequately riparian protected with an additional 21 km of fencing and 27 km of vegetation recommended by riparian plans.

In summary, 85% of these catchments' stream banks are fenced adequately and 49% of banks requiring riparian vegetation are adequately protected by vegetation.

1.4 Resource consents

1.4.1 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.

South Taranaki District Council holds a consent (7521) to discharge treated wastewater, as a consequence of high rainfall, into an unnamed tributary of the Mangawhero Stream. A copy of this consent is contained in Appendix I and will be a component of future monitoring programmes. The consent expires on 1 June 2027 and has review dates of June 2015, June 2017, and June 2021. Special conditions attached to the consent require advice to be provided wherever an overflow occurs, set a minimum storage capacity for the system, provide for a contingency plan and require monitoring of effects.

1.4.2 Air discharge permit

Section 15(2)(a) of the RMA stipulates that no person may discharge any contaminant into the air from any place, in a manner that contravenes a rule in a regional plan, unless the discharge is expressly allowed for by a resource consent, or is an existing lawful activity.

South Taranaki District Council held discharge permit 4618 authorising the discharge of miscellaneous emissions to the air from the Eltham wastewater treatment system. This consent was granted in November 1994, one condition was amended in June 1997, and the consent expired in June 2011.

Following the major upgrade to the system and the expiry of the consent in June, 2011 it was considered unnecessary to renew the consent as the plant would fit into a 'permitted' category within the Regional Air Quality Plan provided that the upgraded treatment plant and disposal system continued to operate without odour issues beyond the boundary of the WWTP. This was generally the case over the period to 30 June 2013.

1.5 Monitoring programme

1.5.1 Introduction

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

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

An appropriate monitoring programme was established for the system in 1987 and upgraded annual programmes have continued since this date. The programme also required integration with other receiving water monitoring programmes for discharge consents in the vicinity of the municipal wastewater treatment plant system. The 2013-2014 monitoring programme consisted of four primary components.

1.5.2 Programme liaison and management

There is generally a significant investment of time and resources by the Taranaki Regional Council in ongoing liaison with resource consent holders over consent conditions and their interpretation and application, in discussion over monitoring requirements, preparation for any reviews, renewals, or new consents, advice on the Council's environmental management strategies and the content of regional plans, and consultation on associated matters. This particularly has been the case involving the consideration of options for the future disposal of wastewater from the Eltham wastewater treatment system.

1.5.3 Site inspections

The Eltham wastewater treatment plant was visited as programmed on four occasions (between the hours of 0755 and 0900) and on three additional occasions during the monitoring period. The main points of interest were plant operation, configuration and performance, air emissions and the diversion of treated wastewater to the Hawera pipeline. These inspections provided for the operation, internal monitoring, and supervision of the plant to be reviewed by the Council, on-site odour surveys to be undertaken, and assessment of the performance of the upgraded pipeline diversion of the wastewater to the Hawera WWTP. [Note: More than 20 additional inspections were performed subsequent to the buttermilk disposal incident after late September, 2013 (see Section 2.2) mainly in response to neighbourhood odour complaints.]

1.5.4 Wastewater and receiving water quality sampling

During the 2010-2011 period, the Taranaki Regional Council had performed a reduced single survey programme of sampling of receiving water physicochemical quality for the purpose of assessing receiving water quality (recovery) in the absence of a wastewater discharge (i.e. establishment of summer low flow baseline water quality conditions). No further low flow receiving water quality surveys were required in the 2011-2012, 2012-2013, or 2013-2014 periods.

1.5.5 Biological surveys

Two macroinvertebrate biological receiving water surveys were undertaken at sites in the Mangawhero Stream and Waingongoro River under spring (November 2013) and late summer receiving water flows, the latter during very low flow conditions in February 2014, for the purposes of establishing recovery in stream/river 'health' in the absence of the previous pre-diversion heavy organic overloading of these receiving water systems.

2. Results

2.1 Inspections of treatment system operation

Four routine inspections were performed during the 2013-2014 period. This frequency was in recognition of the environmental performance history of the system and the relatively early phases of pipeline diversion of the wastes to the Hawera WWTP. These were performed as scheduled during the monitoring period. Three additional inspections were also undertaken. Odour surveys were also performed at various locations around the wastewater treatment system on scheduled inspections. Physical features of the system were recorded, and surface dissolved oxygen concentration was measured at the perimeter of the oxidation pond adjacent to the outlet. Dissolved oxygen monitoring was not required within the re-constructed holding pond. A chlorophyll-a sample was also collected from the oxidation pond at the time of each inspection for an assessment of the phytoplankton 'health' of this pond.

2.1.1 Odour surveys

Four odour surveys were carried out during the monitoring period in conjunction with all programmed site inspections. Odour strength was rated according to the following scale:

0	=	no noticeable odours
1	=	slight occasional wafts
2	=	recognisable and noticeable
3	=	frequently noticeable
4a	=	unpleasant odours, frequently strong
4b	=	unpleasant odours, continuous and noticeable
5	=	putrid.

2.1.1.1 Regular surveys

Eight sites around the wastewater treatment plant were monitored at the time of each mid-morning survey. As odour strength varies naturally according to wind direction and velocity, these variables were also recorded on each survey occasion.

Slight occasional odours were recorded on all inspection visits in the immediate vicinity of the influent entry via the stepscreen to the primary pond. These odours were only slight as the covering of the stepscreen in September, 2010 was effective in reducing odour to the extent that odours were no more than noticeable (scale 2) immediately adjacent to the stepscreen.

Scale 1 odours were slight on two occasions adjacent to the primary pond but were very localised. No hydrogen sulphide was detectable on any occasion near the perimeter of the WWTP. No odours were detectable at the main entrance gate to the WWTP, but they were noticeable on two occasions on Castle St and were slight on one occasion at the Lady's Mile corner of the primary pond (northern boundary of the WWTP) over the period subsequent to the butterfat disposal issues within the EADER (Section 2.2).

With the expiry of air consent 4618 in June 2011 it had been considered unnecessary to require renewal of the consent given the recent performance of the plant provided that no objectionable odours occurred beyond the WWTP boundary.

2.1.1.2 Additional surveys

No additional morning inspection and odour surveys were performed as there were no occurrences of very low dissolved oxygen levels in the primary pond prior to the butterfat disposal issues subsequent to September 2013. No odour complaints were received from neighbours under conditions prior to the buttermilk disposal issues. The pond required dosing with sodium nitrate by the consent holder while aerator repairs were performed in November 2013.

2.1.1.3 Comments

Generally, the odour that local residents experience depends upon three factors. Firstly, the nature of wastewater treated; secondly, the design, maintenance and operation of the treatment system; and thirdly, ambient weather conditions. Air quality in the vicinity of the WWTP is unlikely to change unless either the composition, strength, or volume of the raw wastewater changes, or the treatment and disposal system is upgraded. The aerators on the pond, through their mode of operation, cause release of odour to the atmosphere.

The strength of odour beyond the boundaries of the treatment plant site appears to be governed largely by weather conditions. Odour is strongest under calm condition, when aerial emissions from the pond accumulate. This effect is accentuated when it is overcast, as vertical mixing with ambient air is reduced, and under warm temperatures, when odour-generating bacteria in the pond are most active. Effects may be exacerbated by reduction in aeration capacity (mechanical) in the pond and deterioration in the microfloral population of this pond. Aeration capacity was maintained adequately throughout the 2013-2014 period although additional capacity was required subsequent to the butterfat disposal incident.

It has been concluded that odours of this nature from the Eltham wastewater treatment plant will occur from time to time and will vary in their effect depending upon ambient weather conditions. Therefore, they may only be documented by way of continuing monitoring and recording of incidents, in conjunction with the monitoring of the system now that connection to the Hawera WWTP pipeline has been completed. It is essential that sufficient aeration is provided and capacity is maintained in the primary oxidation pond at all times, particularly coincident with seasonal changes in pond floral communities. It is also essential that industrial wastes pre-treatment is maintained to a satisfactory standard at all times prior to discharge into the WWTP (see Section 2.2).

2.1.2 Dissolved oxygen levels in the primary pond

The results of dissolved oxygen monitoring in the primary pond recorded during regular inspections are included in Table 1.

Table 1 Dissolved oxygen measurements from the surface of the Eltham primary oxidation pond at the perimeter adjacent to the aerators' DO probe

Date	Time (NZST)	Temperature (°C)	Dissolved Oxygen	
			Concentration (g/m^3)	Saturation (%)
27 August 2013	0900	12.3	1.1	10
19 November 2013	0815	20.8	3.5	40
18 December 2013	0755	21.8	0.2	2
4 March 2014	0815	17.1	3.9	41
16 May 2014	0830	12.5	0.4	4
20 June 2014	0900	11.3	2.2	20

The dissolved oxygen concentrations in oxidation pond systems vary both seasonally and during the day as a result of a combination of factors. The photosynthetic activity of the pond's biological flora together with fluctuations in influent waste loadings on the system are major influencing factors. Another major influence in the Eltham system is the degree of mechanical aeration provided in the primary pond (required by the high industrial wastes loadings on the system). Minimum dissolved oxygen concentrations are generally recorded in the early hours of daylight, and therefore pond performance has been evaluated by standardising sampling times toward mid-morning for all regular inspection visits during the monitoring period.

Results in Table 1 indicated a relatively narrow range of dissolved oxygen concentrations (between 2 and 41% saturation) in the surface layer of the primary pond near the outlet for the period when the aerators were operating mainly at full capacity. These levels were typical of the levels generally recorded in this heavily loaded oxidation pond (i.e. supersaturation is seldom recorded). Mechanical aeration of the pond (by seven to nine aerators) maintained positive dissolved oxygen concentrations on each survey occasion with the lowest concentrations measured during mid-summer and late autumn periods. Low concentrations (<1 g/m^3) were indicative of these very high wastes loadings particularly in autumn when nine aerators were operating

The South Taranaki District Council maintained manual on-site dissolved oxygen monitoring throughout the period for internal monitoring and operational purposes. They advised the TRC that aerator breakdowns in November, 2013 necessitated chemical dosing of the primary pond with sodium nitrate (which was on stand-by) as dissolved oxygen levels over this period were relatively low. Mechanical aeration was restored to its normal operational level following the repair of the aerators.

Photo 2 Replacement aerator, June 2013

Two new diffuser aerators (Photo 2) had been installed during the previous period (replacing the brush aerators) and a third installed in the current period. The brush aerators toward the centre of the pond were retained for emergency purposes (STDC, pers. comm., June 2013). Additional aeration was also necessitated following the buttermilk incident of late September, 2013 (see Section 2.2).

2.1.3 Primary pond conditions

Only slight odours were recorded in the immediate vicinity of the primary oxidation pond (mainly near the influent step-screen) on the regular inspection occasions and were slightly more noticeable on one occasion downwind of the pond.

Extensive aeration of the primary pond (six to nine mechanical aerators in operation on all but one occasion) was continued. The pond was turbid in appearance but the colour varied from pale brown to brown to dark green to turbid grey.

There was no evidence of sludge layers close to the surface of the primary pond on all but one inspection occasion, when some sludge was recorded near the south-eastern perimeter. One pond level was raised (by about 20 cm) for additional capacity, in mid period.

Wave action on the pond surface was generally minimal (flat to rippling) as most of the inspections were coincident with light wind to calm conditions. However, the aerators generated localised surface movement but not to the same degree as the paddle aerators had in the past. Observations made in conjunction with dissolved oxygen sampling of the primary pond adjacent to the DO probe (i.e. opposite the inlet position), showed that there was some anticlockwise current around the pond but more in a central pond direction as a result of the different action of the newer air sparge aerators (Photo 2). These currents were present on all inspection occasions due to the significant number of aerators which were operational on the primary pond.

The pond's surrounds were tidy at all times (grazed by sheep), the wavebands were tidy, and the pond surface was free from accumulated debris. Ducks (mainly mallard) were common on the pond almost throughout the year, with large numbers (more than 200) in spring and mid winter, and black swans and gulls occasionally present. These species are common members of the avifauna associated with treatment ponds systems (Don, 2004).

There were no overflow discharges of primary pond treated wastes to the small tributary stream adjacent to the eastern boundary recorded at the time of any inspection visit, and there were no overflows of treated wastewater into the holding pond (i.e. old wetland area) noted on any occasion.

2.1.4 Holding pond conditions

No odours were associated with the holding pond (converted from the wetland) at the time of any inspection visit. The pond contained no wastewater and was generally shallow or empty with occasional increases in stormwater/seepage following wet weather (e.g. at the time of the May, 2014 inspection). All water/wastes were pumped directly into the Hawera WWTP pipeline and no overflows occurred into the

Mangawhero Stream tributary. Pukeko were occasionally associated with this component of the WWTP and mallard ducks were present on one occasion.

Planting of the eastern and northern perimeters of the WWTP (with native vegetation) and the Castle Street boundary was undertaken by the consent holder during the 2009-2010 period. The sludge disposal area has been levelled and grassed for grazing purposes (STDC, pers.comm.)

2.2 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 eg provision of advice and information, or investigation of potential or actual cases of non-compliance or failure to maintain good practices. A pro-active approach that in the first instance avoids issues occurring is favoured.

The Taranaki Regional Council operates and maintains a register of all complaints or reported and discovered excursions from acceptable limits and practices, including non-compliance with consents, which may damage the environment. The Unauthorised Incident Register (UIR) includes events where the company 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).

No problems at the Hawera WWTP (reticulation or other issues in Hawera) caused any cessation of pipeline pumping with consequent usage of the Eltham holding pond facility, and therefore no overflows to the Mangawhero Stream eventuated.

In the 2013-2014 year, there was one (major) incident recorded by the Council associated with the Eltham wastewater treatment plant.

In late September 2013 TRC was advised by STDC that due to an oversupply of buttermilk, Fonterra was permitted by STDC to dispose of up to 8000 cubic metres of buttermilk into the 'moth-balled' EADER at the WWTP by trucking these wastes from the Hawera site. Recommissioning of the EADER required sealing of historical wear and tear of the cover and establishment of a bioreactor on site to promote biological breakdown of the milk product under anaerobic conditions in the EADER after which it was intended to pump these partially treated wastes back to the Hawera WWTP for further treatment and disposal.

Photo 3 EADER after initial receipt of buttermilk, October 2013

Initially these wastes were not intended to be discharged into the aerobic primary pond. STDC undertook to notify neighbouring property owners of the situation particularly the increased truck movements in the vicinity of the Eltham WWTP.

In consideration of historical issues with poor EADER performance, overloading of the primary oxidation pond, and odour problems at the WWTP, TRC undertook additional inspections of the system in October 2013 to ensure that the buttermilk disposal was progressing according to advice supplied by STDC and that no partially treated EADER wastes were entering and overloading the primary pond. Noticeable odours were recorded near the EADER inlet and outlet wet-well at this time.

A total of just over 3000 cubic metres of buttermilk plus 150 cubic metres of contaminated wholemilk was discharged to the EADER (Photo 3) to which STDC added 1500 cubic metres of primary pond wastewater to augment the EADER treatment.

Neighbourhood residential odour complains commenced in late October 2013 and were received by TRC (more than 40 incidents by late March, 2014) and STDC (more than 90 by mid-March, 2014). An abatement notice was issued by TRC in early November 2013 (as a result of a breach of the Regional Air Quality Plan in terms of objectionable/offensive odours beyond the WWTP site boundary) with the subsequent issue of an Infringement Notice. Various public meetings, and media attention, focussed on odour issues and preventative measures taken to mitigate the problems. Compounding the EADER odour issues in mid-December 2013 was the discharge of untreated (rather than pre-treated) industrial dairy wastes directly into the primary pond over several days, which overloaded this component of the WWTP (as evidenced by very low dissolved oxygen levels) resulting in additional odours but from the aerated primary pond. (Industrial trade wastes disposal to the WWTP are the subject of agreements between the STDC and individual industries prior to acceptance into the WWTP). STDC subsequently convened a meeting with the industrial wastes users of the WWTP to discuss matters relating to these agreements.

A managerial meeting between STDC and TRC was convened on 20 December 2013 at which STDC outlined preventative actions taken to reduce/eliminate odours and intended waste treatment options. An application for an Enforcement Order was made on 16 January 2014. The order was granted on 5 February 2014. The order required a strategy to be prepared by an air quality expert that set out the reasonable steps that should in the short term avoid, remedy, or mitigate the adverse affects on the environment. The order also required STDC to instruct an air quality expert to investigate and prepare a written report on the options for a strategy to comply with Rule 41 of the Regonal Air Quality Plan (the permitted rule referred to earlier).

The treatment action subsequently involved continued use of EADER with a controlled discharge to the primary oxidation pond (with increased mechanical aeration by additional aerators) and gas transfer from the EADER into the pond via the aspirator (thus mitigating odours). Gas bubbling commenced near mid-February 2014, and EADER waste entered the primary pond from 21 February, 2014. All primary pond wastewater was pumped as normal through the pipeline to the Hawera WWTP, along with residual sludge from within the EADER. Dosing of the EADER and bioaugmentation of those wastes were discontinued in order to minimise anaerobic activity and more readily manage gas production.

Photo 4 EADER, 20 June 2014

Numerous odour complaints continued to be received through the February to mid-April 2014 period although only four of 20 received by TRC were adjudged to be non-compliant with the Regional Air Quality Plan. The EADER wastewater flow to the aerobic primary pond was substantially completed by the end of the period (Photo 4), partly as a result of additional mechanical aeration capacity and modifications to the aeration system, although it was apparent that pond dissolved oxygen levels decreased during periods of EADER wastewater pumping into the pond (STDC, pers comm). Odour complaints continued to be received up until the end of this monitoring period.

2.3 Results of wastewater treatment plant monitoring

2.3.1 Primary oxidation pond effluent quality

No assessments of the primary pond wastewater quality were required or undertaken during the monitoring year. Primary pond effluent data recorded since the incorporation of the EADER in the treatment system (to August 2001), are summarised in Table 2 for reference purposes and considered to represent typical wastewater quality discharged into the Hawera pipeline.

Table 2 Range of selected results of Eltham wastewater treatment plant's primary pond effluent analyses for the period April 1997 to August 2001 (ie subsequent to EADER installation)

Parameter	Unit	No of samples	Range	Median
BOD_5	g/m^3	64	33-250	87
pH		15	7.4-8.6	7.7
Conductivity @ 20°C	mS/m	26	82-145	113
Ammonia-N	g/m^3N	4	20.7-40.5	31.5
Suspended solids	g/m^3	66	38-400	120
Faecal coliform bacteria	nos/100 ml	24	3600-120000	34500

2.3.2 Wetlands effluent quality

The wetland was constructed (with associated planting of vegetation) in late 1998. All primary pond treated and any clarifier treated wastes were then re-directed to the wetland which discharged via twin outfalls (one from each half of the wetland) to a small unnamed tributary of the Mangawhero Stream (Figure 1). Wetland performance and operation have been documented in previous Annual Reports (e.g. TRC, 2010) and effluent quality data typical of this wetland is summarised for reference purposes in Table 3 for the period 1999 to June 2010.

Table 3 Range of selected results of Eltham wastewater treatment plant's wetland effluent analyses for the period January 1999 to June 2010

Parameter	Unit	No of samples	Range	Median
BOD_5	g/m^3	73	27-180	73
BOD_5 filtered	g/m^3	10	5-24	12
pH		69	6.1-8.6	7.7
Conductivity @ 20°C	mS/m	69	46-177	115
Dissolved reactive phosphorus	g/m^3P	64	0.76-57.8	9.4
Ammonia-N	g/m^3N	65	0.64-41.8	20.0
Nitrate + nitrite-N	g/m^3N	64	<0.02-9.18	0.07
Total phosphorus	g/m^3P	13	8.2-19.8	13.6
Suspended solids	g/m^3	74	23-280	105
Faecal coliform bacteria	nos/100 ml	72	1000-130000	19000
Chromium (soluble)	g/m^3	12	<0.030	<0.030
Zinc (soluble)	g/m^3	11	<0.005-0.096	0.024

These data will be useful for comparative purposes should any authorised overflows eventuate from the holding pond component of the upgraded system.

No sampling was required during the 2011-2012, 2012-2013, or 2013-2014 periods as there were no overflows from the system.

2.3.3 Microflora of the Eltham wastewater treatment 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 e.g. 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.

In the past, samples of the primary pond effluent had been collected at the time of most inspections of the Eltham WWTP system for semi-quantitative microfloral assessment prior to curtailment of this component of the programme during the 2012-2013 period. The microfloral present in the primary oxidation pond have been summarised and discussed in recent annual reports and historical data have been provided in a previous annual report (TRC, 2009).

Samples of the primary pond effluent were collected on all four regular inspection occasions and on one additional occasion for chlorophyll-a analyses. Chlorophyll-a concentration can be a useful indicator of the algal population present in the system 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 change 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 primary pond effluent analyses are provided in Table 4 together with field observations of pond appearance.

Table 4 Chlorophyll-a measurements from the surface of the Eltham primary oxidation pond at the perimeter adjacent to the outlet

Date	Time (NZST)	Appearance	Chlorophyll-a (mg/m^3)
27 August 2013	0900	turbid, pale brown	1000
19 November 2013	0815	turbid, dark brown	2450
18 December 2013	0755	turbid, grey-brown	-
4 March 2014	0815	turbid, brown	399
16 May 2014	0830	turbid, grey	1110
20 June 2014	0900	turbid, grey	590

Despite the high concentrations of chlorophyll-a in the primary pond indicative of a significant phytoplanktonic component, relatively low dissolved oxygen levels were measured, indicative of the high organic wastes' loadings on this system particularly considering the additional mechanical aeration provided within this period.

2.4 Results of receiving environment monitoring

The one component of this part of the monitoring programme which was operative during the period was specifically designed to assess the impacts of diversion of the wastewater treatment plant system effluent discharge out of the catchment upon the biological communities of the former receiving waters of the Mangawhero Stream and Waingongoro River.

2.4.1 Physicochemical receiving water survey

An early autumn assessment of the anticipated improvement in water quality of the Mangawhero Stream and Waingongoro River had been performed in the 2010-2011 monitoring year, on 15 March 2011. Although no receiving water physicochemical surveys are now required, a summary of historical stream and river water quality data is provided prior to and following wastes diversion, in Tables 5 and 6, for comparative and reference purposes.

The location of the sites (Figures 3 and 4) was as follows:

No	Site	Location	GPS reference	Site code
1	Mangawhero Stream	upstream of WWTP discharge outfall	1712475E 5633431N	MWH 000380
WT	Wetlands effluent	at outfall (Note: not in use)	1712435E 5633466N	OXP 006002
3	Mangawhero Stream	approx. 400 m downstream of WWTP discharge outfall (upstream of rubbish tip)	1712302E 5633278N	MWH 000410
3a	Mangawhero Stream	150 m downstream of rubbish tip	1712054E 5633270N	MWH 000425
4	Mangawhero Stream	at farm bridge (u/s SH3 and downstream of rubbish tip)	1711812E 5632999N	MWH 000470
5	Mangawhero Stream	approx. 200 m downstream of the railbridge	1710795E 5632738N	MWH 000490
6	Waingongoro River	approx. 150 m upstream of the Mangawhero Stream confluence	1710708E 5632961N	WGG 000620
7	Waingongoro River	approx. 250 m downstream of the Mangawhero Stream confluence	1710554E 5632790N	WGG 000640
8	Waingongoro River	approx. 2 km downstream of the Mangawhero Stream confluence (Stuart Rd)	1709784E 5632049N	WGG 000665

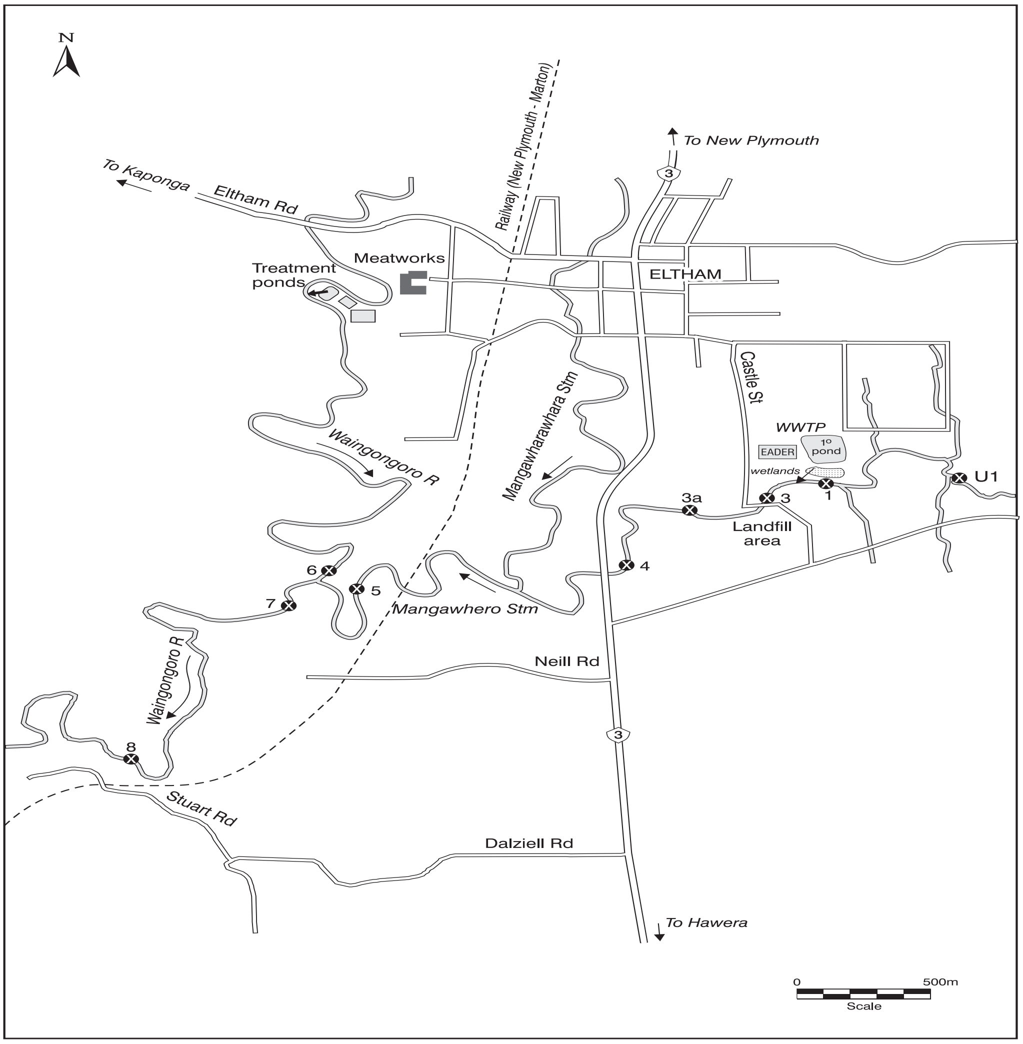

Figure 3 Location of sampling sites in relation to the Eltham wastewater treatment system

Some of these sites (sites 3 to 5) also served as monitoring sites for the evaluation of any impacts of the old Eltham rubbish tip situated adjacent to the Mangawhero Stream (Figure 3).

Figure 4 Aerial location map

Table 5 Summary of Mangawhero Stream water quality low flow data for the period 1992 to 2010 coincident with Eltham WWTP discharge to the stream and in March 2011, following wastes diversion to Hawera WWTP

Site		1			3			4			5		
		MWH000380			MWH000410			MWH000470			MWH000490		
Parameter	**Unit**	**Range**	**Median**	**Mar 11**	**Range**	**Median**	**Mar 11**	**Range**	**Median**	**Mar 11**	**Range**	**Median**	**Mar 11**
Flow	L/s	11-182	40	131	-	-	-	-	-	-	93-491	203	451
Temperature	°C	10.5-20.1	15.0	15.2	10.8-19.3	15.6	15.3	10.7-20.0	15.5	15.3	11.5-20.0	16.3	15.9
Dissolved oxygen	g/m^3	3.6-10.1	7.2	8.2	4.0-9.2	6.6	8.2	1.3-8.2	4.5	8.1	4.2-9.5	7.4	9.5
DO Saturation	%	38-95	73	84	44-88	67	84	14-80	46	83	45-96	75	98
BOD_5	g/m^3	<0.5-34	2.0	2.4	7-34	15	2.2	7-36	14	2.1	1.4-13	4.9	1.7
pH		6.9-7.4	7.1	7.1	7.1-7.7	7.4	7.1	7.1-7.7	7.4	7.2	7.2-7.7	7.4	7.6
Conductivity @20°C	mS/m	18.9-69.0	24.9	24.5	20.1-69.6	40.0	23.7	28.2-74.0	44	23.6	19.3-35.9	26.7	17.8
Chloride	g/m^3	24.3-106	29.4	23.4	33-122	68	22.7	35-124	75	22.9	24.9-58.2	38.1	19.1
Chromium (acid soluble)	g/m^3	<0.03-<0.03	<0.03	-	<0.03-<0.03	<0.03	<0.03	<0.03-<0.03	<0.03	<0.03	<0.03-<0.03	<0.03	<0.03
Zinc (acid soluble)	$/m^3$	<0.005-0.031	0.008	-	<0.005-0.044	0.017	-	<0.005-0.06	0.02	-	<0.005-0.012	<0.005	-
Dissolved reactive phosphorus	g/m^3P	0.007-6.35	0.023	0.018	0.45-6.05	1.99	0.015	0.39-5.01	1.47	0.017	0.14-1.34	0.44	0.021
Ammonia-N	g/m^3N	0.12-13.8	0.24	0.13	0.65-12.6	4.03	0.11	0.52-13.9	3.84	0.08	0.06-3.28	0.35	0.03
Nitrate + nitrite-N	g/m^3N	1.44-2.90	1.96	1.34	0.82-4.19	1.62	1.41	0.26-3.36	1.59	1.40	1.48-3.04	2.19	1.25
Suspended solids	g/m^3	<2-61	5	14	14-76	30	9	11-80	39	<2	3-24	7	5
Black disc	m	0.13-2.25	0.81	0.69	0.11-0.58	0.21	0.72	0.10-0.56	0.25	1.04	0.24-1.32	0.79	0.81
Turbidity	NTU	3.8-24	5.9	13	6.5-41	17	9.6	6.4-46	18	8.8	3.2-20	4.3	5.7
Faecal coliform bacteria	nos/100ml	670-15,000	2000	2700	540-27,000	4600	2200	77-18,000	3050	2200	190-3300	770	960

Table 6 Summary of Waingongoro River water quality low flow data for the period 1992 to 2010 coincident with Eltham WWTP discharge to the Mangawhero Stream and in March 2011, following wastes diversion to Hawera WWTP

Site		6			7			8		
		WGG000620			WGG000640			WGG000665		
Parameter	**Unit**	**Range**	**Median**	**Mar 11**	**Range**	**Median**	**Mar 11**	**Range**	**Median**	**Mar 11**
Flow	L/s	428-816	502	1440	-	-	-	-	-	-
Temperature	°C	11.7-20.3	16.5	15.2	11.6-20.4	16.5	15.5	12.2-20.5	17.0	15.7
Dissolved oxygen	g/m^3	8.2-11.4	9.8	9.7	8.0-11.0	9.5	9.6	8.9-11.6	10.1	9.6
DO Saturation	%	88-116	100	99	87-110	97	98	95-125	105	99
BOD_5	g/m^3	<0.5-6.8	1.3	0.6	0.7-6.0	1.9	0.8	0.8-4.0	1.7	0.9
pH		7.4-8.4	7.7	7.6	7.4-8.1	7.6	7.7	7.6-8.7	7.9	7.7
Conductivity @20°C	mS/m	10.7-14.6	12.6	12.4	13.0-18.5	15.6	13.7	13.8-17.8	16.0	14.0
Chloride	g/m^3	11.5-15.3	13.4	13.6	14.6-23.6	18.2	14.7	15.6-24.5	18.6	14.9
Chromium (acid soluble)	g/m^3	<0.03-<0.03	<0.03	<0.03	<0.03-<0.03	<0.03	<0.03	<0.03-<0.03	<0.03	<0.03
Zinc (acid soluble)	$/m^3$	<0.005-<0.005	<0.005	-	<0.005-<0.005	<0.005	-	<0.005-<0.005	<0.005	-
Dissolved reactive phosphorus	g/m^3P	0.014-0.75	0.051	0.015	0.058-0.84	0.18	0.018	0.062-0.68	0.18	0.020
Ammonia-N	g/m^3N	0.015-1.43	0.033	0.026	0.018-1.12	0.10	0.025	0.016-0.63	0.07	0.019
Nitrate + nitrite-N	g/m^3N	0.43-2.44	0.93	1.25	0.71-2.54	1.23	1.31	0.82-2.75	1.33	1.28
Suspended solids	g/m^3	<2-4	<2	<2	<2-6	3	<2	<2-5	3	3
Black disc	m	1.40-3.6	2.21	2.09	0.68-3.05	1.60	1.32	0.78-3.20	1.67	1.87
Turbidity	NTU	0.9-1.6	1.2	1.6	1.4-5.4	1.9	2.2	1.4-4.7	1.9	2.2
Faecal coliform bacteria	nos/100ml	43-1700	620	320	160-1600	700	360	160-1300	475	350

At the time of the March 2011 survey, the Mangawhero Stream flow (13 L/s upstream of the WWTP discharge) represented a relatively high flow which was well above the median of the range of flows surveyed at comparable times by previous surveys. The moderate water quality upstream of the WWTP's discharge was typical of a swamp drainage developed catchment and indicative of limited impacts possibly due to cattle access, treated dairyshed wastes discharges, and general run-off from farmland (e.g. elevated nutrients, BOD_5, and turbidity levels and a high faecal coliform bacterial number). However, dissolved oxygen saturation level (84%) was slightly higher than typical of such a small swamp drainage and farming catchment stream and above the median recorded previously (Table 6). Turbidity suspended solids, black disc, BOD_5 and faecal coliform levels were indicative of recent diffuse run-off more typical of elevated flow conditions i.e. levels were above historical low flow medians (Table 6).

Downstream of the WWTP outfall, the water quality of the Mangawhero Stream was significantly better than recorded previously for almost all parameters, the majority of which indicated higher physicochemical water quality than minimum/maximum values over the 18 year period prior to wastes diversion to the Hawera WWTP. While some aspects of stream water quality were indicative of upstream diffuse and/or point source impacts (e.g. elevated bacteria, BOD_5, turbidity etc.), further improvement (particularly in aesthetic conditions) might be anticipated under lower flow conditions than the relatively high flow at the time of the March 2011 survey.

The water quality of the Waingongoro River was relatively good (apart from a moderately elevated bacteriological level) upstream of the Mangawhero Stream confluence in the absence of any meatworks treated effluent discharge to the river. Low BOD_5 and relatively low nutrient levels were indicative of the absence of the Riverlands (Eltham) Ltd's meatworks' wastes discharge from the river due to diversion to pasture irrigation at the time of this survey. Slightly turbid conditions were apparent as a result of the recession from recent freshes, but otherwise water quality was relatively typical of conditions recorded over the previous 18 years (Table 7) under late summer-autumn flow conditions. The flow of the Mangawhero Stream was measured at 451 L/s (upstream of the confluence) which, with a recorded flow of 1440 L/s in the Waingongoro River, indicated an approximate dilution of the Mangawhero Stream of about three times by the main river. Water quality in the river downstream of the confluence was impacted to a small degree by the slightly discoloured Mangawhero Stream but nowhere to the same degree as pre-Eltham WWTP wastes diversion (see Table 7). The majority of the two downstream river site's parameters were better than median historical levels and toward minima, indicative of much improved down river water quality (particularly in terms of nutrients, bacteria, and BOD_5) subsequent to the diversion of the Eltham WWTP discharge out of the catchment and in the absence of the meatworks' wastewater discharge to the river.

2.4.2 Physicochemical quality of the Waingongoro River

2.4.2.1 Pre-diversion of WWTP wastes discharge

In addition to the previous late summer-autumn low flow surveys of the receiving waters, Taranaki Regional Council has been monitoring water quality conditions in the Waingongoro River (sites WGG000620 and WGG000640) and Mangawhero

Stream (site MWH000498) in conjunction with the monthly state of the environment monitoring programme (TRC, 2013). The data for the period from January 2001 to June 2010 represents river quality during the period prior to diversion of the wastewater discharge out of the catchment. This water quality monitoring has focused on nutrient species. A summary of the data is presented in Table 7. (This dataset also includes all summer low flow monitoring surveys from February 2001 to the survey of March 2010).

Table 7 Summary of selected water quality results from two sites in the Waingongoro River (N = 125 samples) above and below the Mangawhero Stream confluence and one site in the lower Mangawhero Stream (N = 114 samples) for the pre-wastewater diversion period January 2001 to June 2010

Site		Waingongoro River				Mangawhero Stream (MWH000498)	
		u/s confluence (WGG000620)		d/s confluence (WGG000640)			
Parameter	**Units**	**Range**	**Median**	**Range**	**Median**	**Range**	**Median**
Temperature	°C	4.5-22.2	12.8	4.6-22.2	13.2	4.8-22.1	13.2
Conductivity @ 20°C	mS/m	5.1-20.2	12.1	6.6-21.6	14.6	12.3-50.0	21.1
pH		7.2-8.4	7.6	7.0-8.2	7.6	6.8-8.4	7.4
Dissolved reactive phosphorus	g/m^3P	0.014-0.880	0.046	0.030-0.947	0.108	0.020-1.57	0.175
Total phosphorus	g/m^3P	0.024-0.984	0.082	0.052-1.02	0.161	0.082-1.7	0.31
Ammoniacal nitrogen	g/m^3N	0.010-3.87	0.120	0.014-2.80	0.174	0.022-3.03	0.222
Nitrite nitrogen	g/m^3N	0.007-2.48	0.022	0.010-1.75	0.040	0.014-0.51	0.056
Nitrate nitrogen	g/m^3N	0.22-2.42	1.36	0.53-2.42	1.51	0.62-3.73	2.00
Total Kjeldahl nitrogen	g/m^3N	0.01-4.43	0.43	0.03-3.36	0.63	0.22-4.32	1.06
Total nitrogen	g/m^3N	0.41-8.93	1.96	0.88-7.04	2.25	2.07-7.16	3.10
Turbidity	NTU	0.6-41	1.7	0.5-38	2.9	1.3-50	5.9

Median parameter values have indicated an approximately two and a half times dilution of the Mangawhero Stream flow by the flow of the Waingongoro River during the sampling surveys which included ten summers during which shorter periods and/or reduced loadings of Riverlands Eltham Ltd's meatworks treated wastes were discharged to the river.

All the principal nutrient species showed increases in the main river below the Mangawhero Stream confluence due to the relatively high nutrient loadings carried by that stream as a consequence of the Eltham WWTP discharge.

These increases were usually more pronounced in the absence of the meatwork's wastes discharges (due to summer diversion to pasture irrigation) when upstream river concentrations were typically at lower background levels. Median nutrient concentrations indicated downstream increases in individual nutrient species in the main river varying between 11% and 135% with total nitrogen and total phosphorus increasing by 15% and 96% respectively.

2.4.2.2 Post-diversion of WWTP wastes discharge

The comparative data have been reassessed in terms of the impacts of diversion of the WWTP wastes out of the Mangawhero Stream, subsequent to connection into the Hawera pipeline in June 2010.

The monthly monitoring at the lower Mangawhero Stream and two Waingongoro River sites has been continued between July 2010 and June 2014. A summary of this data is presented in Table 8 and may be compared with pre-wastes diversion data in Table 7.

Table 8 Summary of selected water quality results from two sites in the Waingongoro River (N = 48 samples) above and below the Mangawhero Stream confluence and one site in the lower Mangawhero Stream (N = 48 samples) for the post-wastewater diversion period July 2010 to June 2014

Site		Waingongoro River u/s confluence (WGG000620)		Waingongoro River d/s confluence (WGG000640)		Mangawhero Stream (MWH000498)	
Parameter	**Units**	**Range**	**Median**	**Range**	**Median**	**Range**	**Median**
Temperature	°C	6.0-18.2	12.1	6.3-18.0	12.2	7.3-17.6	12.7
Conductivity @ 20°C	mS/m	7.6-15.1	11.4	9.3-15.4	13.0	13.8-27.8	17.2
Chloride	g/m^3	9.2-15.6	12.9	10.8-18.6	14.4	15.0-34.0	18.0
pH		7.3-8.0	7.6	7.2-8.2	7.6	7.0-8.0	7.6
Dissolved reactive phosphorus	g/m^3P	0.004-0.194	0.030	0.003-0.139	0.028	0.003-0.230	0.023
Total phosphorus	g/m^3P	0.022-0.351	0.049	0.030-0.294	0.052	0.038-1.25	0.072
Ammoniacal nitrogen	g/m^3N	0.013-1.16	0.038	0.011-0.767	0.047	0.007-3.01	0.075
Nitrite nitrogen	g/m^3N	0.003-0.22	0.011	0.004-0.015	0.014	0.002-0.045	0.020
Nitrate nitrogen	g/m^3N	0.56-2.03	1.23	0.57-1.98	1.34	0.64-2.33	1.57
Total Kjeldahl nitrogen	g/m^3N	0.05-1.69	0.27	0.11-1.34	0.33	0.10-6.82	0.46
Total nitrogen	g/m^3N	0.66-3.24	1.62	0.72-2.98	1.80	0.92-7.90	2.08
Turbidity	NTU	0.9-41	2.4	1.0-36	3.0	2.5-42	5.8

Selected parameters' median values have indicated an approximate two and a half times dilution of the Mangawhero Stream flow by the flow of the Waingongoro River over this four year sampling period which included four summers during which Riverlands Eltham Ltd's meatworks treated wastes were discharged to land irrigation.

Median nutrient concentrations in the Mangawhero Stream post-diversion of WWTP wastes have reduced by 22% to 87%, with total nitrogen and total phosphorus lower by 33% and 77% respectively.

All the principal nutrient species showed small increases in the main river below the Mangawhero Stream confluence with these increases very much reduced subsequent to the diversion of the Eltham WWTP discharge out of the Mangawhero Stream. Median concentrations indicated downstream increases in individual nutrient species in the main river varying between 0% and 27% (lower by 1% to 133% since wastes diversion), with total nitrogen and total phosphorus now increasing by 11% and 6% respectively; reductions of 4% and 90% respectively since diversion of the Eltham WWTP discharge.

2.4.3 Macroinvertebrate and microflora biomonitoring surveys

The Taranaki Regional Council performed reduced spring and late summer biomonitoring surveys in association with the consented overflow discharge from the Eltham wastewater treatment system and adjacent to the old rubbish tip site. In the absence of consented discharges, both surveys were performed to assess anticipated improvements in the biological 'health' of the receiving waters of both the Mangawhero Stream and Waingongoro River subsequent to the diversion of the Eltham WWTP discharge to the Hawera WWTP in mid-2010. Results of these surveys are summarised in Table 9 together with appropriate historical pre-diversion data (from the freshwater biology database). The full reports are included as Appendix II.

Table 9 Summary of the results of 2013-2014 biomonitoring surveys and past (pre-diversion) biomonitoring data (1985-2010)

Site		Macroinvertebrate Fauna									
		Taxa Numbers				MCI values				No of surveys	
		2013-2014 surveys		Wastes diversion		2013-2014 surveys		Wastes diversion			
				Pre	Post			Pre	Post	Pre	Post
No	Code	Nov 13	Feb 14	1985-2010	2010-2014	Nov 13	Feb 14	1985-2010	2010-2014	1985-2010	2010-2014
Mangawhero Stream											
1	MWH000380	17	17	10-25 [16]	12-24 [16]	74	76	58-85 [73]	74-85 [77]	41	8
5	MWH000490	22	30	13-25 [19]	16-30 [23]	93	92	63-86 [77]	84-102 [91]	36	8
Waingongoro River											
6	WGG000620	-	21	16-35 [27]	19-28 [22]	-	116	77-105 [91]	96-116 [104]	25	4
7	WGG000640	-	28	17-35 [26]	21-31 [27]	-	109	78-100 [91]	105-109 [107]	24	4
8	WGG000665	15	27	14-30 [21]	15-27 [19]	109	96	77-105 [93]	96-111 [105]	32	8

[Note: [ ] = median]

The spring survey, performed under moderately low recession flow conditions, some three years after diversion of the wastes, concluded that macroinvertebrate community richnesses were slightly lower or similar to past median taxa numbers but the MCI scores were much higher than past medians and nearer to historical maxima at downstream sites in the Mangawhero Stream and Waingongoro River. A significant improvement was found in MCI score between the two stream sites in a downstream direction. Greater abundances of certain 'highly' and 'moderately sensitive' taxa, which might be expected to be present at the 'better' physical habitat of site 5, 3km downstream of the wastewater treatment plant's discharge outfall, were indicative of improved physicochemical water quality conditions at the time of this survey. The MCI and $SQMCI_s$ scores recorded in the Waingongoro River downstream of the Mangawhero Stream confluence were indicative of improved water quality below the confluence which was dissimilar to trends frequently found by previous surveys during wastewater discharges and more often under lower flow conditions. Improvement in physicochemical water quality and the associated macroinvertebrate faunal communities in the Mangawhero Stream and Waingongoro River associated with the diversion of the discharge out of the catchment to the Hawera WWTP were recorded by this survey some three years after wastewater diversion. No impacts of leachate from the old landfill to the Mangawhero Stream were indicated by this spring survey.

The late summer survey was performed during very low flow conditions in the Mangawhero Stream and in the Waingongoro River some three and a half years after the diversion of the Wastewater Treatment Plant's wastes out of the Mangawhero Stream by way of the constructed pipeline to the Hawera WWTP.

This survey was the fourteenth summer survey since the willow removal work had been undertaken in the stream through the reach below the SH3 culvert resulting in some physical stream habitat improvements to the mid-reaches of the stream below the wastes discharge.

Macroinvertebrate richness and MCI values found in the lower reaches of the Mangawhero Stream were influenced by the improved physicochemical water quality conditions despite very low flow conditions following removal of the wastewater discharge from the catchment. Aspects of community composition (particularly moderate $SQMCI_s$ values and higher MCI scores) emphasised these improvements in physicochemical water quality conditions downstream of the Eltham wastewater treatment system discharge outfall. These improvements were most apparent at the furthest downstream site, where recovery in community composition also was coincident with the improvement in physical habitat and dilution provided by the Mangawharawhara Stream tributary to the extent that the highest taxa richness and significantly higher than median MCI score were recorded for the twenty-nine years of monitoring to date.

The diversion of the discharge from the Eltham Wastewater Treatment Plant (to the Hawera WWTP) have resulted in improvements in the microfloral streambed communities in the Mangawhero Stream downstream of the discharge outfall in the mid-reaches of the stream where previously, protozoan growths frequently were attached to the harder components of the substrate under conditions of low receiving water dilution rates. At the time of the late summer survey, no growths of heterotrophic organisms were found at the downstream site in the Mangawhero Stream nor at any of the sites in the Waingongoro River.

Relatively similar biological communities were recorded in the Waingongoro River between the upstream site and the two sites downstream of the Mangawhero Stream confluence under very low, late summer flow conditions. Minimal significant differences in individual taxon abundances occurred in this reach of the main river and $SQMCI_s$ scores showed atypical downstream increases. Improvements in MCI scores, compared with historical data, at the two sites downstream of the Mangawhero Stream confluence, more particularly at the site immediately downstream, were coincident with physicochemical water quality improvement and consistent with scores recorded since diversion of the Eltham WWTP discharge out of the catchment.

Both surveys confirmed that anticipated improvements in physicochemical water quality and the macroinvertebrate faunal communities of the Mangawhero Stream following the removal of the wastewater discharge out of the Mangawhero Stream catchment (to the Hawera WWTP) continued to be apparent, and extended into the mid-Waingongoro River downstream of the Mangawhero Stream confluence.

More recently, statistical temporal trend analyses of macroinvertebrate data collected over the 18-year period from 1995 to 2013 (Stark and Fowles, 2006 and TRC, 2014a) have identified significant temporal trends of improvement (increasing MCI scores) at the downstream Mangawhero Stream (Figure 5) and Waingongoro River at Stuart Road (Figure 6) sites which were also both ecologically significant.

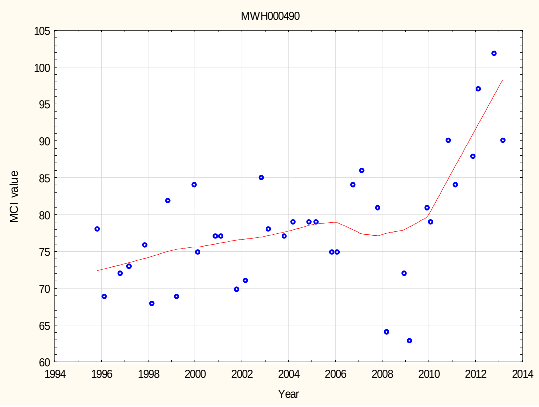

Figure 5 Trend in MCI at the Mangawhero Stream site downstream of the Mangawharawhara Stream confluence (MWH000490)

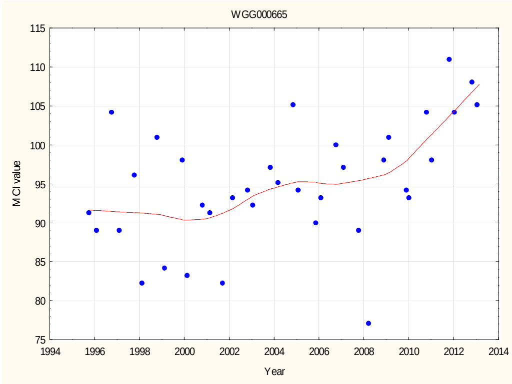

Figure 6 Trend in MCI at the Stuart Road site in the Waingongoro River (WGG00065)

The biological 'health' at both of these sites have improved by one band in MCI grading over this period. These trends have become apparent particularly since the diversion of the wastewater from the catchment (i.e. post July 2010).

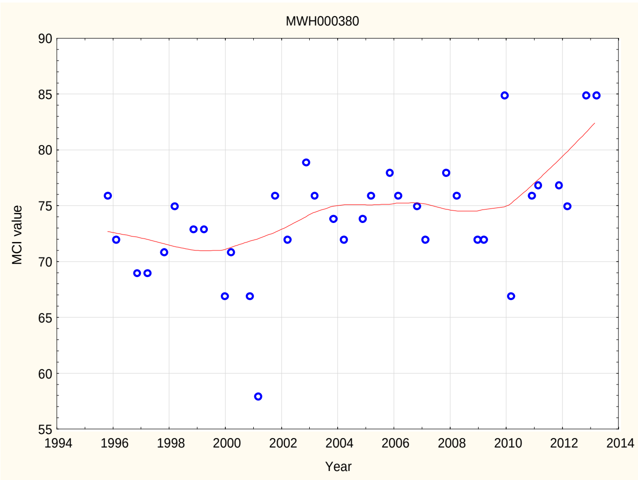

Figure 7 Trend in MCI at the Mangawhero Stream site upstream of the WWTP outfall (MWH000380)

A more steady significant improving trend has been detected at the upstream Mangawhero Stream site (Figure 7), which, however has not been of ecological significance, and the MCI gradation of 'health' altered by one category only in the last year of this period (TRC, 2014).

3. Discussion

3.1 Discussion of plant performance

Most aspects of plant performance and normal maintenance were compliant during the 2013-2014 year, with good liaison maintained between the consent holder and the Council. However, issues related to the disposal of additional dairy wastes (buttermilk) within the previously redundant EADER resulted in breaches of the Taranaki Regional Air Quality Plan.

The adoption of the option for the cessation of the discharge to the Mangawhero Stream and transfer, by pipeline, of the wastes for ocean outfall discharge via the Hawera WWTP wastewater treatment system involved the construction of the pipeline and associated pumping station, which began during the 2008-2009 monitoring period, was completed in June 2010 with diversion of the primary treated wastes to the Hawera WWTP. Conversion of the wetland to the storage pond component was completed in early 2011. A consent for infrequent overflow discharges from the storage pond was granted in November 2009.

No overflows from the storage pond have occurred since the installation of the diversion pipeline, and it has seldom been necessary to utilise the storage pond at all. Brief duration overflows to the storage pond occurred on two occasions during the 2011-2012 period after which wastewater was pumped back into the primary pond but no such overflows occurred during the 2012-2013 or 2013-2014 periods. Stormwater may accumulate in this pond for brief periods following wet weather.

The Eltham wastewater treatment system was well maintained during the twelve month monitoring period and as no overflows occurred from the primary pond to the holding pond, there were no consented discharges to the stream. Relatively low dissolved oxygen concentrations were recorded in the primary pond through the period; lower than normal on occasions due to additional dairy industrial wastes loadings placed upon the system. Odours were occasionally noticeable but generally slight at some locations about the WWTP, under normal pond operational conditions during the period. However, significant odour issues resulting from the on site buttermilk storage and disposal caused more than 150 odour complaints from within the township and breached the Regional Air Quality Plan at times.

3.2 Environmental effects of exercise of water permits

Past significant impacts on the receiving water quality of the Mangawhero Stream and to a lesser effect on the Waingongoro River downstream of the confluence with the Mangawhero Stream, have been alleviated with the pipeline diversion of the wastewater to the Hawera WWTP. No physicochemical surveys were required as no overflows occurred to the Mangawhero Stream. However, monthly sampling of the lower reach of the Mangawhero Stream and mid-reaches of the Waingongoro River, confirmed marked improvements in water quality (e.g. nutrient reduction) in the absence of the wastewater discharge.

Significant improvements in the macroinvertebrate fauna and the flora of the Mangawhero Stream below the original discharge outfall were also recorded during spring and summer low flow conditions. No significant impacts were recorded on the Waingongoro River below the Mangawhero Stream confluence with improvements in the macroinvertebrate fauna noted at these sites in comparison with historical (pre-wastes diversion) data. State of the environment trend monitoring over an eighteen year period has shown significant statistical and ecological improvements in stream and river biological health at both sites downstream of the wastewater outfall which have become particularly apparent subsequent to diversion of the discharge out of the catchment.

Future riparian planting and dairy shed treated wastes land irrigation initiatives combined with the removal of the wastewater discharge from the Mangawhero Stream, overall should continue to contribute to marked improvements in physicochemical and biological water quality of the receiving waters of this stream and consequently, further downstream in the Waingongoro River.

Evaluation of performance

A tabular summary of the South Taranaki District Council's compliance record for the year under review is set out in Table 10.

Table 10 Summary of performance for Consent 7521-1 - discharge of sewage treatment plant wastes to surface water

Condition requirement	Means of monitoring during period under review	Compliance achieved
1. Timing of discharges	Inspections; liaison with consent-holder	Yes (no overflows)
2. Storage capacity provision	Inspections; plant upgrade	Yes (upgrade completed)
3. Limit on plant modifications	Inspections; liaison with consent holder	N/A
4. Reporting overflows	Consent holder records	N/A (no overflows)
5. Avoidance of adverse effects	Inspections; sampling	N/A (no overflows)
6. Immediate advice of discharge	Consent holder reporting	N/A (no overflows)
7. Provision of contingency plan	Liaison with consent holder	Yes
8. Provisions for monitoring	Sampling programme	Yes
9. Review provisions	Not due until June, 2015	N/A
Overall assessment of consent compliance		**High**
Overall assessment of environmental compliance		**High**

The South Taranaki District Council demonstrated a high level of compliance with operational aspects of the resource consent conditions although there were additional wastes loadings on the system during the period as a result of the storage and disposal of buttermilk in the EADER component of the WWTP. The completion of the transfer of wastewater by pipeline to the Hawera WWTP system (in July, 2010), resulted in a high standard of environmental performance (in terms of the

Mangawhero Stream) which was accentuated by no consented overflows to natural water during the period.

However, **very poor performance** in terms of environmental compliance with the Regional Air Quality Plan resulted from the decision to re-utilise the (redundant) EADER component of the WWTP for disposal of significant quantities of surplus buttermilk and also the coincidental period of receipt of untreated dairy industrial wastes directly into the primary aeration pond which compounded odour issues.

The consent granted for the infrequent overflow from the Eltham WWTP storage pond under high intensity rainfall condition came into effect from the time the diversion to the Hawera pipeline was completed.

3.3 Recommendations from the 2012-2013 Annual Report

The previous Annual Report (TRC 2013-31) contained the following recommendations in relation to consents monitoring of the operation of the wastewater treatment plant system:

1. THAT monitoring be continued for the 2013-2014 period by formulation of a suitable monitoring programme, similar in format to that of the 2012-2013 programme, with a minor change to the microfloral component of the inspectorial requirements, designed in conjunction with the requirements of the recently granted consents.

2. THAT regular liaison continues between the consent holder and the Regional Council with respect to monitoring records of primary pond dissolved oxygen levels in relation to aerator effectiveness, and monitoring storage pond levels in general.

3. THAT the consent holder immediately advises the Taranaki Regional Council of any operational problems with the primary pond aerators, and the steps taken to ensure that aerobic conditions are maintained within the ponds' system.

4. THAT the consent holder immediately reports any overflow events to the Taranaki Regional Council as required by Special Conditions 4 and 6 of consent 7521.

5. THAT the Taranaki Regional Council maintains a suitable inspection programme and recording system and reports upon wastes disposal management in the Mangawhero Stream catchment, particularly in respect of agricultural wastes disposal upstream of the WWTP system outfall.

All recommendations were complied with and the consent holder maintained liaison and reporting to the Regional Council in relation to the diversion of the wastewater out of the Mangawhero Stream. The requisite consent granted for occasional overflow of treated wastes from the upgraded system to the Mangawhero Stream was operative but was not utilized during the period. Timely advice was received from the consent holder in relation to one incident of aerator issues in the primary pond (required by Recommendation 3). The Regional Council continued inspections of waste disposal practices in the upstream catchment of the Mangawhero Stream (by way of the regular annual round of dairy shed inspections), as required by Recommendation 5, with follow-up inspections where necessary and internal reporting within the existing consents' database. The (reduced) monitoring programme was performed as scheduled by the Regional Council in recognition of the significant upgrade to the waste disposal system but significant increased monitoring and/or complaint responses were required subsequent to the buttermilk disposal incident.

3.4 Alterations to the monitoring programme for 2014-2015

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

Some alterations to the more intensive pre-2010 monitoring programme were made for subsequent periods as the alternative wastes disposal pipeline had been completed and was almost completely operational at the end of the 2009-2010 period. These alterations included:

- no further wetland wastewater analyses;
- a reduction in inspection frequency from six to four inspections over the twelve month period (including odour surveys);
- no summer low flow receiving water/wastewater discharge physicochemical survey;
- a reduction in the number of sites biomonitored during the summer period; the remaining biomonitoring component designed to assess the recovery in biological ‘health’ in both catchments, whilst maintaining consistency with state of the environment protocols.

It is intended that this programme be retained for future compliance monitoring purposes including the minor change to the microfloral monitoring of the pond system instigated in the 2013-2014 period where chlorophyll-a analyses replaced the requirement for detailed phytoplankton evaluation at the time of each inspection.

3.5 Exercise of optional review of consent

Resource consent 7521 provides for an optional review in June 2015. Based upon the high standard of performance of the pipeline diversion of the treated wastewater to the Hawera WWTP and the almost total non-usage of the holding pond, together with a record of no consented overflows to the receiving waters of the Mangawhero Stream, it is considered that there are no grounds requiring this review to be pursued. The next operational review provided by Special Condition 9 of consent 7521 is in June 2017.

4. Recommendations

As a result of the 2013-2014 monitoring programme for consent 7521 the following recommendations are made:

1. THAT monitoring be continued for the 2014-2015 period by formulation of a suitable monitoring programme, similar in format to that of the 2013-2014 programme designed in conjunction with the requirements of the recently granted consent.

2. THAT regular liaison continues between the consent holder and the Regional Council with respect to monitoring records of primary pond dissolved oxygen levels in relation to aerator effectiveness, and monitoring storage pond levels in general.

3. THAT the consent holder immediately advises the Taranaki Regional Council of any operational problems with the primary pond aerators, and the steps taken to ensure that aerobic conditions are maintained within the ponds' system.

4. THAT the consent holder immediately reports any overflow events to the Taranaki Regional Council as required by Special Conditions 4 and 6 of consent 7521.

5. THAT the Taranaki Regional Council maintains a suitable inspection programme and recording system and reports upon wastes disposal management in the Mangawhero Stream catchment, particularly in respect of agricultural wastes disposal upstream of the WWTP system outfall.

6. THAT the consent holder liaises with the Taranaki Regional Council in advance of any proposals for significant additional industrial wastes disposal into the Eltham WWTP system.

7. THAT the consent holder monitors authorised trade wastes connections to the sewerage reticulation in terms of ensuring that waste loadings placed upon the WWTP do not compromise the operation of that system thereby resulting in possible non-compliance with its resource consent and/or the Regional Air Quality Plan.

5. Acknowledgements

The Job Manager for the programme was Chris Fowles (Scientific Officer) who was the author of this Annual Report and also performed the macroinvertebrate surveys. Field inspections were undertaken by Ray Harris (Technical Officer) with physicochemical wastewater analyses performed by the Taranaki Regional Council ISO-9000 accredited laboratory.

Responses to the many odour complaints were undertaken by several members of the Investigating Officers staff.

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.
CBOD	Carbonaceous biochemical oxygen demand. A measure of the presence of degradable organic matter, excluding the biological conversion of ammonia to nitrate.
cfu	Colony forming units (nos/100 ml). A measure of the concentration of bacteria.
CONDY	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
Cr*	Chromium.
DO	Dissolved oxygen.
DRP	Dissolved reactive phosphorus.
EADER	Earthern Anaerobic DigestER.
E.coli	*Escherichia coli,* an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as the number of colonies per 100 ml.
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as the number of colonies per 100 ml.
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as the number of colonies per 100 ml.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
g/m^3	Grammes per cubic metre, and equivalent to milligrammes per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
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.
l/s	Litres per second.
MCI	Macroinvertebrate community index; a numerical indication of the state of biological life in a stream that takes into account the sensitivity of the taxa present to organic pollution in stony habitats.
MfCI	Microflora community index; a numerical indication of the state of treatment pond biological life which takes into account the sensitivity of floral taxa to wastewater quality.

MOW 'rock' test	Observations of any plume associated with a solid object lobbed into the treatment pond.
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).
NO_3	Nitrate, normally expressed in terms of the mass of nitrogen (N).
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	Measurement of both physical properties(e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment.
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15)
RMA	Resource Management Act 1991 and subsequent amendments.
SS	Suspended solids.
Taxon	A group of animals.
Temp	Temperature, measured in °C (degrees Celsius).
Turb	Turbidity, expressed in NTU.
UI	Unauthorised Incident.
UIR	Unauthorised 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.
Zn*	Zinc.

*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

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Appendix I

Resource consents held by South Taranaki District Council

TARANAKI
REGIONAL
COUNCIL

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

Please quote our file number
on all correspondence

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

Name of Consent Holder:	South Taranaki District Council Private Bag 902 HAWERA 4640
Consent Granted Date:	10 November 2009

Conditions of Consent

Consent Granted:	To discharge, as a consequence of high rainfall, partially treated wastewater from the Eltham Wastewater Treatment Plant into an unnamed tributary of the Mangawhero Stream in the Waingongoro catchment at or about (NZTM) 1712439E-5633480N
Expiry Date:	1 June 2027
Review Date(s):	June 2015, June 2017, June 2021
Site Location:	Castle Street, Eltham
Legal Description:	Pt Lot 3 DP 1564 Lot 9 DP 2321
Catchment:	Waingongoro
Tributary:	Mangawharawhara Mangawhero

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

General conditions

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

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

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

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

Special conditions

1. The discharge shall only occur as a consequence of high rainfall events when the inflows to the wastewater treatment plant are such that the holding capacity of the treatment plant is exceeded.

2. The total storage capacity of the treatment plant shall be no less than 25,000 cubic metres.

3. The consent holder shall not undertake any modifications to the treatment plant that may result in an increase in the frequency of the discharge.

4. The consent holder shall record the timing and duration of the overflow to the unnamed stream, and report these records to the Chief Executive, Taranaki Regional Council, on request.

5. 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 on the environment from the exercise of this consent.

6. The consent holder shall phone the Taranaki Regional Council immediately after becoming aware of each discharge authorised by this permit, in order to enable the undertaking monitoring of the discharge in accordance with special condition 8.

7. Within three months of the granting of this consent, the consent holder shall prepare and maintain a contingency plan. The contingency plan shall be adhered to in the event of a discharge and shall, to the satisfaction of the Chief Executive, Taranaki Regional Council, detail measures and procedures to be undertaken to avoid, remedy or mitigate the environmental effects of the discharge.

8. Subject to Section 36 of the Resource Management Act [1991], monitoring, including physicochemical, bacteriological and ecological monitoring of the wastewater treatment system and receiving waters shall be undertaken, as deemed reasonably necessary by the Chief Executive, Taranaki Regional Council, to understand the effects of the discharge.

9. In accordance with section 128 and section 129 of the Resource Management Act 1991, the Taranaki Regional Council may serve notice of its intention to review, amend, delete or add to the conditions of this resource consent by giving notice of review during the month of June 2015 and/or June 2017 and/or June 2021, for the purpose of ensuring that the conditions are adequate to deal with any adverse effects on the environment arising from the exercise of this resource consent, which were either not foreseen at the time the application was considered or which it was not appropriate to deal with at the time.

Signed at Stratford on 10 November 2009

For and on behalf of
Taranaki Regional Council

Director-Resource Management

Appendix II

Biomonitoring surveys performed in November 2013 and February 2014

To	Monitoring Manager-Environmental Management, K Brodie
From	Scientific Officer, Chris R Fowles
Report No	CF607
Doc No	1324894
Date	March 2014

Biomonitoring of the Mangawhero Stream and Waingongoro River in relation to South Taranaki District Council's Eltham wastewater treatment plant's discharge and rubbish tip leachate discharge, February 2014

Method

The standard '400 ml kick sampling' technique was used to collect streambed (benthic) macroinvertebrates from two established sampling sites in the Mangawhero Stream on 25 February 2014. Two sites in the Waingongoro River (illustrated in Figure 1) and an additional site, established in the river (site 8) approximately 2 km further downstream for monitoring use in conjunction with the Riverlands Eltham Ltd discharges, and the state of the environment monitoring programme, were also sampled on 25 February 2014.

This survey was performed some three and a half years after commissioning of the pipeline for conveyance of the WWTP wastewater to the Hawera WWTP and the cessation of the discharge of partially treated wastewater into the Waingongoro catchment. No (consented) overflows from the WWTP to the Mangawhero Stream had occurred during this period, nor were occurring at the time of the survey. In recognition of the successful diversion of the wastewater, recent surveys have been reduced (by two sites in the Mangawhero Stream) from the previous intensity (see CF528 and other references) and will continue at this level in order to address temporal stream and river 'health' recovery.

The sites sampled were:

Site No	Site code	GPS reference	Location
1	MWH000380	E1712475 N5633431	Mangawhero Stream: upstream of wastewater treatment plant's discharge
5	MWH000490	E1710795 N5632738	Mangawhero Stream: approximately 200 m downstream of rail bridge
6	WGG000620	E1710708 N5632961	Waingongoro River: approx 150 m upstream of Mangawhero S. confluence
7	WGG000640	E1710554 N5632790	Waingongoro River: approx 200 m downstream of Mangawhero S. confluence
8	WGG000665	E1709784 N5632049	Waingongoro River: approx 2 km downstream of Mangawhero S. confluence (off Stuart Road)

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:

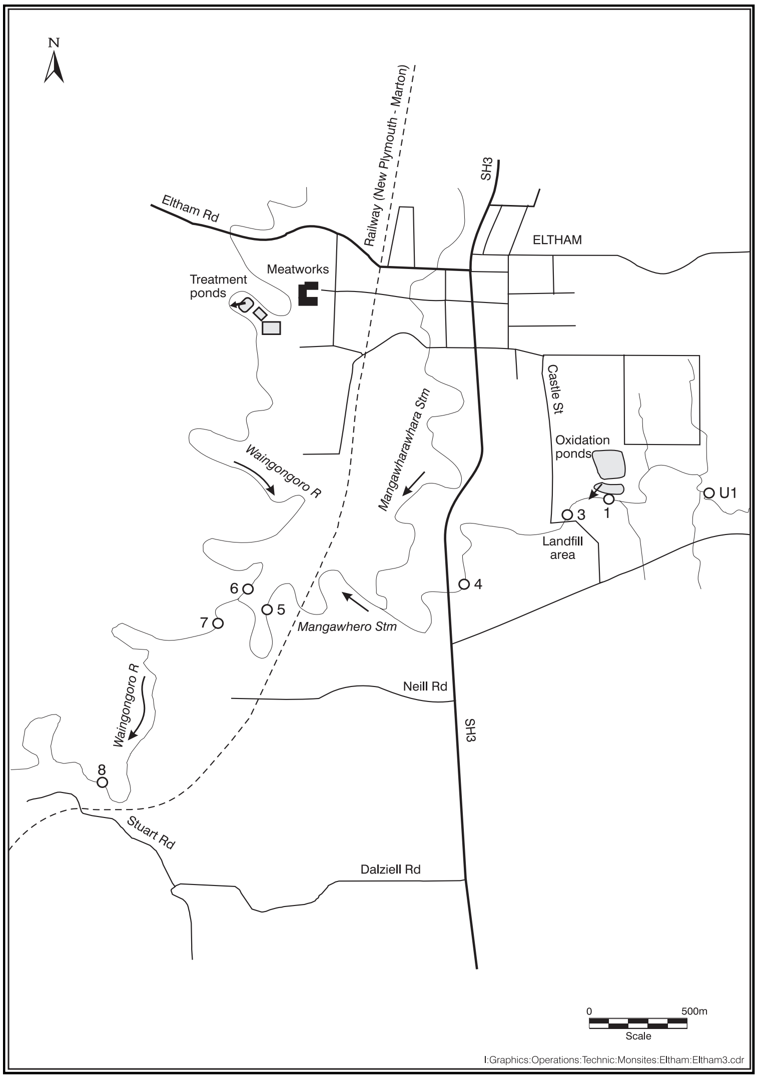

Figure 1 Biomonitoring site locations in the Mangawhero Stream and Waingongoro River in relation to Eltham wastewater treatment plant and landfill [Note: sites 1, 5, 6, 7 and 8 used in current survey]

Figure 2 Location of biomonitoring sites in relation to the Eltham WWTP and landfill

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

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

A semi-quantitative MCI value, $SQMCI_S$ (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 were also taken from the macroinvertebrate samples and were scanned under 40-400x magnification to determine the presence or absence of any mats, plumes or dense growths of bacteria, fungi or protozoa (‘undesirable biological growths’) at a microscopic level. The presence of these organisms is an indicator of organic enrichment within a stream.

Results and discussion

This late summer survey was performed under very low flow conditions in the Mangawhero Stream some 35 days after a significant fresh in this stream. The stream was dirty and brownish in appearance upstream of the wastewater treatment plant’s outfall, where there was patchy aquatic vegetation at the stream margins. However, in the absence of any wastes discharge the appearance was slightly cloudy but uncoloured at the swifter, low flowing, harder substrate of site 5 below the Mangawharawhara Stream confluence where there were sparse beds of aquatic vegetation only at the margins of the stream channel. Stream water temperatures ranged from 15.4˚C to 15.8˚C during this mid-morning survey. Thin periphyton mats and patchy moss but no filamentous algae were present at site 1 and mats, filamentous green algal growth, and moss were patchy at site 5, with aquatic weed at the edges of sites 1 & 5. No ‘sewage fungus’ was noticeable on the hard substrate at either of the two sites.

A very low recession flow (0.45 m^3/sec) was recorded in the Waingongoro River at Eltham Road at the time of the survey which occurred 34 days after a fresh in excess of three times median flow and 51 days after a fresh in excess of seven times median flow. The river was clear and uncoloured upstream of the Mangawhero Stream confluence and also downstream of the confluence and at Stuart Road (site 8) during a very dry period. The river flow was much lower than the average mean monthly flow (1.40 m^3/sec) for February but slightly in excess of the minimum mean monthly flow (0.390m^3/sec) for the period 1975 to 2013. River temperatures ranged from 16.4°C to 17.1°C at sites 6, 7, and 8 at the time of this late morning survey. Thin periphyton mats and patchy filamentous algae were recorded at all three sites and patchy moss was found only at site 8.

Macroinvertebrate communities

The results of past biomonitoring surveys performed at the various river and stream sites prior to WWTP wastes diversion and surveys since this diversion are summarised in Table 1 and illustrated in Figures 3 and 4.

Table 1 Summary of macroinvertebrate taxa numbers and MCI values for previous surveys performed between January 1985 and November 2013

Site	Pre-diversion (Jan 1985 to July 2010)					Post-diversion (Nov 2010 to Nov 2013)				
	No. of Surveys	Taxa Numbers		MCI Values		No. of Surveys	Taxa Numbers		MCI Values	
		Range	Median	Range	Median		Range	Median	Range	Median
1	41	10-25	16	58-85	73	7	12-24	15	74-85	77
3	25	6-22	15	47-72	61	1	-	16	-	79
4	23	8-18	14	48-74	60	1	-	19	-	74
5	36	13-25	19	63-86	77	7	16-29	22	84-102	90
6	25	16-35	27	77-105	91	3	19-28	27	96-106	102
7	24	17-35	26	78-100	91	3	21-31	26	105-108	106
8	32	14-30	21	77-105	93	7	15-27	18	98-111	105

The macroinvertebrate fauna recorded at the two Mangawhero Stream sites (1 and 5) and three Waingongoro River sites (6, 7 and 8) are presented in Tables 2 and 3 respectively.

Mangawhero Stream: Site 1 (upstream of wastewater treatment plant's wetlands discharge and upstream of the old rubbish tip)

The flow at this site was very low, dirty, brown, and swift. The relatively channelised habitat was comprised of thin periphyton mats, no filamentous algae, and patchy moss on a mainly hard clay substrate with some silt. The riparian vegetation planting was well established since being undertaken along the stream banks subsequent to the drain clearance work about fifteen years previously and provided partial shading of the stream.

A average taxa richness (17 taxa) was recorded, one taxon more than the median richness recorded by 48 previous surveys at this site (Table 1). No 'highly sensitive' taxa were found at this site, with the fauna characterised by three 'tolerant' taxa [oligochaete worms, net-building caddisfly (*Aoteapsyche*), and sandfly (*Austrosimulium*)]; and two 'moderately sensitive' taxa [extremely abundant amphipod (*Paracalliope*); and mayfly (*Austroclima*)]. Several of these dominant taxa and many of the remainder of the fauna found at this site (Table 2) are generalists and often common inhabitants of weedy, sedimented beds, in slower flowing Taranaki streams which may be characterised by moderate physicochemical water quality, particularly when swamp-fed. All of these dominant taxa have been characteristic of this site on at least 40% of previous survey occasions (TRC, 2014). The MCI score (76) was two units above the median of previous surveys' results at this site (Table 1 and Figure 2). This score was within three units of the median score (79) from 169 surveys of small non-ringplain Taranaki streams at 'control' sites within the altitude range from 200 to 249 m asl (TRC 1999 (updated 2013)) and relatively typical of small, weedy, swamp-fed Taranaki streams draining developed farmland catchment and subject to moderate organic enrichment. It also reflected the absence of 'highly sensitive' taxa, typical components of the fauna of higher quality ring plain streams; and the relatively high proportion of 'tolerant' taxa (53% of total taxa) in the community.

Table 2 Macroinvertebrate fauna of the Mangawhero Stream in relation to Eltham WWTP discharge sampled on 25 February 2014

Taxa List	Site Number	MCI score	1	5
	Site Code		MWH000380	MWH000490
	Sample Number		FWB14162	FWB14163
NEMERTEA	Nemertea	3	R	R
ANNELIDA (WORMS)	Oligochaeta	1	A	VA
	Lumbricidae	5	-	R
MOLLUSCA	*Ferrissia*	3	-	R
	Potamopyrgus	4	C	VA
CRUSTACEA	Ostracoda	1	C	-
	Paracalliope	5	XA	XA
	Talitridae	5	-	VA
	Paranephrops	5	-	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	C
	Coloburiscus	7	-	R
	Deleatidium	8	-	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	-	R
COLEOPTERA (BEETLES)	Elmidae	6	-	VA
	Hydraenidae	8	-	R
	Hydrophilidae	5	R	-
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	R	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	VA	XA
	Costachorema	7	-	A
	Hydrobiosis	5	C	A
	Oxyethira	2	R	C
	Pycnocentria	7	-	A
	Pycnocentrodes	5	-	A
DIPTERA (TRUE FLIES)	*Aphrophila*	5	R	C
	Maoridiamesa	3	-	A
	Orthocladiinae	2	C	A
	Polypedilum	3	R	A
	Tanytarsini	3	C	C
	Empididae	3	-	R
	Muscidae	3	-	A
	Austrosimulium	3	A	C
	Tanyderidae	4	-	R
ACARINA (MITES)	Acarina	5	R	-
		No of taxa	17	30
		MCI	76	92
		SQMCIs	4.7	4.6
		EPT (taxa)	3	9
		%EPT (taxa)	18	30
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

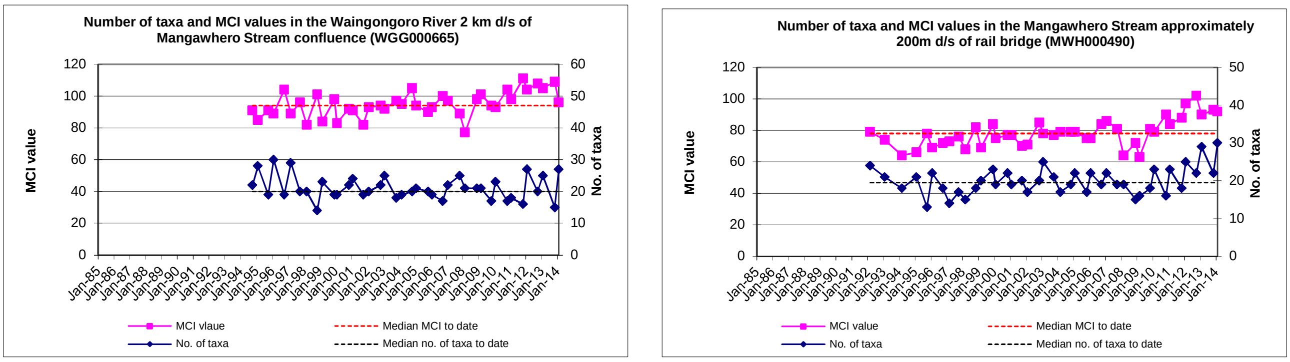

Figure 3 Taxa richness and MCI values for the two Mangawhero Stream sites to date

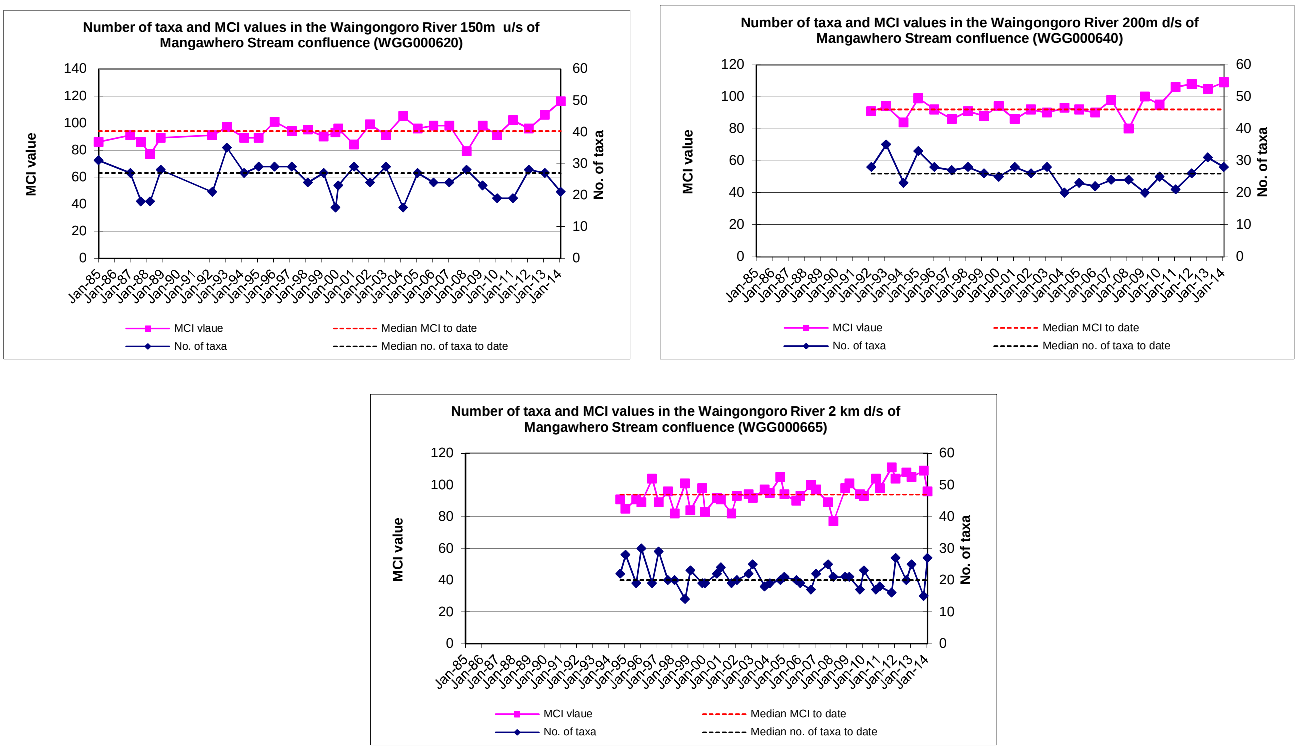

Figure 4 Taxa richness and MCI values for the three Waingongoro River sites to date

Mangawhero Stream: Site 5 (downstream of Mangawharawhara Stream and upstream of Waingongoro River confluences)

The habitat at this site differed significantly from that at the upstream site, with slightly deeper, swifter, open flow over a silt-sandy, gravel, and mainly cobble- boulder substrate, with aquatic weed only present at the margins under summer very low flow conditions. Patchy periphyton mats and filamentous algal growths and moss were present. Some areas of silty, softer sediment were noted in addition to the cobble and boulder substrate. Flow at this site was slightly cloudy but uncoloured in appearance with marked visual improvement compared with conditions recorded prior to Eltham WWTP wastewater diversion from the stream, and partly as a result of the increased dilution by the clearer ringplain Mangawharawhara Stream tributary.

A relatively high taxa richness (30 taxa) was recorded with a much increased richness in comparison with the taxa number at the upstream 'control' site. This taxa number was eleven taxa more than the median number (19 taxa) found from previous surveys prior to wastewater diversion and the highest richness since diversion (Table 1), although rarities contributed 30% of this taxa richness. This richness was also above that recorded by all of the previous surveys (Figure 3) and one higher than the previous maximum recorded (by the summer 2013 survey). A significantly higher MCI value of 92 units was recorded compared to that at the upstream 'control' site. This value was a significant (Stark, 1998) 15 units higher than the median of MCI scores previously surveyed at this downstream site prior to wastewater diversion, reflecting improvement subsequent to wastes diversion out of the reach of the stream below the WWTP outfall. This MCI score (92) was 16 units higher than the score recorded at the 'control' site (1) upstream of the wastewater treatment plant's discharge outfall coincident with very low flow conditions but improved physical habitat conditions and improved physicochemical water quality provided by the Mangawharawhara Stream inflow, sourced on the ringplain. This score categorised the site as having 'fair' stream biological generic health (TRC, 2014) at the time of this survey (compared with a median category of 'poor' health prior to wastewater diversion out of the catchment).

The dominant taxa (Table 2) included seven 'tolerant' taxa [oligochaete worms, snail (*Potamopyrgus*), net-building caddisfly (*Aoteapsyche*), midges (orthoclads, tanytarsids, and *Maoridiamesa*), and muscid flies]; eight 'moderately sensitive' taxa [(amphipods (talitrids and extremely abundant *Paracalliope*), elmid beetles, dobsonfly (*Archichauliodes*), free-living caddisflies (*Hydrobiosis* and *Costachorema*) and stony-cased caddisflies (*Pycnocentrodes* and *Pycnocentria*)]; and one 'highly sensitive' taxon [very abundant mayfly (*Deleatidium*)]. By way of comparison, this was seven more 'sensitive' taxa than were dominant at the time of the summer 2009-2010 survey, which had been preceded by a continuous period of wastewater discharges. The numerical dominance of the community by one 'sensitive' and one 'tolerant' taxa resulted in the moderate $SQMCI_s$ value (4.6 units) which was 1.8 units below the maximum of those recorded by all surveys at this site to date and almost identical to the score recorded upstream at site 1. Certain 'sensitive' taxa, which generally were recorded at this lower stream site in earlier surveys prior to increased loadings on the WWTP, had become more abundant numerically in the macroinvertebrate fauna at the time of this survey. These taxa included two mayfly taxa, dobsonfly (*Archichauliodes*), elmid beetles, and some caddisfly taxa in particular. Conversely, certain 'tolerant' taxa were numerically less abundant or absent when compared with pre-wastes diversion surveys.

Waingongoro River: Sites 6, 7 and 8 (upstream and downstream of the Mangawhero Stream confluence)

All three sites' habitats were characterised by relatively shallow, swift, riffle flows over substrates composed of some silt, sand and gravel, but primarily of cobbles and boulders. Algal mats were thin through the reach surveyed with patchy filamentous green algal growths only at site 8 and patchy moss at site 8.

Table 3 Macroinvertebrate fauna of the Waingongoro River in relation to Eltham WWTP discharge sampled on 25 February 2014

Taxa List	Site Number	MCI score	6	7	8
	Site Code		WGG000620	WGG000640	WGG000665
	Sample Number		FWB14157	FWB14158	FWB14159
ANNELIDA (WORMS)	Oligochaeta	1	-	R	C
MOLLUSCA	*Potamopyrgus*	4	R	R	R
EPHEMEROPTERA (MAYFLIES)	*Ameletopsis*	10	R	-	-
	Austroclima	7	C	A	A
	Coloburiscus	7	A	A	C
	Deleatidium	8	XA	XA	XA
	Nesameletus	9	C	R	-
	Zephlebia group	7	R	R	R
PLECOPTERA (STONEFLIES)	*Megaleptoperla*	9	-	R	-
	Zelandobius	5	-	R	R
	Zelandoperla	8	R	R	-
COLEOPTERA (BEETLES)	Elmidae	6	VA	VA	A
	Ptilodactylidae	8	-	R	-
	Staphylinidae	5	-	-	R
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	A	A	A
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	XA	VA	VA
	Costachorema	7	C	A	A
	Hydrobiosis	5	A	VA	A
	Neurochorema	6	-	-	R
	Psilochorema	6	-	R	-
	Confluens	5	-	R	-
	Pycnocentria	7	C	R	C
	Pycnocentrodes	5	R	R	R
DIPTERA (TRUE FLIES)	*Aphrophila*	5	C	A	A
	Eriopterini	5	R	R	R
	Maoridiamesa	3	C	A	A
	Orthocladiinae	2	R	A	A
	Polypedilum	3	R	-	-
	Tanytarsini	3	-	A	A
	Empididae	3	-	R	R
	Ephydridae	4	-	-	R
	Muscidae	3	-	-	R
	Austrosimulium	3	C	R	C
	Tabanidae	3	-	-	C
	Tanyderidae	4	-	R	R
		No of taxa	21	28	27
		MCI	116	109	96
		SQMCIs	6.0	6.6	6.7
		EPT (taxa)	12	15	11
		%EPT (taxa)	57	54	41
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa			

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

The macroinvertebrate communities recorded at sites 6 and 7 were of relatively good richnesses with a moderate increase in richness in a downstream direction (Table 3) and ranging from 21 to 28 taxa. Sites' taxa numbers near the Mangawhero Stream confluence were below to slightly above median numbers previously recorded (Table 1) and richness at Stuart Road (site 8) was well above historical median richness (Figure 4). MCI values (96 to 116) were significantly higher (two sites) and higher than medians of past surveys' values prior to wastewater diversion out of the catchment (Table 1 and Figure 4) and ten units higher than the historical pre-wastes diversion maximum at site 6 upstream of the Mangawhero Stream confluence and one unit above the historical maximum at site 7 downstream of the confluence despite very low flow conditions preceding the survey. There were very few significant differences in individual taxon abundances between sites, with increases in 'tolerant' midges taxa numbers downstream at site 7 and an increase in a single tolerant' (tabanid) taxon number at site 8. These subtle changes in community composition had minimal influence on the $SQMCI_s$ values which increased by 0.6 unit and 0.7 unit at the sites downstream of the Mangawhero Stream confluence.

No significant changes in MCI scores were recorded between sites immediately adjacent to the Mangawhero Stream confluence with a more typical downstream decrease of 7 units. However, the MCI score found at the Stuart Road site, 2 km further downstream, was a significant 13 units lower than with the score immediately downstream of the Mangawhero Stream confluence. The overall improvement in MCI scores in this reach was typical of the trend found by recent surveys unlike the pre-wastewater diversion surveys which showed decreases downstream of the Mangawhero Stream confluence attributable to deterioration in physicochemical water quality at this site due to the wastewater loadings on this tributary. The current trend was indicative of improvements subsequent to wastes diversion out of the catchment some three and a half years earlier but was somewhat less marked than that found by the two previous summer low flow surveys when river flows were higher.

In general, this 2.5 km reach of the river was characterised by one 'highly sensitive' taxon [extremely abundant mayfly (*Deleatidium*)]; up to seven 'moderately sensitive' taxa [mayflies (*Austroclima* and *Coloburiscus*), elmid beetles, dobsonfly (*Archichauliodes*), caddisflies (*Costachorema* and *Hydrobiosis*), and cranefly (*Aphrophila*)]; and up to four 'tolerant' taxa [net-building caddisfly (*Aoteapsyche*), and midges (orthoclads, tanytarsids, and *Maoridiamesa*)]. These characteristic taxa were typical of those found in the communities in this reach of the river and almost identical in number to those found by the previous summer survey. Comparatively, this summer survey found the same total number of taxa (35) in this reach of the river, of which 17 were recorded at all three sites but with a moderate number (five) of these taxa (one 'highly sensitive', three 'moderately sensitive', and one 'tolerant' taxa) abundant at all sites. All three of the MCI scores recorded over this reach of the river however, were slightly higher than or close to typical scores found during summer flows in the mid-reaches of a river draining developed catchments and receiving point source wastes discharges and agricultural run-off. Taxa richnesses (21 to 28 taxa) were above the median richness (20 taxa) recorded by 358 previous surveys of 'control' sites located between 155 and 199 m asl. in National Park-sourced ringplain streams and rivers (TRC, 1999 (updated 2013)). MCI scores (96 to 116 units) categorised these sites as having 'fair' (site 8) to 'good' generic river health (TRC, 2014) at the time of this late summer survey. These scores ranged from 7 units below to a significant (Stark, 1999) 13 units above predicted MCI scores for National Park-sourced ringplain river 'control' sites at an altitude of 180 m asl and were 2 to a significant 15 to 22 units above predicted scores for such sites between 27 and 30 km downstream of the National Park boundary (Stark and Fowles, 2009).

Microscopic streambed heterotrophic assessment

Mangawhero Stream

No heterotrophic growths were visually apparent in the field at the time of the survey. Where necessary, closer inspection and microscopic analysis of samples from each site showed that there were no mats, plumes or dense growths of heterotrophic organisms at either site in the Mangawhero Stream coincidental with diversion of the wastewater discharge out of the stream.

Waingongoro River

Visual and microscopic analysis of samples from the Waingongoro River showed no evidence of mats, plumes or dense growths of heterotrophic organisms on the river substrate, consistent with diversion of the wastewater treatment plant's discharge out of the Mangawhero Stream (some 4 km upstream of the confluence with the river) three and a half years earlier.

Conclusions

This late summer survey was performed during very low flow conditions in the Mangawhero Stream and in the Waingongoro River coincidental with the diversion of the Wastewater Treatment Plant's wastes out of the Mangawhero Stream by way of the relatively recently constructed pipeline to the Hawera WWTP. This survey was the fourteenth summer survey since the willow removal work had been undertaken in the stream through the reach below the SH3 culvert result which had resulted in some physical stream habitat improvements to the mid-reaches of the stream below the historical wastes discharge.

Macroinvertebrate richness and MCI values found in the lower reaches of the Mangawhero Stream were influenced by the improved physicochemical water quality conditions despite very low flow conditions following removal of the wastewater discharge from the catchment some three and a half years prior to this survey. Aspects of community composition (particularly moderate $SQMCI_s$ value and higher MCI score) emphasised these improvements in physicochemical water quality conditions downstream of the Eltham wastewater treatment system discharge outfall. These improvements were most apparent at the furthest downstream site, where recovery in community composition was also coincident with the improvement in physical habitat and dilution provided by the Mangawharawhara Stream tributary to the extent that the highest taxa richness and the significantly higher than median MCI score was recorded for the twenty-nine years of monitoring to date.

The diversion of the discharge from the Eltham Wastewater Treatment Plant (to the Hawera WWTP) had resulted in improvements in the microfloral streambed communities in the Mangawhero Stream downstream of the discharge outfall in the mid-reaches of the stream where previously, protozoan growths frequently were attached to the harder components of the substrate under conditions of low receiving water dilution rates. At the time of the current survey, no growths of heterotrophic organisms were found at the downstream site in the Mangawhero Stream nor at any of the sites in the Waingongoro River.

Relatively similar biological communities were recorded in the Waingongoro River between the upstream site and the two sites downstream of the Mangawhero Stream confluence under very low, late summer flow conditions. Minimal significant differences in individual taxon abundances occurred in this reach of the main river and $SQMCI_s$ scores showed atypical downstream increases. Improvements in MCI scores, compared with historical data, at the two sites downstream of the Mangawhero Stream confluence, more particularly at the site immediately downstream, were coincident with physicochemical water quality improvement and consistent with scores recorded since diversion of the Eltham WWTP discharge out of the catchment.

Summary

The Council's standard 'kick-sampling' technique was used at two established sites to collect streambed macroinvertebrates from the Mangawhero Stream and at three established sites in the Waingongoro River. Samples were sorted and identified to provide number of taxa (richness) and MCI and SQMCIs scores 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 $SQMCI_s$ between sites may indicate the degree of adverse effects (if any) of the discharges being monitored.

This late summer macroinvertebrate survey during a period of very low recession flow indicated that the diversion of treated wastewater from the Eltham WWTP out of the stream to the Hawera WWTP had resulted in a marked improvement in the macroinvertebrate community at the downstream site in the lower reaches of the Mangawhero Stream. Changes in the macroinvertebrate communities were recorded between the upstream 'control' site and the site nearly 3 km downstream of the original WWTP discharge outfall near the confluence with the Waingongoro River, coincident with improvements in aesthetic aspects of physicochemical water quality. Macroinvertebrate communities were of better 'health' than prior to wastes diversion. As a result of diversion of the wastewater discharge out of the catchment, a marked improvement in the MCI score was recorded and there was no visual or microscopic evidence of 'heterotrophic growths' on the stream substrate (which have often been associated with summer, warmer, low flow conditions during wastewater discharges).

The macroinvertebrate communities of the Mangawhero Stream contained a relatively high proportion of 'tolerant' taxa at both sites, but with a downstream increase in 'sensitive' taxa since wastes diversion with numerical dominance by a 'highly sensitive' taxon and an increased number of 'moderately sensitive' taxa at the downstream site where the community was also comprised of an increased proportion of more 'sensitive' taxa. Taxonomic richness (number of taxa) was average to high at the time of this summer survey coincident with thin to patchy periphyton mats and limited filamentous algal cover, and a marked decrease in aquatic weed growth at the site downstream of the WWTP outfall where a much higher community richness was present.

MCI scores indicated that the Mangawhero Stream communities were of 'poor' to 'fair' generic health at both the upstream 'control' site and at the furthest downstream site respectively, and more typical of the condition recorded in equivalent reaches of similar Taranaki streams.

No impacts of leachate from the old landfill on the macroinvertebrate community of the lower Mangawhero Stream site were indicated by the results of this summer survey in the absence of any wastewater discharge to the stream.

The macroinvertebrate communities found in the Waingongoro River below the Mangawhero Stream confluence showed improved $SQMCI_s$ and MCI scores and generally were consistent with those scores found through the surveyed reach of the river (in association with Riverlands meatworks (CF606)) further upstream of the confluence. Scores were less typical of the deteriorating downstream trend found by most past pre-wastes diversion surveys, and reflected the improvements in physical and physicochemical habitats associated with removal of the Eltham WWTP wastewater discharge from the Mangawhero Stream.

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To	Keith Brodie, Environmental Monitoring Manager
From	Chris Fowles, Scientific Officer
Document	1305858
Report	CF594
Date	3 February 2014

Biomonitoring of the Mangawhero Stream and Waingongoro River in relation to the South Taranaki District Council's Eltham Wastewater Treatment Plant System and Rubbish Tip leachate discharge, November 2013

Introduction

This spring survey was the first of two surveys programmed for the 2013-2014 monitoring period. Since summer 2011, biomonitoring surveys in the Mangawhero Stream have been reduced from four sites to two sites in recognition of the minimal usage of the WWTP consented overflow facility to the Mangawhero Stream in recent years. No overflows to the stream have occurred since this time.

These sites have also been incorporated within the Council's State of the Environment monitoring programme (TRC, 2014).

Method

The standard '400 ml kick sampling' technique was used to collect streambed (benthic) macroinvertebrates and algae from two established sampling sites (sites 1 and 5) in the Mangawhero Stream and one site (site 8) in the Waingongoro River (illustrated in Figure 1) on 13 November 2013.

This survey was the eighteenth spring biomonitoring programme coincident with riparian planting of the Mangawhero Stream banks and stream willow clearance work over the past several years. It was performed some three years after commissioning of the pipeline for conveyance of the Eltham WWTP wastewater to the Hawera WWTP and the cessation of the discharge of partially treated wastewater into the Waingongoro catchment. No (consented) overflows from the WWTP to the Mangawhero Stream had occurred during this period.

These sites were:

Site No	Site code	Map reference	Location
1	MWH000380	Q20: 227 952	Mangawhero Stream: upstream of WWTP discharge outfall
5	MWH000490	Q20: 210 946	Mangawhero Stream: approximately 200 m downstream of rail bridge and downstream of the Mangawharawhara Stream confluence
8	WGG000665	Q20: 199 937	Waingongoro River: approximately 2 km downstream of Mangawhero Stream confluence

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).

Figure 1 Aerial location map of biomonitoring site locations in the Mangawhero Stream and Waingongoro River in relation to Eltham WWTP and landfill

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

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

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

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

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

Results and discussion

This spring survey was performed under moderately low recession flow conditions, 12 days after a significant fresh in the Mangawhero Stream and 12 days after a fresh in excess of 3 times and 7 times the median flow in the Waingongoro River. The survey followed a wet early spring period with five significant river freshes recorded over the preceding month. The low flow in the Mangawhero Stream was clear and pale brownish in appearance upstream of the discharge outfall (site 1) and slightly cloudy but uncoloured at the downstream, swifter flowing site 5. Filamentous algae were patchy on the clay substrate site (1) with no periphyton mats but some marginal aquatic weed. Periphyton mats and filamentous algae were patchy on the stony, harder substrate site (5) where there was no moss but some marginal aquatic weed present (unlike the more extensive weed beds prior to wastewater diversion out of the stream). Stream water temperatures ranged from 12.7°C (site 1) to 12.9°C (site 2) during this mid morning survey.

Flow in the Waingongoro River at Eltham Road was 1.44 m^3/sec at the time of the survey, below the average monthly mean flow (2.44 m^3/sec) for November, and well above the minimum monthly mean flow (0.87 m^3/sec). River flow was moderately low, clear, and uncoloured at the sampling site with patchy periphyton mats but no filamentous algal growth, or moss, present on the substrate. Water temperature was 13.6°C at the time of this mid morning survey.

Macroinvertebrate communities

The results of past biomonitoring surveys performed at the various established stream sites are summarised in Table 1 and illustrated in Figure 2.

Table 1 Summary of macroinvertebrate taxa numbers and MCI values for previous surveys performed between January 1985 and February 2013

Site	Site code	No. of surveys	Taxa numbers		MCI values	
			Range	Median	Range	Median
1	MWH000380	47	10-25	16	58-85	74
5	MWH000490	42	13-29	19	63-102	78
8	WGG000665	38	14-30	20	77-111	94

The macroinvertebrate fauna recorded by the current survey at each of the three sites are presented in Table 2.

Table 2 Macroinvertebrate fauna of the Mangawhero Stream (sites 1 and 5) in relation to the Eltham WWTP, sampled on 13 November 2013

	Site Number	MCI score	1	5
	Site Code		MWH000380	MWH000490
	Sample Number		FWB13293	FWB13294
COELENTERATA	Coelenterata	3	R	-
NEMERTEA	Nemertea	3	R	-
NEMATODA	Nematoda	3	R	-
ANNELIDA (WORMS)	Oligochaeta	1	XA	XA
MOLLUSCA	*Potamopyrgus*	4	R	A
CRUSTACEA	*Paracalliope*	5	R	VA
	Paraleptamphopidae	5	R	-
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	A	C
	Coloburiscus	7	-	R
	Deleatidium	8	-	VA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	R	A
COLEOPTERA (BEETLES)	Elmidae	6	-	VA
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	-	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	C	A
	Costachorema	7	-	C
	Hydrobiosis	5	C	C
	Oxyethira	2	R	R
	Pycnocentria	7	-	C
	Pycnocentrodes	5	-	VA
DIPTERA (TRUE FLIES)	*Aphrophila*	5	A	C
	Maoridiamesa	3	C	A
	Orthocladiinae	2	A	A
	Polypedilum	3	R	R
	Tanytarsini	3	-	C
	Empididae	3	-	R
	Austrosimulium	3	R	R
		No of taxa	17	22
		MCI	74	93
		SQMCIs	1.5	3.3
		EPT (taxa)	4	9
		%EPT (taxa)	24	41
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa		

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

Table 3 Macroinvertebrate fauna of the Waingongoro River at Stuart Road (site 8) in relation to the Eltham WWTP, sampled on 13 November 2013

Taxa List	Site Number	MCI score	8
	Site Code		WGG000665
	Sample Number		FWB13290
MOLLUSCA	*Potamopyrgus*	4	R
EPHEMEROPTERA (MAYFLIES)	*Austroclima*	7	C
	Coloburiscus	7	C
	Deleatidium	8	XA
PLECOPTERA (STONEFLIES)	*Zelandobius*	5	C
COLEOPTERA (BEETLES)	Elmidae	6	A
MEGALOPTERA (DOBSONFLIES)	*Archichauliodes*	7	C
TRICHOPTERA (CADDISFLIES)	*Aoteapsyche*	4	A
	Costachorema	7	C
	Hydrobiosis	5	R
	Beraeoptera	8	A
	Pycnocentrodes	5	VA
DIPTERA (TRUE FLIES)	Tanytarsini	3	R
	Austrosimulium	3	R
	Tabanidae	3	R
		No of taxa	15
		MCI	109
		SQMCIs	7.3
		EPT (taxa)	9
		%EPT (taxa)	60
'Tolerant' taxa	'Moderately sensitive' taxa	'Highly sensitive' taxa	

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

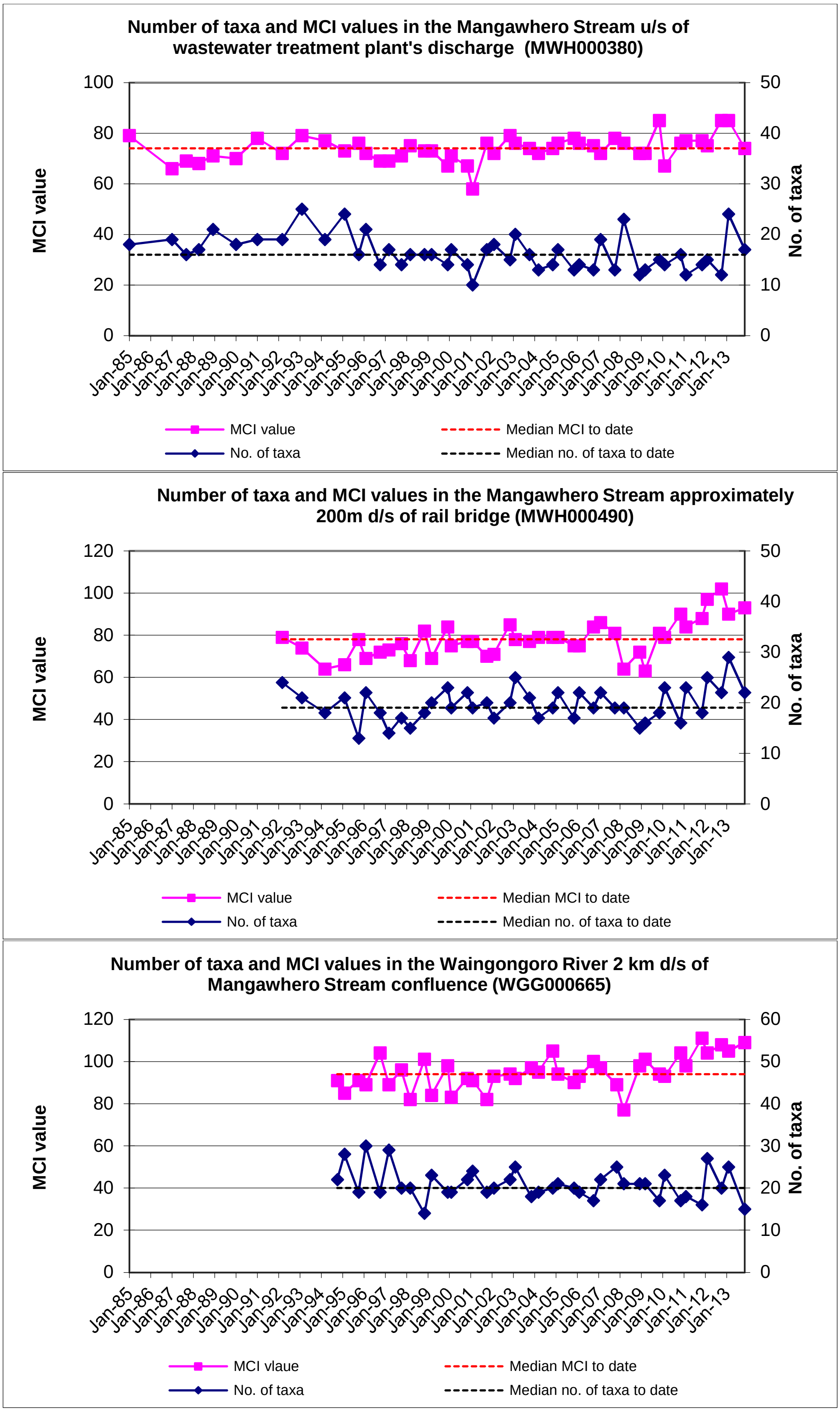


Figure 2 Taxa richness and MCI scores recorded to date

Mangawhero Stream: site 1 (upstream of the WWTP outfall) and site 5 (downstream of Mangawharawhara Stream confluence; approx 3 km below the WWTP outfall and old landfill)

Each of these two sites has a very different habitat and, together with the deterioration in water quality downstream of the Eltham Wastewater Treatment Plant's discharge in the past, these factors have been reflected in the macroinvertebrate communities found at each site on the majority of occasions prior to the current survey (i.e. until mid 2011).

At the time of the current survey this upstream site (1) was dominated by two 'moderately sensitive' taxa [mayfly (*Austroclima*) and cranefly (*Aphrophila*)] and two 'tolerant' taxa [extremely abundant oligochaete worms; and orthoclad midges]. Each of these taxa had also been dominant in a majority of previous spring surveys with the number of characteristic taxa in this survey slightly lower than typical of most past surveys.

Although sections of the stream at this upstream site were slower flowing, swifter velocities were apparent amongst areas where no filamentous algae were attached to the substrate of the stream. Some of the dominant taxa and other components of the fauna found at this site are commonly found in these types of habitat (e.g. amphipods, midges), and the abundances of the mayfly, *Austroclima* and the presence of other 'sensitive' taxa continued to indicate reasonably well oxygenated flow conditions as a component of this habitat. Taxa richness (17) was very similar to the median number recorded from previous surveys (Table 1). The survey recorded a MCI value of 74 units which was equal with the median of all past survey results and relatively typical of a small swamp seepage stream subject to moderate nutrient enrichment from developed farmland drainage. The score reflected the absence of 'highly sensitive' taxa and the presence of a high percentage of 'tolerant' taxa (65% of richness) in the community at this site. This score was slightly lower than the median value (79 units) found by 169 surveys of 'control' sites in similar seepage sourced hill country streams in the region (TRC, 1999 (updated, 2013)) at equivalent altitudes to this site.

The macroinvertebrate fauna community at the downstream site (5) showed a increase in taxa richness (of 5 taxa), a richness which was slightly higher than the median number previously recorded at this site (Table 1). A marked increase in number of dominant taxa included five 'tolerant' taxa [extremely abundant oligochaete worms; snail *(Potamopyrgus)*, net-building caddisfly (*Aoteapsyche*), and midges (orthoclads and *Maoridiamesa*)], four 'moderately sensitive' taxa [(amphipod (*Paracalliope*), stonefly *(Zelandobius)*, elmid beetles, and stony-cased caddisfly (*Pycnocentrodes*)], and one 'highly sensitive' taxon [very abundant mayfly (*Deleatidium*)]. This mayfly had never been a dominant taxon at this site prior to wastewater diversion from the stream. A few of these dominant taxa (mainly 'tolerant' taxa) were associated with the periphyton substrate cover. Variation in stream habitat probably accounted for most of the changes in abundances of individual taxa between the two sites, including the significant increases in abundances of 'sensitive' beetles, stoneflies, caddisflies, and one 'highly sensitive' mayfly. The extreme abundance of the 'highly sensitive' mayfly in particular, and increased abundances amongst three 'moderately sensitive' taxa, increased the $SQMCI_s$ score (by 1.8 units) above that recorded at the upstream site.

The MCI value (93) at this site represented a significant increase of 19 units (Stark, 1998) above the score recorded at the upstream ('control') site. Improvement in physical stream habitat conditions, and the removal of WWTP wastes from the Mangawhero Stream, contributed to this increase in MCI score. This score was a very significant 15 units higher than the median value of scores from all past surveys although it was 9 units below the historical maximum score found by the previous spring survey (Table 1). A large increase (of 20%) in the proportion of 'sensitive' taxa at this site, coincident with the physical substrate improvement at this site in the lower stream, was indicative of improved water quality conditions, as the MCI value for such a habitat in the absence of the discharge has increased to a score significantly higher than recorded by all surveys prior to wastewater diversion from the catchment (Figure 2). For instance, the current survey's MCI score categorised this site as having 'fair' health (TRC, 2014) at the time of this survey (compared with median health categorised as 'poor'). Although it was 11 units lower than the predicted MCI score for a ringplain stream arising outside of the National Park, at a site at an altitude of 190 m asl (Stark & Fowles, 2009), scores at this site have been consistently much lower than this predictive value in pre-wastewater diversion surveys.

The current score reflected the more lowland nature of the headwater catchment stream (with a major ringplain tributary) but particularly the improvement to the physicochemical water quality of the stream since removal of the Eltham municipal WWTP discharge by pipeline diversion to the Hawera WWTP.

Waingongoro River site (downstream of the Mangawhero Stream confluence (site 8))

Thirty-eight surveys have been undertaken previously at this site, approximately 2 km downstream of the Mangawhero Stream confluence (which previously had been the receiving water for the Eltham municipal wastewater treatment system discharge).

The number of taxa found in the present survey (15) was lower than the median and only one taxon above the minimal richness found at this site to date and fewer than typical of macroinvertebrate community richnesses found in the mid-reaches of Taranaki ringplain rivers following several significant river freshes (five) in the four week spring period preceding this survey. The community was characterised by two 'highly sensitive' taxa [extremely abundant mayfly (*Deleatidium*); and flare-cased caddisfly (*Beraeoptera*)]; and two 'moderately sensitive' taxa [stony-cased caddisfly (*Pycnocentrodes*) and elmid beetles]; and only one 'tolerant' taxon [net-building caddisfly (*Aoteapsyche*)] (Table 2). The abundances of the 'highly sensitive' taxa and other 'moderately sensitive' taxa at this river site were indicative of recent good physicochemical water quality. The proportion of characteristic 'sensitive' to 'tolerant' taxa was much higher than found by the majority of previous surveys which had been performed while discharges from the WWTP were occurring into the Mangawhero Stream, upstream of this site.

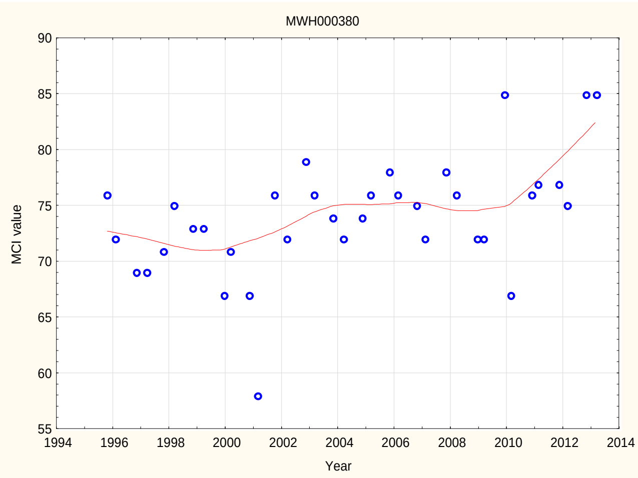
The MCI score (109) indicated limited deterioration in the macroinvertebrate community in comparison with the communities present in the reach in the vicinity of the Riverlands meatworks upstream of the Mangawhero Stream where the MCI scores ranged from 114 to 124 units at the time of the same day monitoring of the meatworks' discharge (CF595). Very few differences in characteristic community taxa resulted in a very similar $SQMCI_s$ score at this site below the confluence. The current MCI score (at site 8) of 109 units was a significant 15 units higher than the median score recorded by past surveys at this site, and was within 2 units of the previous maximum. It categorised this site as having 'good' generic stream health and 'expected' predictive health (TRC, 2014) at the time of this spring survey. It was also six units higher than the predicted MCI score for a National Park-sourced ringplain 'control' site at an altitude of 180 m asl and a significant 15 units higher than the predicted MCI score for this site, 29.6 km downstream of the National Park boundary (Stark and Fowles, 2009), a reflection of the improvement subsequent to the removal of the WWTP discharge from the Mangawhero Stream upstream of this site.

This improvement in MCI value below the Mangawhero Stream confluence was atypical of the trend of downstream decreases recorded by many earlier surveys (since 1994) and was dissimilar to the trends often recorded at the time of past spring surveys. However, it was coincident with the diversion of the Eltham WWTP discharge out of the catchment which had occurred some three years earlier.

Temporal trends in MCI scores (1995-2013)

Non-parametric statistical trend analysis of MCI data (Stark and Fowles, 2006) has been performed on the eighteen years of SEM results collected to summer 2013 from the two sites in the Mangawhero Stream and site in the Waingongoro River at Stuart Road. The MCI has been chosen as the preferable indicator of 'stream/river health' for SEM trend purposes. A graphical presentation of the LOWESS plot of trends in MCI data and the Mann-Kendall test of significance are provided for all sites. The LOWESS (tension 0.4) trend plots of MCI data are presented in Figures 3, 4, and 5.

Site MWH000380

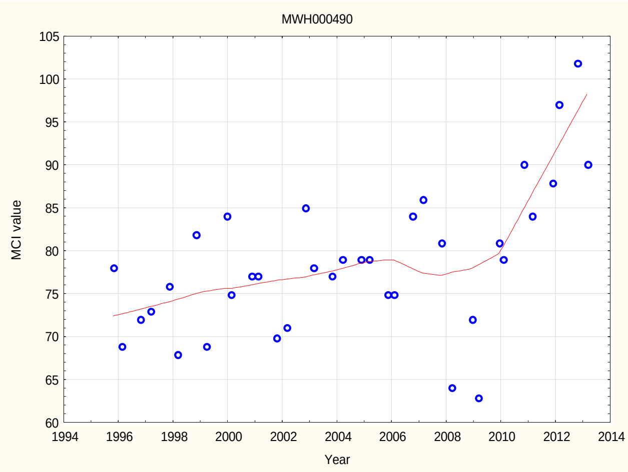


N = 36
Kendall tau = +0.369
p value = 0.002 [>FDR, p = 0.004]
Significant at p <0.05 and p < 0.01 levels; and after FDR application

Figure 3 LOWESS trend plot of MCI data at the site upstream of Eltham WWTP discharge

A positive and statistically significant temporal trend in MCI scores ($p < 0.01$ after FDR) has been found over the eighteen year monitoring period at this site with the early trend of slightly increasing scores having been followed by a plateauing of scores a few units above those recorded early in the programme and a more recent steady increase. However, the narrow range of LOWESS-smoothed scores (5 units) until 2012-2013 had not been of ecological significance but the range has widened to 10 units very recently. LOWESS-smoothed MCI scores consistently have been indicative of 'poor' generic stream health throughout the period until an improvement to 'fair' in the 2012-2013 period.

Site MWH000490



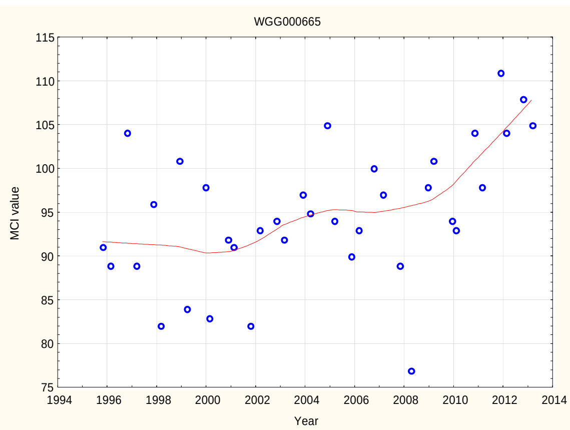
N = 36
Kendall tau = +0.410
p value = 0.0004 [>FDR, p = 0.001]
Significant at p <0.05 and p < 0.01; and significant after FDR

Figure 4 LOWESS trend plot of MCI data at the site downstream of the Mangawharawhara Stream confluence

A moderate and recently much more pronounced, and now statistically significant ($p < 0.01$, after FDR), temporal improvement in MCI scores has been illustrated at this more ringplain-like site in the lower reaches of the stream near its confluence with Waingongoro River. The wide range in LOWESS-smoothed scores (26 units) has more recently become ecologically significant over the eighteen year period. Scores trended downwards for 3 years after a steady improvement between 1995 and 2006 prior to the most recent marked improvement due to improved scores since the diversion of the Eltham WWTP wastes discharge out of the stream in July 2010.

The MCI scores generally have been indicative of 'poor' generic stream health (TRC, 2014) with sporadic incursions into the 'fair' health category prior to 2010. The LOWESS-smoothed scores have remained in the 'poor' category through the period until 2010 and subsequently improved into the 'fair' category and most recently bordered on 'good' health. In terms of predictive relationships (TRC, 2014) for a site in the mid-reaches of a ringplain stream (recognising the partial ringplain component of this catchment and the position of the site in the lower reach of this small stream prior to joining the mid-reaches of a larger ringplain river), stream health has been 'worse than expected' almost throughout the entire eighteen year period, but entered the 'expected' category in the previous 2011-2012 survey period.

Site WGG000665



N = 36
Kendall tau = +0.363
p value = 0.002 [>FDR, p = 0.005]
Significant at p <0.05 and p < 0.01 and after FDR application

Figure 5 LOWESS trend plot of MCI data at the Stuart Road site

A positive statistically significant trend in MCI scores has been found (at the 5% and 1% levels and after FDR application) over the period with a gradual improvement in MCI scores since 2002 (coincident with summer diversion of the treated meatworks wastes discharge (at Eltham) from the river to land irrigation) and particularly most recently (since 2009) following the diversion of treated municipal Eltham wastewater out of the catchment (to the Hawera WWTP and ocean outfall). The LOWESS-smoothed range of scores (17 units) has also been ecologically significant over the eighteen year period. Smoothed MCI scores consistently have been indicative of 'fair' generic river health until more recently when they have been more indicative of 'good' generic health (TRC, 2014). In terms of predictive relationships for a site in the mid reaches of a ringplain river, health has been in the 'expected' category almost throughout the period until approaching the 'better than expected' category in the last two years.

Microscopic streambed heterotrophic assessment

The microscopic heterotrophic assessments of substrate growths performed for all sites indicated an absence of any mats, plumes or dense growths of heterotrophic organisms at each of the three sites.

Conclusions

This survey was the nineteenth spring survey performed subsequent to upgrades to the Eltham WWTP and the fourth spring survey since diversion of the wastewater discharge out of the catchment to the Hawera WWTP, with no consented overflow discharges to the stream in the interim. The survey coincided with moderately low recession flows following a number of early spring freshes and limited periphyton substrate cover at both Mangawhero Stream sites and the Waingongoro River downstream of the Mangawhero Stream confluence.

Macroinvertebrate community richnesses were slightly lower or similar to past median taxa numbers at all sites but the MCI scores were much higher than past medians and nearer historical maxima at sites in the lower Mangawhero Stream and in the Waingongoro River. A significant improvement was found in MCI score between the two stream sites in a downstream direction. Greater abundances of certain 'highly and moderately sensitive' taxa, which might be expected to be present at the 'better' physical habitat of site 5, 3 km downstream of the wastewater treatment plant's original discharge outfall were indicative of improved physicochemical water quality conditions at the time of this survey. The MCI and $SQMCI_s$ scores recorded in the Waingongoro River downstream of the Mangawhero Stream confluence were indicative of improved water quality below the confluence which was dissimilar to trends frequently found by previous surveys during wastewater discharges and more often under lower flow conditions. Improvement in physicochemical water quality and the associated macroinvertebrate faunal communities in the Mangawhero Stream and Waingongoro River associated with the diversion of the discharge out of the catchment to the Hawera WWTP have been recorded by this survey some three years after wastewater diversion. No impacts of leachate from the old landfill to the Mangawhero Stream were indicated from the results of this spring survey.

Temporal trends in MCI scores have been indicative of statistically significant improvements in stream and river biological river health at all three sites over an eighteen year period mainly due to markedly higher scores at sites downstream of the original wastewater outfall discharge point subsequent to the pipeline diversion of wastes to the Hawera WWTP which occurred three years previously.

Summary

The Council's standard 'kick-sampling' technique was used at two established sites to collect streambed macroinvertebrates from the Mangawhero Stream and at one established site in the Waingongoro River. Samples were sorted and identified to provide number of taxa (richness) and MCI and SQMCIs scores 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 $SQMCI_s$ between sites may indicate the degree of adverse effects (if any) of the discharges being monitored.

This spring macroinvertebrate survey indicated that the diversion of the discharge of treated wastewater from the Eltham WWTP out of the stream to the Hawera WWTP more than three years earlier had resulted in an improvement in the macroinvertebrate community of the downstream site in the Mangawhero Stream. Changes in the macroinvertebrate communities were recorded between the upstream 'control' site and the site nearly 3 km downstream of the original WWT Plant discharge outfall near the confluence with the Waingongoro River where improvements in aesthetic aspects of physicochemical water quality were also noticeable. As a result of diversion of the wastewater discharge out of the catchment, an improvement in MCI score continued to be recorded and there was no microscopic evidence of 'heterotrophic growths' (which more often had been associated with summer, warmer, low flow conditions). Eighteen year temporal trends showed statistically significant stream/river health improvements at all sites, but more significantly at the two sites downstream of the WWTP outfall attributable to pipeline diversion of the wastewater discharge out of the catchment.

The macroinvertebrate communities of the Mangawhero Stream contained relatively higher proportions of 'tolerant' taxa at the upper site, with numerical dominance by numbers of 'highly and moderately sensitive' taxa only at the downstream site when the community was comprised of a higher proportion of 'sensitive' taxa. Taxonomic richness (number of taxa) was moderate at the time of this spring survey coincident with no or patchy periphyton mats, no or patchy filamentous algal cover, but some marginal weed growth.

MCI scores indicated that the Mangawhero Stream communities were of 'poor' health upstream, and 'fair' health at the downstream site, but relatively typical of the condition recorded in equivalent reaches of similar Taranaki streams, sourced outside the National Park and/or in lowland swamps.

The macroinvertebrate community found in the Waingongoro River below the Mangawhero Stream confluence showed very similar $SQMCI_s$ and equivalent MCI scores compared with the surveyed reach of the river (in association with Riverlands meatworks) above the confluence and an improvement on wastewater pre-diversion conditions; atypical of the trend found by many past surveys, but consistent with the removal of the Eltham WWTP wastewater discharge from the Mangawhero Stream.

No impacts of leachate from the old landfill on Mangawhero Stream macroinvertebrate communities were indicated by the results of this spring survey.

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