South Taranaki District Council
Hawera Municipal Oxidation Ponds
Monitoring Programme
Annual Report
2016-2017

Technical Report 2017-76

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Executive summary

The South Taranaki District Council (STDC) operates seven municipal oxidation pond systems within the district of South Taranaki. This report, for the period July 2016 to June 2017, focusses on the oxidation ponds system located in Hawera, which comprises an anaerobic pond, two primary/facultative ponds in parallel, and a maturation pond. The report describes the monitoring programme implemented by the Taranaki Regional Council (the Council) to assess STDC's environmental and consent compliance performance during the period under review. The report also details the results of the monitoring undertaken and assesses the environmental effects of STDC's activities in relation to the Hawera Wastewater Treatment Plant (HWWTP).

STDC holds two resource consents for the site which include a total of 26 conditions setting out the requirements that STDC must satisfy. STDC holds consent 5079-1 for operation of the Hawera oxidation ponds system, and consent 7520-1 to discharge to an unnamed stream in the event of high rainfall.

During the monitoring period, STDC demonstrated an overall level of environmental performance that requires improvement.

The Council's monitoring programme for the year under review included six inspections, during which effluent samples were collected from the aerobic ponds and maturation pond. Shellfish and seawater samples were also collected during the year, and two marine ecological surveys were undertaken. STDC provided the Council with continuous dissolved oxygen (DO) and outflow data as well as an annual report.

The monitoring showed that there were a number of non-compliances of consent conditions during the year relating to DO concentrations in Ponds 1 and 2 and exceedances of the volume of wastewater discharged through the outfall. Two fourteen-day letters (ie an explanation is required from the operator) were issued in response to the latter and additional shellfish monitoring was undertaken.

For reference, in the 2016-2017 year, consent holders were found to achieve a high level of environmental performance and compliance for 74% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 21% of the consents, a good level of environmental performance and compliance was achieved.

In terms of overall environmental and compliance performance by the consent holder over the last several years, this report shows that the consent holder's performance requires improvement in relation to consent compliance.

This report includes recommendations for the 2017-2018 year.

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1 Introduction

1.1 Compliance monitoring programme reports and the Resource Management Act 1991

1.1.1 Introduction

This report is for the period July 2016 to June 2017 by the Taranaki Regional Council (the Council) describing the monitoring programme associated with resource consents held by South Taranaki District Council (STDC). STDC operates the Hawera Wastewater Treatment Plant (HWWTP) situated on Beach Road in Hawera.

The report includes the results and findings of the monitoring programme implemented by the Council in respect of the consents held by STDC that relate to the discharge of wastewater from the HWWTP into the Tasman Sea via the Whareroa outfall (the Outfall). This is the 24th annual report to be prepared by the Council to cover STDC's discharge of municipal wastewater from the HWWTP and its effects.

1.1.2 Structure of this report

Section 1 of this report is a background section. It sets out general information about:

- consent compliance monitoring under the *Resource Management Act 1991* (RMA) and the Council's obligations;
- the Council's approach to monitoring sites though annual programmes;
- the resource consents held by STDC;
- the nature of the monitoring programme in place for the period under review; and
- a description of the activities and operations conducted at the HWWTP.

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

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

Section 4 presents recommendations to be implemented in the 2017-2018 monitoring year.

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

1.1.3 The Resource Management Act 1991 and monitoring

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

a. the neighbourhood or the wider community around an activity, and may include cultural and social-economic effects;

b. physical effects on the locality, including landscape, amenity and visual effects;

c. ecosystems, including effects on plants, animals, or habitats, whether aquatic or terrestrial;

d. natural and physical resources having special significance (for example recreational, cultural, or aesthetic); and

e. risks to the neighbourhood or environment.

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

1.1.4 Evaluation of environmental and administrative performance

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

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

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

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

Environmental Performance

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

Good: Likely or actual adverse effects of activities on the receiving environment were negligible or minor at most. There were some such issues noted during monitoring, from self reports, or in response to unauthorised incident reports, but these items were not critical, and follow-up inspections showed they have been dealt with. These minor issues were resolved positively, co-operatively, and quickly. The Council was not obliged to issue any abatement notices or infringement notices in relation to the minor non-compliant effects; however abatement notices may have been issued to mitigate an identified potential for an environmental effect to occur.

For example:

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

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

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

Administrative performance

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

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

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

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

For reference, in the 2016-2017 year, consent holders were found to achieve a high level of environmental performance and compliance for 74% of the consents monitored through the Taranaki tailored monitoring programmes, while for another 21% of the consents, a good level of environmental performance and compliance was achieved.

1.2 Treatment plant description

Up until February 2001, effluent from the HWWTP was discharged into a small unnamed coastal stream and across the foreshore before entering the Tasman Sea. Consent 1335-3 authorised the discharge of up to 10,000 m^3/day of treated wastewater from the municipal ponds system. That consent lapsed during the 2000-2001 monitoring period. Consent 5079-1 was granted in February 2001, for the discharge of the same volume of wastewater from the refurbished ponds system into the Tasman Sea via the Outfall, located approximately 3 km to the southeast of the plant.

Currently, the oxidation pond system at the HWWTP treats both industrial and domestic wastes from Hawera and Eltham. Partially treated (screened) wastewater from meat processors Silver Fern Farms and Graeme Lowe Protein Limited are treated in an anaerobic lagoon before discharging into the oxidation pond system (Figure 1).

Since 2000, the ponds have been reconfigured several times. Prior to November 2000, the two primary ponds (Ponds 1 and 2) operated in parallel. After November 2000, the two ponds were operated in series to increase treatment efficiency, with the treated wastewater from Pond 2 discharging to a pipeline that transferred the final effluent to the Outfall. However, since 2010, the ponds changed back to operate in parallel, with effluent from these two ponds now passing into a tertiary/maturation pond (divided into 4 cells) which is the final pond system (Figure 1).

Since June 2010, primary treated wastewater from the single oxidation pond at Eltham has discharged intermittently to the HWWTP, at approximately 90 m^3/hour. Raw domestic wastewater from Hawera and primary wastewater from Eltham combine on site at the HWWTP with the anaerobic lagoon effluent and are then split 60:40 to enter the two primary ponds (Figure 1). Both Ponds 1 and 2 have surface aerators. The hydraulic residence time (HRT) for Pond 1 is approximately 20 days (NIWA, 2012).

The effluent from both Ponds 1 and 2 combines at the outlet points from each pond and flows through to the new maturation pond, constructed in 2009 (Photo 1). The maturation pond has three baffles dividing the pond into four cells to increase the residence time within the pond. The total HRT for the ponds is estimated to be approximately 60 days (NIWA, 2012). Final treated effluent from the maturation pond is gravity-fed to the pump station, from where it is pumped (preferentially at night) via a 2.8 km pipeline, to the mixing chamber on the cliff top and combines with wastewater from the Whareroa dairy factory for discharge via the 1,845 m long Outfall.

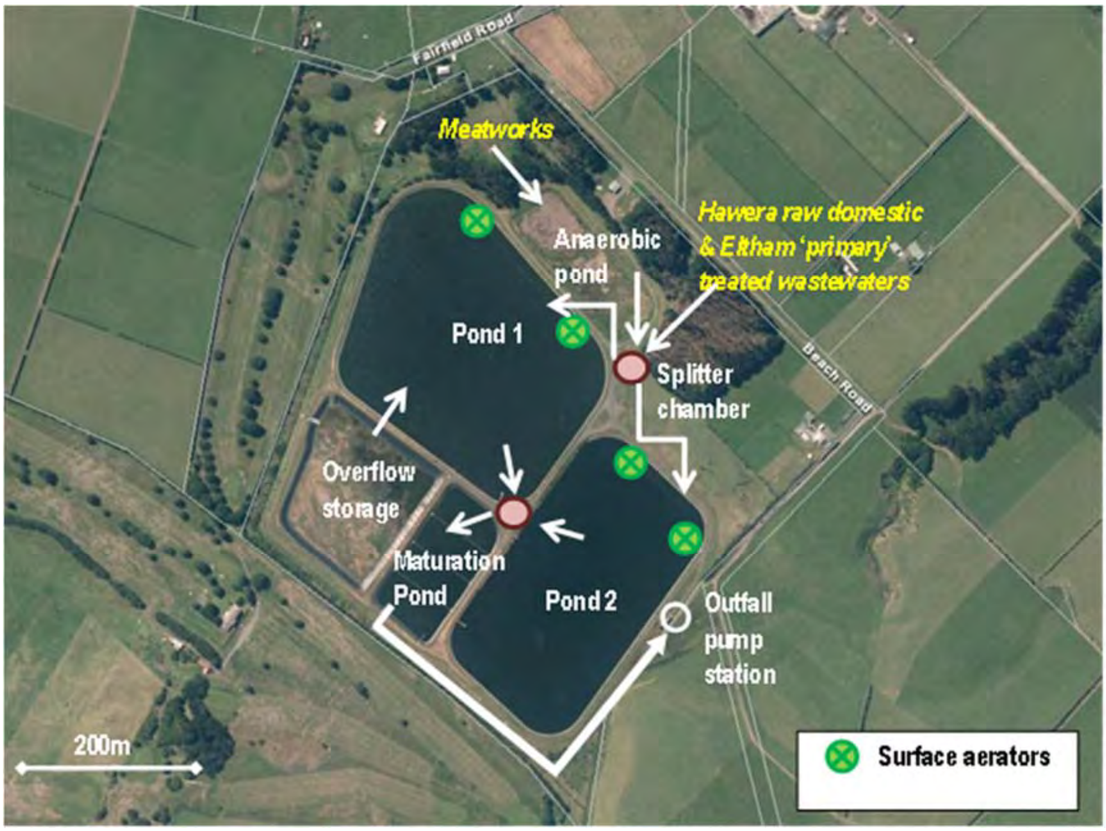

Figure 1   Configuration of the HWWTP (adapted from NIWA, 2012)

During high rainfall events, the maturation pond can overflow into the neighbouring emergency overflow/storage detention pond (capacity approximately 65,000 m^3, NIWA, 2012) with wastewater then being passed back into Pond 1. Consent 7520-1 has been granted to allow overflow from the detention area into the local stream that borders the HWWTP. Since being granted in 2009, this consent has not yet needed to be exercised.

Photo 1 Aerial photograph of the Hawera pond system, 8 March 2016

STDC's wastewater treatment staff undertake frequent, regular maintenance and operational surveillance surveys of the HWWTP system.

1.3 Resource consents

1.3.1 Water discharge permit

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

STDC holds consent **5079-1** to allow the discharge of up to 12,000 m^3/day (seven day average discharge) of treated municipal wastes generated in the Hawera and Eltham townships, including treated meat processing and dairy industry wastes, through a combined outfall into the Tasman Sea near Hawera (Appendix 1).

The consent was originally granted on 22 March 1998. However, in June 2003 STDC applied to change consent 5079-1 to increase the discharge volume from 10,000 m^3/day to 12,000 m^3/day to allow for the additional treatment and discharge of partially treated industrial and domestic wastewater from Eltham. This wastewater would be treated in the HWWTP, pumped to the Outfall and then discharged to the Tasman Sea.

This consent required pre-hearing meetings, held during 2004-2005 and 2005-2006, due to submissions against the consent. The consent variation was the subject of a formal hearing with the decision to grant the variation subsequently appealed by one submitter early in the 2006-2007 period.

A meeting was held on 16 July 2007 between the Council, STDC and authorised representatives of Inuawai - Okahu and Kanihi - Umutahi hapu. Positive progress was made with agreement that a scheduled mediation meeting on 20 August 2007 would not be required. An agreed deadline for reaching a conclusion on the state of the hapu appeal was 30 August 2007. If an agreement was not reached by this date then it was agreed that a hearing would be requested, otherwise the Hapu's counsel would submit a memorandum to the Court requesting that the Hearing Committee's decision stands.

On 1 August 2007, STDC wrote to iwi and the Council committing to: work on decreasing storm water ingress to the Hawera sewerage system; testing the permeability of the detention storage pond; not exceed the 12,000 m^3/day volume of the consent; and undertaking the necessary work under the consent (condition

10) to review in 2009 the best practicable option for treatment and disposal of wastewater, including the option of disposal to land.

Iwi agreed to withdraw the appeal, and this was lodged with the registrar of the Environment Court on 19 September 2007. The appellants wished to inform the Court that the discharge of treated human waste and industrial pollutants to the sea is, and always will be, culturally abhorrent to both hapu.

On 23 October 2007 the Environment Court recommended to the Minister of Conservation that the decision to grant the changes to consent 5079-1 stand. Approval was sought from the Department of Conservation (Wanganui branch) and the variation to consent 5079-1 was granted on 19 December 2007. Conditions on the consent increased from 14 to 17 to reflect these changes.

On 29 June 2010 amendments were made to Conditions 1 and 2 in order to comply with pond best practice guidelines and bring in line with other wastewater treatment facilities in South Taranaki.

Condition 1 was altered slightly to include the words 'during daylight hours' so that the condition reads:

"The consent holder shall properly and efficiently maintain and operate the oxidation ponds system, with aerobic ponds maintained in an aerobic condition during daylight hours."

Condition 2 was changed to include a time period where the dissolved oxygen (DO) is to be maintained above 2 g/m^3, so that the condition reads:

"For 90% of the time between 1100 and 1400 hours the dissolved oxygen level in the aerobic ponds, and in the waste water immediately prior to discharge, shall be maintained at or above 2 g/m^3 and that the consent holder shall monitor the dissolved oxygen levels in the aerobic ponds, on a continuous basis, and supply the results to the Chief Executive, Taranaki Regional Council, upon request."

There are 17 special conditions on coastal permit 5079-1.

Conditions 1 and 2 both deal with maintaining aerobic conditions in the ponds.

Conditions 3, 4, 5 and 7 deal with the discharge including effects on the Tasman Sea beyond the mixing zone, effects on shellfish on the shoreline, volume of the wastewater and management of the discharge.

Condition 6 requires the consent holder to advise and consult with the Council should trade wastes be accepted in to the wastewater system, as it may be necessary to place limits on toxic or hazardous components in the discharge.

Conditions 8, 9 and 10 deal with reporting, including a contingency plan (to be reviewed annually), an annual report outlining the performance of the system and compliance with the consent, and a report on the best practicable option for treatment and disposal of wastewater generated at Hawera and Eltham (to be provided by December 2009).

Condition 11 requires the reduction of stormwater infiltration into the system, and upgrade of the Eltham and Hawera wastewater treatment plants and the construction of a pipeline for the transfer of sewage from Eltham to Hawera.

Condition 12 requires reports on the implementation of condition 11, and condition 13 requires the consent holder and staff of the Council to meet at least once per year, with representatives from iwi, submitters and other interested parties, to discuss any matters relating to the consent.

Conditions 14 and 15 both deal with the establishment of a monitoring programme to analyse effects of the exercise of the consent on the intertidal reefs and coastal water quality adjacent to the discharge.

Condition 16 requires the consent holder to install a screen to prevent the discharge of undisintegrated solids into and from the oxidation pond.

Condition 17 deals with review of the consent.

The consent expired on 1 June 2015, however, in accordance with Section 124 of the RMA, the consent holder applied to renew the consent prior to its expiry, and therefore, continues to operate under the expired consent.

STDC holds consent **7520-1** to discharge, as a consequence of high rainfall, partially treated wastewater from the HWWTP into Unnamed Stream 22. The consent was originally granted on 4 November 2009.

There are nine special conditions on coastal permit 7520-1.

Condition 1 states that the discharge shall only occur as a consequence of high rainfall events.

Conditions 2 and 3 relate to the holding capacity of the pond, and modifications to the plant.

Conditions 4, 5 and 6 address record keeping, adopting the best practicable option and notification of the Council during and after overflow events.

Conditions 7 and 8 outline the requirements for STDC to supply a contingency plan and for the Council to undertake necessary monitoring in response to any discharges.

Condition 9 deals with review of the consent.

The consent is due to expire on 1 June 2027.

These permits are attached to this report in Appendix I.

This summary of consent conditions may not reflect the full requirements of each condition. The consent conditions in full can be found in the resource consents which are appended to this report.

1.4 Monitoring programme

1.4.1 Introduction

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

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

The monitoring programme for the HWWTP consisted of five primary components.

1.4.2 Programme liaison and management

There is generally a significant investment of time and resources by the Council in:

- ongoing liaison with resource consent holders over consent conditions and their interpretation and application;
- in discussion over monitoring requirements;
- preparation for any consent reviews, renewals or new consent applications;
- advice on the Council's environmental management strategies and content of regional plans; and
- consultation on associated matters.

1.4.3 Site inspections

The HWWTP was visited six times during the monitoring period. With regard to consents for the discharge to water, the main points of interest were plant processes with potential or actual discharges to receiving watercourses, including contaminated stormwater and process wastewaters. Air inspections focused on plant processes with associated actual and potential emission sources and characteristics, including potential odour, dust, noxious or offensive emissions. Sources of data being collected by STDC were identified and accessed, so that performance in respect of operation, internal monitoring, and supervision could be reviewed by the Council. The neighbourhood was surveyed for environmental effects.

1.4.4 HWWTP monitoring

Physical and chemical properties of wastewater in the HWWTP were measured in order to ascertain plant performance during the 2016-2017 monitoring period. The monitoring was undertaken by the Council and STDC.

The Council collected samples from Ponds 1 and 2 on six occasions during the year. These samples were analysed for temperature, DO and chlorophyll a. In order to satisfy Condition 2 of consent 5079-1, STDC also recorded continual DO measurements over the year in Ponds 1 and 2.

The Council collected samples of the ponds' combined effluent (from the maturation cells) on six occasions during the year. These samples were analysed for pH, conductivity, uninhibited biochemical oxygen demand (BOD; total, carbonaceous and filtered), total grease, suspended solids, ammonia, nitrogen, phosphorus, turbidity, faecal coliforms and enterococci bacteria.

The volume of wastewater discharged from the plant was also subjected to continuous monitoring by STDC, as required by Condition 5 of consent 5079-1.

1.4.5 Receiving environment monitoring

During the monitoring period, the Council conducted two intertidal surveys at four sites to assess the effect of discharges from the Outfall on intertidal communities. The surveys were undertaken near the peak of the dairy season in December 2016, and in the post-peak period in March/April 2017.

The Council carried out one complete microbiological surveys of water quality at five shoreline sites and one river site in relation to discharges of municipal wastewater (also sampled) through the outfall. Faecal coliforms counts were obtained using the most probable number (MPN) method, as is recommended for shellfish gathering waters (Ministry for the Environment and Ministry of Health, 2003).

A microbiological survey of shellfish (green lipped mussel) tissue quality was carried out on one occasion, at four shoreline sites, in relation to discharges of municipal wastewater through the outfall. Shellfish tissue analysis for trace metals was not carried out during this period, and will be analysed again in the 2017-2018 monitoring period.

1.4.6 Additional reporting requirements

Consent conditions require STDC to provide various reports during the monitoring period. These reports were reviewed by Council staff.

2 Results

2.1 Inspections

Routine inspections of the HWWTP were carried out on six occasions at approximately two-monthly intervals, from August 2016 to June 2017. The condition of the pond system was assessed during these inspections. Each inspection, DO field measurements were collected from both oxidation ponds. Samples were also collected from both oxidation ponds and the maturation pond during each inspection.

An additional inspection was also carried out on 2 April 2017, in connection with the unauthorised discharge of sewage overflow from a manhole in Eltham to land, and possibly surface water.

Odours ranging from slightly noticeable to strong were detected downwind of the anaerobic lagoon during every inspection. No odours were detected beyond the site boundary.

Parklink Ltd continues to carry out bacterial dosing of Pond 1 for desludging. Levels seem to have plateaued and it is expected during the 2017/18 year to change the desludging treatment to maintenance level dosing, which is likely to occur in alternating years. Pond 2 sludge levels were measured and results indicate maintenance bacterial dosing will also be initiated.

Photo 2 Parklink staff undertaking a sludge index survey in pond 1

The level of effluent in the maturation cells was highest during the winter inspection. The cells appeared dark green during the majority of the inspections.

The retention pond had received and contained an effluent overflow prior to the inspection on 26 April 2017. Overflow from the recent high influent flow was being pumped back into Pond 1 at the time of the inspection. The retention pond was otherwise found to be dry during the inspections.

No significant issues were noted upon inspecting the old coastal outfall and perimeter drains, although a partially clogged outlet screen was found to be impeding flow to the underground coastal tunnel on one occasion.

2.2 HWWTP monitoring

2.2.1 Dissolved oxygen

Conditions 1 and 2 of consent 5079-1 require that the ponds are maintained in an aerobic condition, with the DO maintained at a level at, or exceeding, 2 g/m^3 for 90% of the time during the hours of 11:00 to 14:00.

The photosynthetic activity of the microalgae within the ponds is a major factor affecting variation in pond DO concentrations. However, fluctuating industrial loadings, operation of the mechanical aeration system and weather conditions can also influence DO concentrations in pond systems.

Results from the DO field measurements recorded by the Council are presented in Table 1.

The DO saturation from these field measurements ranged from 46 to 105% in Pond 1, and from 22 to 85% in Pond 2. The lowest DO concentration was recorded in Pond 2 in April 2017 (2.2 g/m^3). This concentration was compliant with the 2 g/m^3 limit stated in Condition 2. It is important to note that all of these samples were collected in the morning and only one set was collected within the time period specified in condition 2 (11:00-14:00). Lower DO concentrations would be expected earlier in the morning due to shorter hours of daylight and less time for oxygen accumulation due to photosynthesis.

Table 1 Council DO measurements from the surface of the HWWTP oxidation ponds (Ponds 1 & 2) for the 2016-2017 monitoring year

Date	Pond 1				Pond 2			
	Time (NZST)	Temp (°C)	Dissolved oxygen		Time (NZST)	Temp (°C)	Dissolved oxygen	
			Concentration (g/m^3)	Saturation (%)			Concentration (g/m^3)	Saturation (%)
24-Aug-16	11:15	13.0	8.4	81	11:30	12.0	7.5	71
26-Oct-16	09:45	16.6	4.8	48	09:55	16.5	3.7	38
12-Dec-16	10:15	17.4	10.0	105	10:25	17.7	8.0	85
03-Feb-17	09:45	19.8	4.1	46	N/D	19.3	2.8	30
26-Apr-17	10:35	16.1	8.8	89	10:50	15.7	2.2	22
13-Jun-17	10:15	12.2	2.8	27	10:40	12.0	4.1	38

Condition 2 also requires that STDC monitors the DO concentrations on a continuous basis and supplies the results to the Council (Table 2; Figure 2). The condition further requires that a DO concentration of at least 2 g/m^3 is maintained in the ponds for 90% of the year, between the hours of 11:00 and 14:00. Portable grab sampling of the maturation cells shows that the 2 g/m^3 limit was achieved for 97% of the time. Pond 1 was above the minima for an average of 88.1% of the time and Pond 2 was above the 2 g/m^3 for 87.6% of the time.

Table 2 Percentage of time DO was greater than 2.0 g/m^3, between the hours of 11:00 and 14:00, for the 2016-2017 monitoring year

Month	Pond 1 (DO g/m^3)			Pond 2 (DO g/m^3)		
	Average	Max	% > 2.0	Average	Max	% > 2.0
Jul-16	10.7	19.8	100.0	7.0	11.1	100.0
Aug-16	10.2	20.0	99.4	9.9	20.0	100.0

Month	Pond 1 (DO g/m^3)			Pond 2 (DO g/m^3)		
	Average	Max	% > 2.0	Average	Max	% > 2.0
Sep-16	7.8	20.1	71.6	7.1	19.3	94.7
Oct-16	7.1	20.0	41.9	10.6	20.0	93.0
Nov-16	16.4	20.0	100.0	7.0	20.0	99.0
Dec-16	11.1	20.0	91.3	7.7	20.0	90.1
Jan-17	10.9	20.0	95.8	4.2	16.7	77.4
Feb-17	10.3	20.0	87.5	8.9	20.0	97.2
Mar-17	10.5	20.0	80.1	5.02	17.3	77.7
Apr-17	11.2	20.0	97.7	4.6	19.7	74.8
May-17	6.7	21.2	95.6	4.5	17.4	78.5
Jun-17	6.1	11.9	96.1	5.6	19.8	69.0
Pond 1 yearly total			88.1%	**Pond 2 yearly total**		87.6%

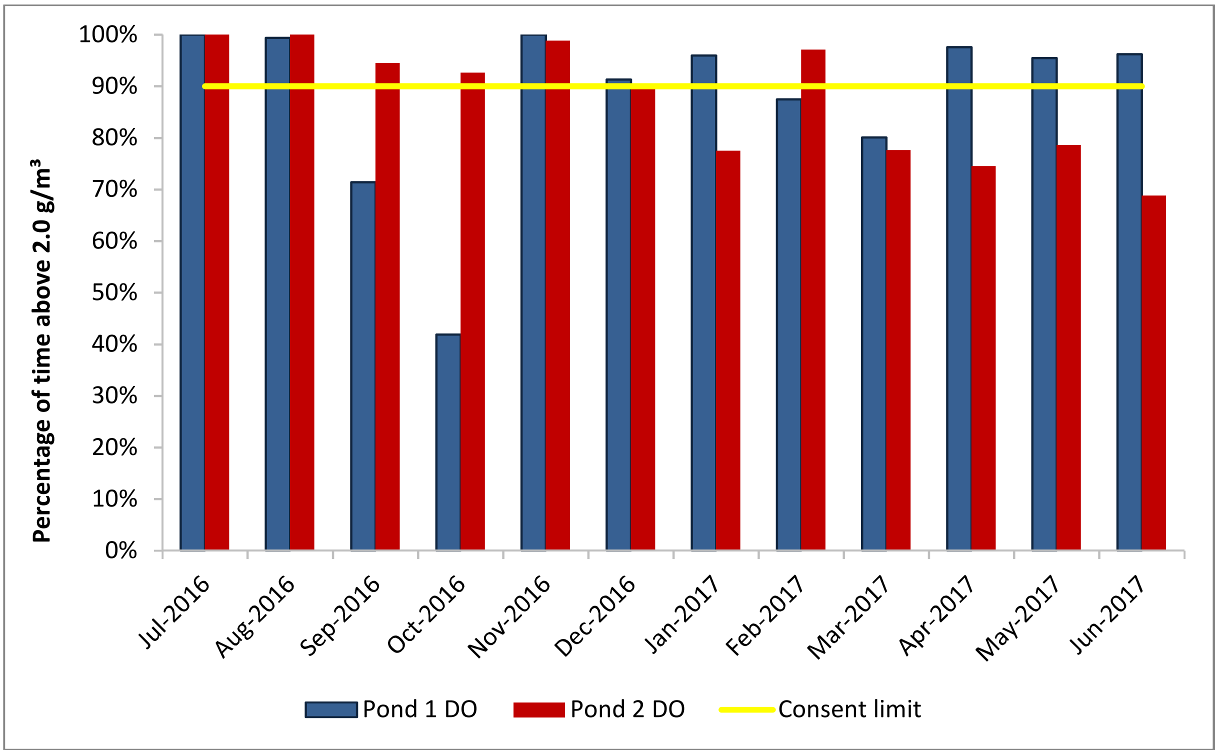

Figure 2 Compliance of DO concentration (g/m^3) with consent conditions in the primary and secondary oxidation ponds in 2016-2017, between the hours of 11:00 and 14:00. Data was collected from the pond outlet

2.2.2 Chlorophyll *a*

To maintain facultative conditions in a pond system, the presence of an algal community is required in the surface layer. The principal function of algae in an oxidation pond is the production of oxygen, which maintains aerobic conditions while the main nutrients are reduced by biomass consumption. Elevated pH levels, due to algal photosynthetic activity, and solar radiation combine to reduce faecal bacteria numbers significantly.

Effluent samples from Ponds 1 and 2 were collected during inspections of the HWWTP for semi-quantitative microalgal assessment prior to curtailment of this component of the programme in July 2013. The microalgal taxa present in both ponds has been summarised and discussed in previous annual reports.

During the 2016-2017 inspections, samples were collected from Ponds 1 and 2 for chlorophyll *a* analysis. Chlorophyll *a* concentration can be used as an approximation of algal biomass in the system. Pearson (1996) recommends that a minimum in-pond chlorophyll *a* concentration of 300 mg/m^3 is necessary to maintain stable facultative conditions. Seasonal fluctuations in algal populations, as well as periodic dilutions by stormwater infiltration, are expected to occur in wastewater treatment systems. These factors, together with waste loading fluxes, can result in chlorophyll *a* variability.

The results of Pond 1 and 2 effluent chlorophyll *a* analyses are provided in Table 3.

Table 3 Chlorophyll *a* (Chl-*a*) concentrations in Ponds 1 and 2 during the 2016-2017 period

Date	Pond 1		Pond 2	
	Time (NZST)	Chl-*a* (mg/m^3)	Time (NZST)	Chl-*a* (mg/m^3)
24-Aug-16	11:15	170	11:30	86
26-Oct-16	09:45	1,720	09:55	3
12-Dec-16	10:15	428	10:25	358
03-Feb-17	09:45	325	N/D	1,260
26-Apr-17	10:35	782	10:50	427
13-Jun-17	10:15	272	10:40	300
Median		377	Median	329
Summary statistics (2013-2016)				
No. of samples		17	No. of samples	17
Minimum		3.2	Minimum	20
Maximum		2,130	Maximum	1,840
Median		266	Median	283

The median chlorophyll *a* concentration for each pond during the 2016-2017 monitoring period was greater than the respective historical median (Table 3).

Higher chlorophyll *a* concentrations were recorded from summer through to autumn. Lower concentrations were recorded in winter/spring, a time of elevated rainfall resulting in the greatest stormwater dilution through the HWWTP system.

2.2.3 Final effluent quality

During the 2016-2017 period, samples of the combined effluent of the ponds' parallel configuration were collected from the maturation cells. These samples provide an indication of the degree of treatment that the wastewater has received. The samples also provide insight into the source of the influent waste.

The results from the physicochemical effluent analyses are presented in Table 4 and are discussed below.

Table 4 Physical and chemical parameters of the final effluent collected from the maturation cells during the 2016-2017 period, including the median for that period and a summary of historical statistics (2010-2016)

Parameter		Sample date and time (2016-2017)							Summary statistics			
		24-Aug-16 11:50	26-Oct-16 10:30	12-Dec-16 10:50	03-Feb-17 10:15	26-Apr-17 11:10	13-Jun-17 11:15	Median	No. of samples	Min	Max	Median
BOD	Total (g/m³)	13	35	22	165	N/D	73	35	36	11	330	55
	Total carbonaceous (g/m³)	13	30	22	28	15	15	18.5	37	9.2	86	22
	Filtered (g/m³)	7.4	15	5.1	67	N/D	4.7	7.4	34	4.2	87	13
Nutrients	Ammonia (g/m³)	29.6	22.5	37.7	33.7	30.5	33.1	31.8	33	4.62	74.8	39.6
	Total N (g/m³)	33.4	26.8	41.1	52.5	36.9	42.2	39	37	29.6	92.2	50.4
	Total P (g/m³)	5.66	5.68	8.88	12.4	8.48	8.08	8.28	37	5.44	21	9.26
Temperature		12.1	16.9	17.9	19.9	16.7	12.5	16.8	65	7.6	23.2	16.4
Conductivity @20°C (mS/m)		60.3	56.6	75.0	78.2	64.6	69.3	66.95	66	42.9	127	75.2
pH		7.6	8.2	8.0	7.7	7.6	7.6	7.65	37	6.8	8.1	7.7
Suspended solids (g/m³)		20	48	45	88	40	32	42.5	37	9	170	48
Turbidity (NTU)		10	18	36	70	24	17	21	37	12	98	33
Total grease (g/m³)		6	2.5	5	6	12	2.5	5.5	27	<5	33	2

Median values for the effluent constituents in the 2016-2017 period were comparable with the respective historical medians (Table 4). With the exceptions of temperature and total grease, all medians recorded were below the historical medians. The only parameter to exceed its historical maximum was pH, with a pH value of 8.2 recorded in October 2016.

Effluent quality demonstrated seasonal variability, with patterns evident for a number of the analysed effluent parameters (Table 4). Most parameters, including suspended solids and turbidity, were greatest over the summer months, a period of less rainfall and therefore less dilution via infiltration. Lower BOD concentrations were found during late winter and spring.

Previous investigations into the nature of the high total BOD concentrations have indicated that, at times, there has been a significant non-carbonaceous component (83-88 % of total BOD, March-June 2007). This indicates nitrification contributions, which are likely to be associated with the high industrial waste loadings.

The results from the faecal indicator bacteria analyses are provided separately in Table 5 and are discussed below.

Table 5 Faecal indicator counts in the final effluent from the maturation cells (2016-2017)

Parameter	Sample date and time					
	24-Aug-16	26- Oct-16	12-Dec-16	03-Feb-17	26-Apr-17	13-Jun-17
	11:50	10:30	10:50	10:15	11:10	11:15
Temperature (°C)	12.1	16.9	17.9	19.9	16.7	12.5
Conductivity	60.3	56.6	75.0	78.2	64.6	69.3
E. coli (cfu/100ml)	10,000	250	5,400	73,000	N/D	N/D
Enterococci (cfu/100ml)	3,100	70	110	8,300	170	1,400
Faecal coliforms (cfu/100ml)	15,000	310	7,800	83,000	1,300	14,000

Faecal coliform counts from the past seven years, since the installation of the maturation pond in 2010, are presented in Figure 3. The results from the current monitoring period are comparable with results from the past seven years (Figure 3). Faecal indicator counts demonstrated notable seasonal variability, with the counts much lower in spring/summer than during the autumn/winter months (Table 5; Figure 3).

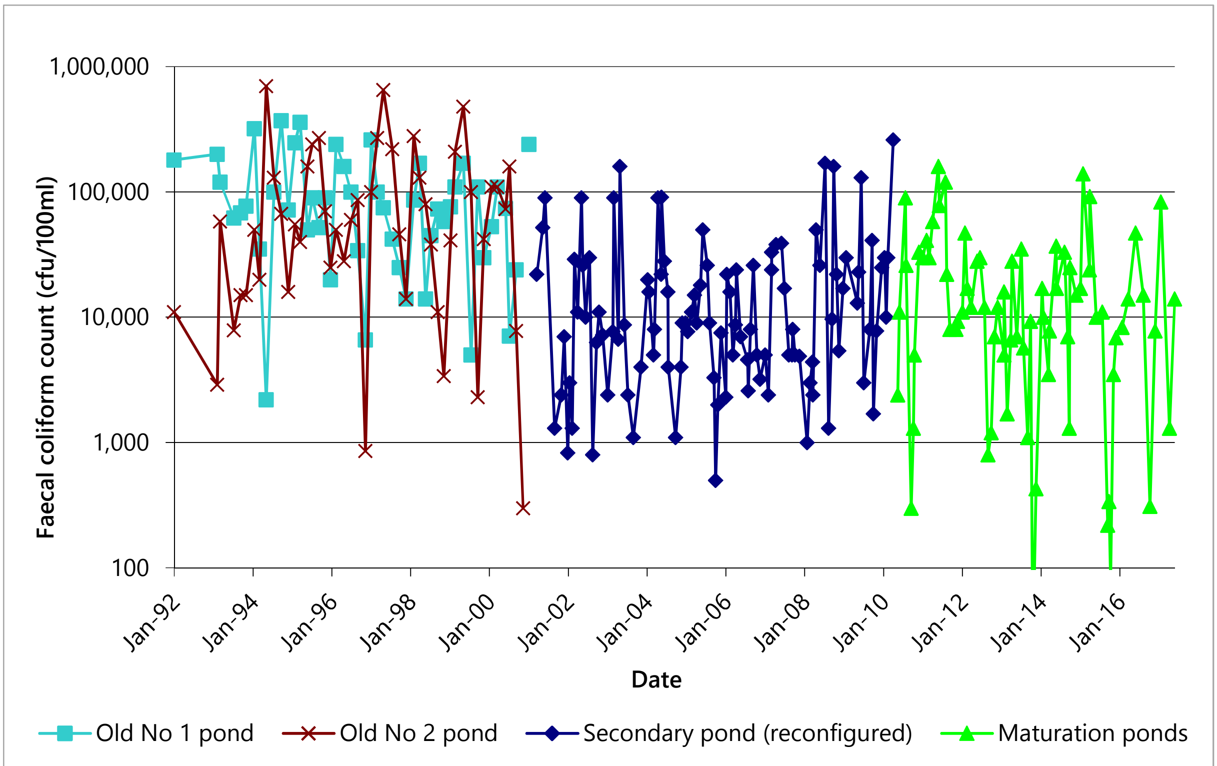

Figure 3 Faecal coliform counts in the final effluent from the maturation cells (1992-2017)

The results from the metals analyses are provided separately in Table 6 and are discussed below.

Table 6 Trace metal (g/m^3) analyses from the final effluent from the maturation cells (2016-2017). Historical medians for the HWTTP, Fonterra plant and New Plymouth Wastewater Treatment Plant (NPWWTP) are also presented

Parameter	HWTTP maturation pond			Fonterra WW *	NP WWTP #
	26-Oct-16	03-Feb-17	Median (2001-2016)	Median (2002-2016)	Median (1995-2016)
Arsenic	<0.001	N/D	<0.001	<0.001	N/D
Cadmium	<0.005	<0.005	0.002	0.002	0.005
Chromium	<0.03	<0.03	0.02	0.02	0.02
Copper	<0.01	<0.01	<0.01	0.02	<0.01
Lead	<0.05	<0.05	0.02	0.02	0.02
Mercury	<0.0001	<0.0001	0.0001	0.0001	0.0001
Nickel	<0.02	<0.02	0.01	0.02	0.01
Zinc	0.030	0.020	0.02	0.125	0.022

* = Site IND001001
# = Site SWG002002

Concentrations of trace metals in wastewater at the HWWTP have consistently been low, near or below levels of detection for routine analyses of municipal wastewaters for most metals (Table 6). Traces of cadmium, chromium, copper, mercury and nickel and low levels of zinc have occasionally been found since the reconfiguration of the system in early 2001. Trace metal concentrations were similar to those measured elsewhere in the region, during the period under review.

2.2.4 Discharge volume

Condition 5 of consent 5079-1 requires STDC to provide records of discharge volumes to the marine outfall. The consent holder supplied records for the current monitoring period, from 1 July 2016 to 30 June 2017 (Figure 4).

The purpose of the consent is to discharge no more than 12,000 m^3 per day (based on the seven day average) from the HWWTP to the Outfall. There were four separate exceedance events in relation to this limit in the 2016-2017 monitoring year. The first exceedance occurred in August 2016, was associated with heavy winter rain and lasted 7 days. The remaining three periods of exceedance occurred April (7 days), May (3 days) and May/June (23 days) after continued heavy rainfall over the summer and autumn 2017. The total number of days where the seven day average was above the consent limit was 40.

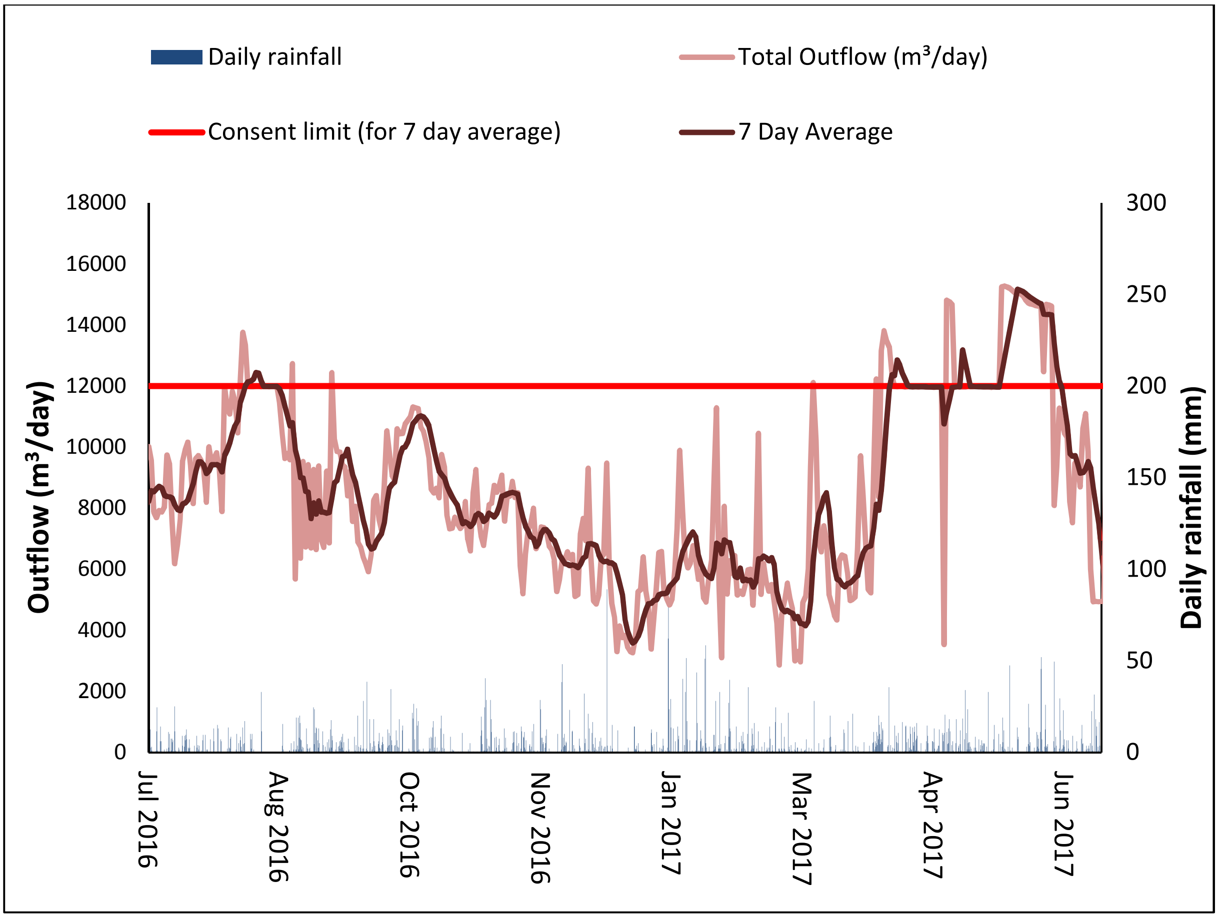

Figure 4 Daily discharge volumes (m^3/day) from the HWWTP and daily rainfall data (mm) from a Council rainfall station located approximately 5 km east of the site (2016-2017)

2.3 Receiving environment monitoring

Condition 3 of the consent requires that the discharge does not give rise to various effects on the Tasman Sea beyond a mixing zone of 200 m from the center-line of the outfall diffuser. Sub-condition d) requires that there are no significant adverse effects on aquatic life. Condition 14 requires that the consent holder ensures that a monitoring programme is established to record and analyse effects on the intertidal reefs and coastal water quality adjacent to the discharge. Monitoring is by way of marine ecological surveys, shellfish tissue analysis and shoreline water quality.

2.3.1 Marine ecology

In order to assess the effects of the Whareroa dairy factory and the HWWTP combined outfall discharge on the nearby intertidal communities, spring and summer surveys were conducted in December 2016 and March-April 2017 respectively, at four sites (Figure 5). The surveys included three potential impact sites either side of the outfall (two southeast and one northwest) and one control site (further northwest). It was expected that adverse effects of the marine outfall discharge on the intertidal communities would have been evident as a significant decline in species richness and diversity at the potential impact sites, relative to the control site. The two survey reports, including statistical analyses of the results and further discussion of the findings, are included in Appendix II. The main findings of these survey reports are summarised below, and are presented in Figures 6 to 9.

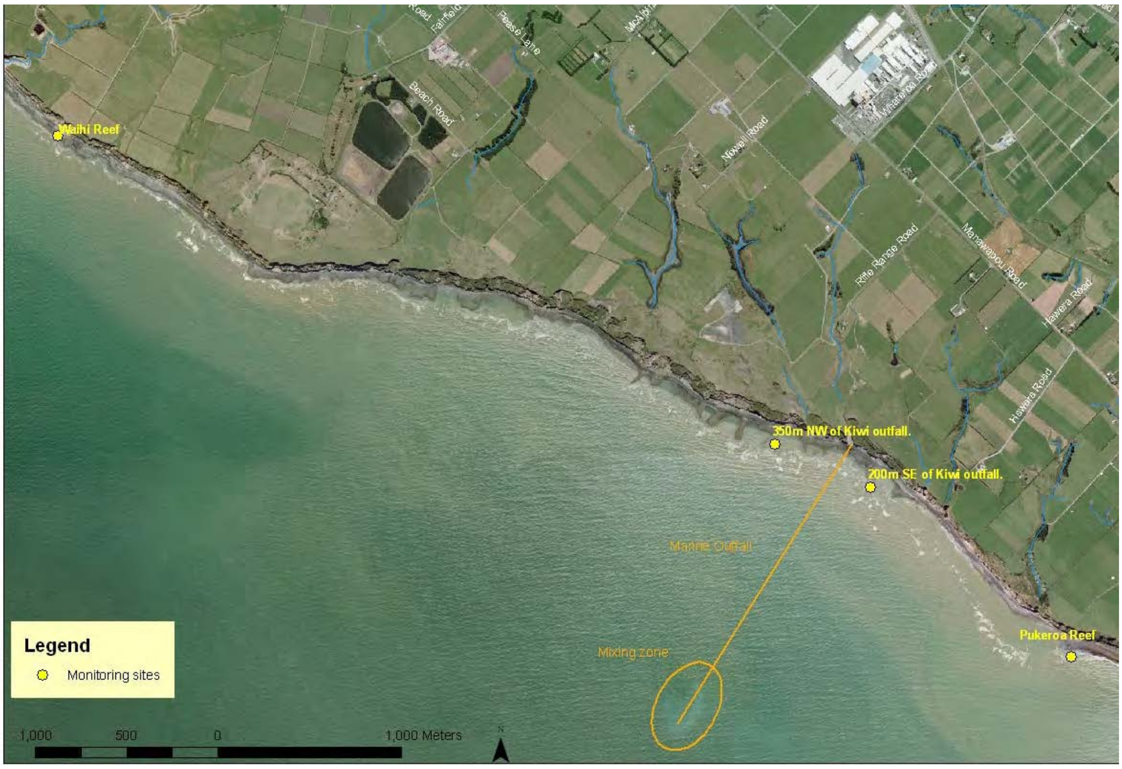

Figure 5 Map of sampling sites in relation to the outfall

None of the potential impact sites showed significant declines in species richness or diversity in relation to the control site. Instead, the potential impact sites located 350 m NW of the outfall and at Pukeroa Reef had significantly greater species richness and diversity than Waihi Reef (the control site). The remaining potential impact site located 200 m SE of the outfall showed signs of recovery after having been buried by a slip in 2015. Furthermore, there is no evidence of the potential impact sites declining in species richness or diversity over time, relative to the control site.

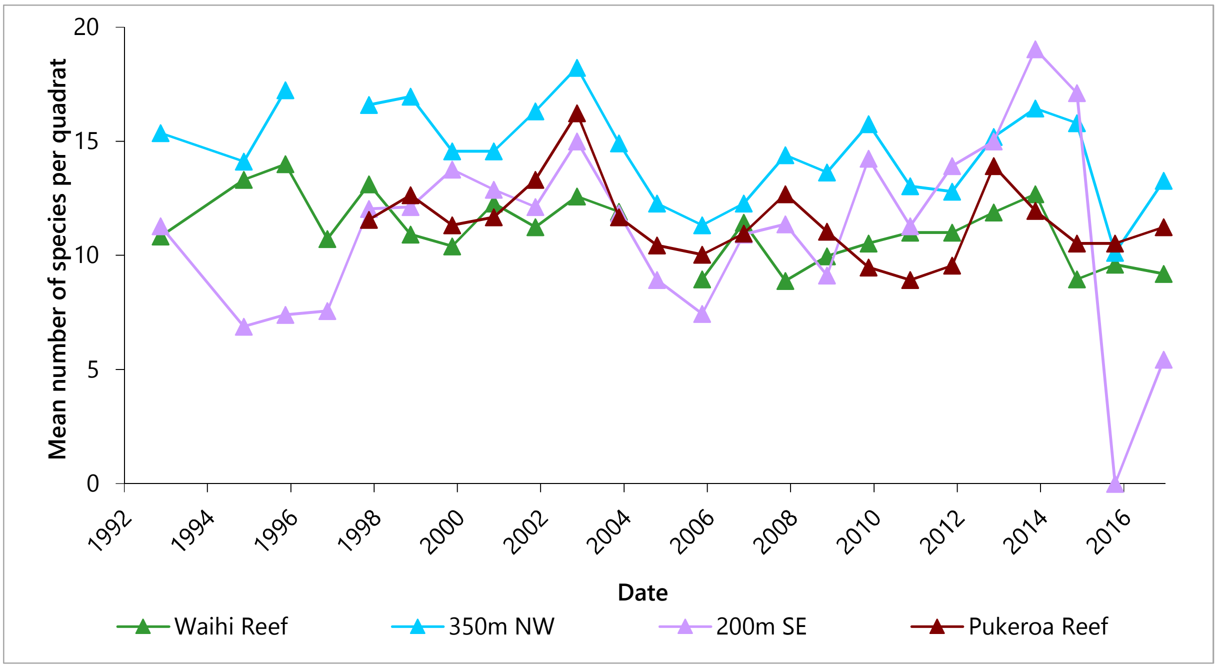

Figure 6 Mean number of species per quadrat for spring surveys (1992-2017)

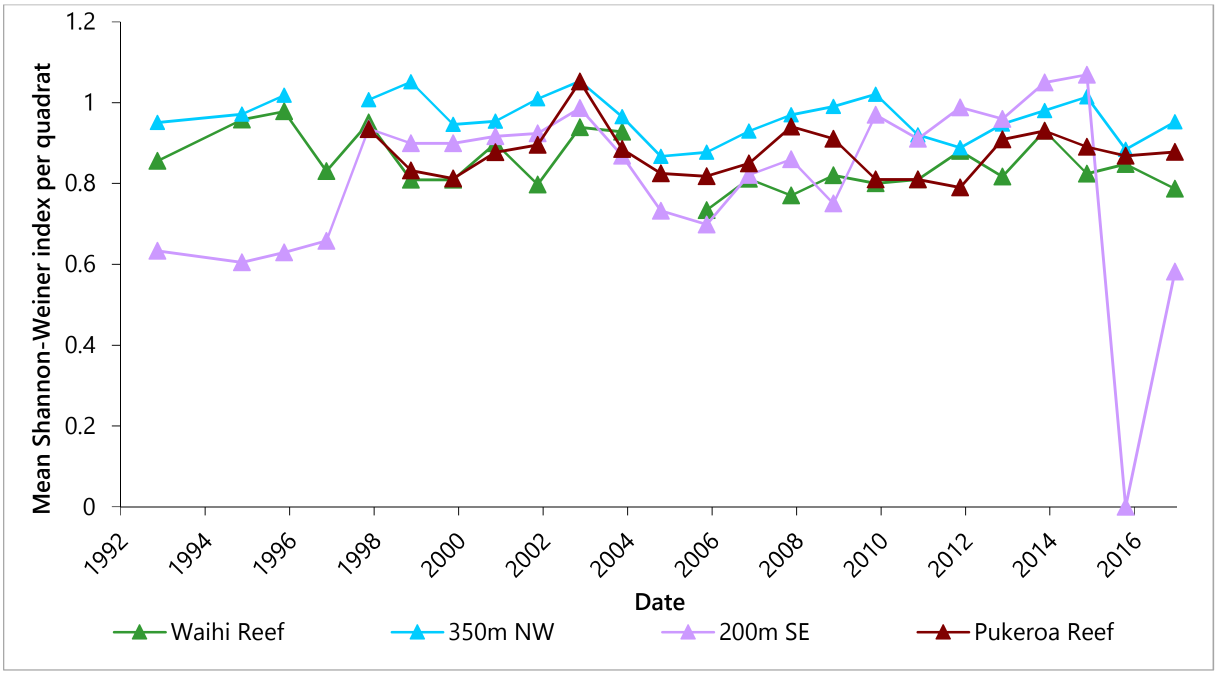

Figure 7 Mean Shannon-Weiner indices per quadrat for spring surveys (1992-2017)

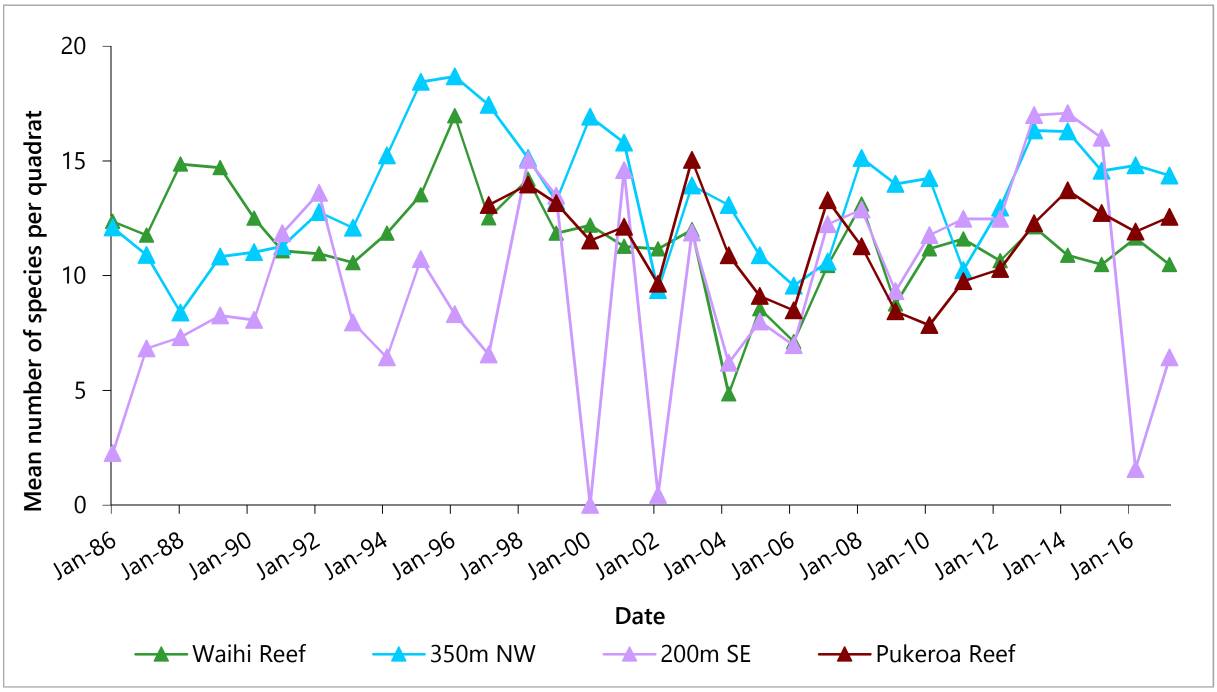

Figure 8 Mean number of species per quadrat for summer surveys (1986-2017)

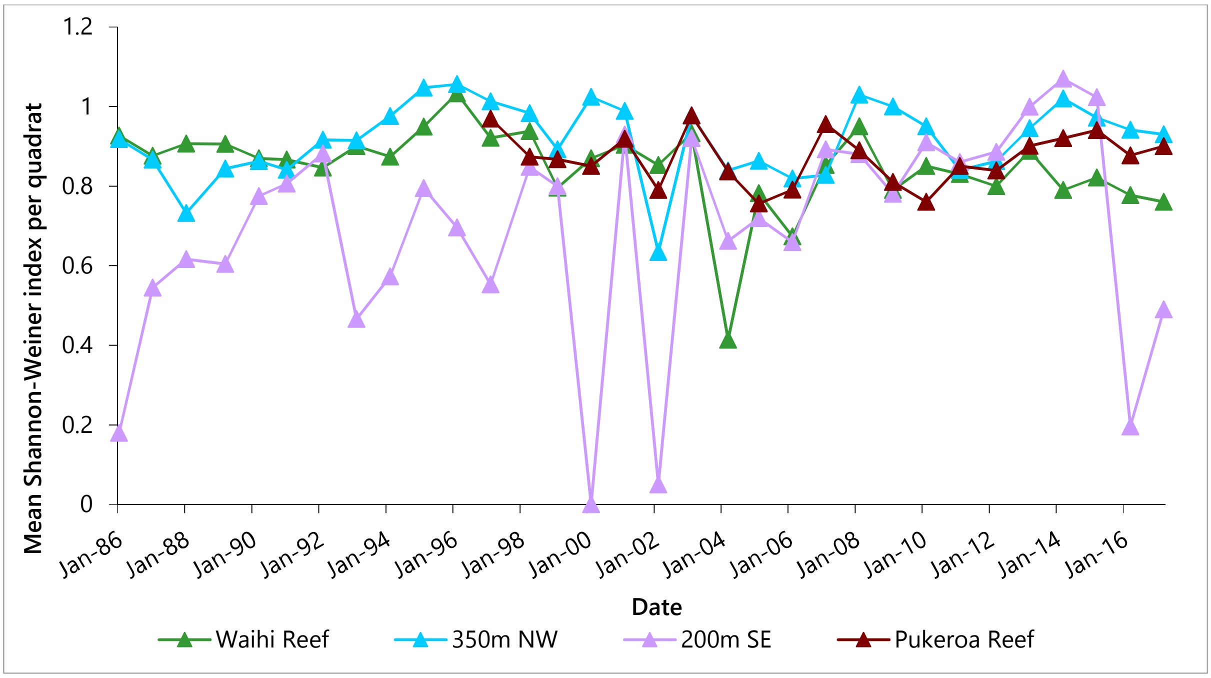

Figure 9 Mean Shannon-Weiner Indices per quadrat for summer surveys (1986-2017)

Overall, neither survey provided evidence to suggest that the outfall was having any adverse effects on the intertidal reef communities of South Taranaki. Natural environmental factors, including coastal erosion, exposure and substrate mobility, appear to remain the dominant drivers of species richness and diversity at the sites surveyed.

2.3.2 Shellfish tissue

Condition 4 of the consent states that the discharge shall not result in the guidelines for shellfish-gathering waters, as specified in the 'Provisional Microbiological Water Quality Guidelines for Recreational and Shellfish-Gathering Waters in New Zealand', being exceeded at the shoreline.

Figure 10 Shoreline water sampling and shellfish collection sites

Samples of the green lipped mussel, *Perna canaliculus*, were gathered from scattered natural populations at four sites (Figure 10; Table 7; Photo 4).

Table 7 Locations of the shellfish (mussel) monitoring sites

Site Code	Location	GPS coordinates
SEA906049	350 m NW of outfall	1710960 - 5612942
SEA906062	1,000 m SE of outfall	1712138 - 5612117
SEA906067	1,650 m SE of outfall	1712574 - 5611784
SEA906072	3,200 m SE of outfall	1713874 - 5610803

2.3.2.1 Faecal coliforms

Faecal coliform counts in shellfish tissue provide information relating to the bioaccumulation of faecal indicator bacteria which may originate from non-point source runoff, particularly into nearby rivers and streams, and/or point source discharges, such as sewage treatment systems.

Mussel samples collected at shoreline sites in the vicinity of the outfall discharge were analysed for faecal coliform concentration by the most probable number (MPN) method.

There are microbiological standards for a lot/consignment of bivalve molluscs under the Australia New Zealand Food Standards Code (2002): The acceptable concentration of *Escherichia coli* (230 MPN/100 g), should not be exceeded in more than one in five samples of food, and no sample of food shall exceed a concentration of 700 MPN/100 g. *E. coli* belong to the faecal coliform group and in some environmental samples, *E. coli* can account for the majority of faecal coliforms present. When assessing the results from the Council's monitoring against these guidelines, all mussels sampled at an individual site during the monitoring period were considered to be from the same "lot of food".

Photo 3 Green lipped mussels, *Perna canaliculus*, at Pukeroa Reef

Between 2002 and 2015, shellfish sampling in the vicinity of the outfall occurred six times each year, at approximately two-month intervals. However, following the floods of June 2015, large sections of the coastal cliffs north and south of the outfall became unstable, leading to increased erosion (see Section 2.3.1). There were a number of subsequent slips which buried vast expanses of reef as far as the low water mark. For obvious safety reasons, the remaining shellfish sampling that was scheduled for the 2015-2016 monitoring period was cancelled.

One sampling round was undertaken in the 2016-2017 period. The results of this sampling are presented in Table 8, along with a summary of the historical data. All monitoring data since early 1997 is presented in Figure 11.

Table 8 Mussel tissue faecal coliform counts (MPN/100g) from coastal sites adjacent to the outfall in 2016-2017

Date	Sites			
	SEA906049	SEA906062	SEA906067	SEA906072
26-Apr-17	230	45	78	<18
Historical data (2001-2016)				
No. of samples	76	75	78	75
Min	76	<18	<18	<18
Max	9000	3000	3000	2400
Median	80	80	70	110

The shellfish faecal coliform concentrations were comparable with the results from recent years. Of the four samples collected, two sites had faecal coliform counts below the respective historical median. The mussel sample with the highest faecal coliform count (230 MPN/100 g) was collected at SEA906049, 350 m NW of the outfall.

No samples exceeded the acceptable concentration limit for faecal coliforms (>230 MPN/100 g). It should be noted that there was an insufficient number of samples to assess compliance with this limit; only one date was sampled. The limit requires at least five.

No samples exceeded the maximum concentration limit for faecal coliforms (>700 MPN/10 0 g).

The annual median counts at all four sites have been within the guideline limit (230 MPN/100 g) since 2001. However, since 2001, six samples have exceeded the maximum *E. coli* limit (700 MPN/100 g) at SEA906049 (7 %), three at SEA906062 (3 %), seven at SEA906067 (8 %), and ten at SEA906072 (12 %). These exceedances have typically followed wet weather events, when faecal coliform levels in coastal seawater have increased due to run-off from the numerous local, small coastal streams and the nearby Tangahoe River catchment (TRC, 2004).

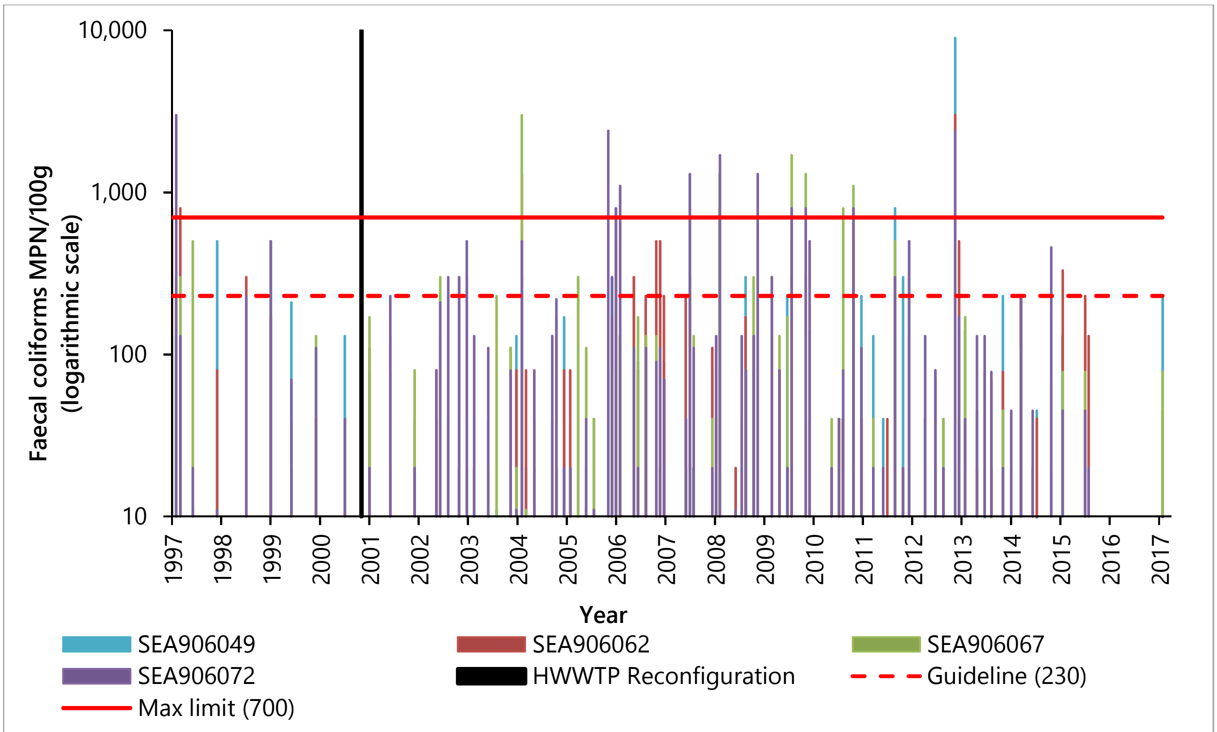

Figure 11 Shellfish (mussel) tissue faecal coliform bacteria numbers (MPN/100g) from surveys of coastal sites adjacent to the outfall (1997-2017)[1].

2.3.2.2 Trace metals

Shellfish tissue trace metal concentrations can provide evidence of longer term bio-accumulation of metals, which may originate from non-point source run-off and/or point source discharges e.g. sewage treatment systems.

Trace metal concentrations in shellfish tissue are monitored in relation to discharges from the HWWTP system and the Fonterra Co-operative Group Limited dairy factory at Whareroa biennially. Each mussel sample is depurated, where the animals are placed in seawater for a period of time to allow the elimination of waste products from the gut, prior to the analysis of a number of trace metals. Mussel samples were not analysed for trace metals during the current monitoring period, as trace metal analysis is next scheduled to be undertaken in 2017-2018. Previous analyses are summarised in Table 9.

Table 9 Ranges of previous mussel trace metal concentrations (mg/kg wet weight), from before and after the redirection of HWWTP wastewater to the outfall in February 2001

Metal		Site				Australia NZ Food Standards Code 2016
		350 m NW SEA906049	1,000 m SE SEA906062	Pukeroa Reef SEA906067	3,200 m SE SEA906072	
Arsenic	Post	0.92-1.12	0.84-1.02	0.82-1.2	0.85-1.1	1.0
Cadmium	Pre	0.015	<0.005	0.008 - 0.032	0.014	2.0
	Post	0.031-0.048	0.024-0.046	0.022-0.05	0.022-0.048	
Chromium	Pre	0.26	0.21	0.2 - 0.22	0.19	-
	Post	0.06-0.14	0.03-0.10	0.03-0.13	0.03-0.10	
Copper	Pre	1.18	0.84	0.87 - 0.98	0.97	-
	Post	0.56-1.39	0.60-1.35	0.42-1.82	0.64-1.96	
Iron	Post	28	17.1	11.6	17.2	-
Lead	Pre	<0.05	<0.05	<0.05	<0.05	2.0
	Post	0.043-0.12	0.032-0.10	0.02-<0.1	<0.05-0.26	
Mercury	Pre	0.010	0.009	0.010-0.012	0.014	0.5
	Post	0.0096-0.012	0.0081-0.014	0.009-0.014	0.0096-0.016	
Nickel	Pre	0.67	0.46	0.51 - 0.55	0.58	-
	Post	0.28-1.60	0.33-0.77	0.27-1.1	0.31-1.6	
Zinc	Pre	5.7	4.2	4.2 - 5.9	4.3	-
	Post	5.6-8.06	4.5-7.5	2.8-6.7	4.2-8.1	

*Australia New Zealand Food Standards Code guideline is for inorganic arsenic which is estimated to be 10 % of total arsenic. The Council results are for total arsenic.

Historically, concentrations of cadmium and lead have remained well below their respective limits in the Australia New Zealand Food Standards Code 2002 guidelines.

Levels of arsenic have also remained well below the guideline value, taking into consideration that the Council results are for total arsenic and that the Australia New Zealand Food Standards Code guideline is for inorganic arsenic, which is estimated to be 10 % of total arsenic.

Although no guidelines exist for the remaining metals, these trace metal levels are consistent with ranges of concentrations found in shellfish elsewhere on the Taranaki coastline.

2.3.3 Shoreline water quality

Special condition 4 of consent 5079-1, which provides for the discharge of Hawera municipal effluent from the outfall, states:

'That the discharge shall not result in the guideline for shellfish-gathering waters, as specified in the document 'Provisional Microbiological Water Quality Guidelines for Recreational and Shellfish-Gathering Waters in New Zealand ' (Department of Health 1992), being exceeded at the shoreline.'

That is, the median faecal coliform content of samples taken over a shellfish gathering season shall not exceed 14 MPN/100 ml, and no more than 10 % of the samples should exceed 43 MPN/100 ml (five-tube decimal dilution test).

To determine compliance with this condition, the Council monitored bacteriological water quality at five sites along the coastline and one site at the Tangahoe River mouth (Table 11; Figure 12).

Background monitoring started in April 1997, with three surveys conducted prior to the commissioning of the long outfall. Seventeen surveys were undertaken during the period when only the dairy factory wastewater was discharged. A further 87 surveys have been undertaken since the introduction of the HWWTP discharge to the outfall in February 2001. Due to the safety concerns outlined in Section 2.3.2, only one survey was undertaken in the 2016-2017 monitoring period.

Table 10 Locations of bacteriological receiving water quality monitoring sites

Site code	Location	GPS coordinates
SEA906020 (control site)	Tasman Sea; NW Waihi S, 5.7 km NW of outfall	1706405 - 5615244
SEA906047	Tasman Sea; 1.05 km NW of outfall	1710549 - 5613060
SEA906062	Tasman Sea; Pukeroa reef (north end), 1 km SE of outfall	1712139 - 5612118
SEA906067	Tasman Sea; Pukeroa reef (south end), 1.65 km SE of outfall	1712575 - 5611785
SEA906072	Tasman Sea; 3.2 km SE of outfall	1713874 - 5610904
TNH000998	Tangahoe River; at mouth, 5 km SE of outfall	1715337 - 5609999
OXP008002	Maturation cells, final effluent from the three cell ponds	1708744 - 5614285

The samples were analysed for faecal coliforms by the MPN method. Conductivity was analysed to provide an indication of the influence of freshwater inflows from coastal streams and/or the Tangahoe River. Results for the 2016-2017 monitoring period are presented in Table 11.

Table 11 Receiving water faecal coliform (FC) counts and conductivity values (mS/m @ 20°C) from the maturation pond and sites adjacent to the outfall during the 2016-2017 period

Date	Site													
	OXP008002		SEA906020		SEA906047		SEA906062		SEA906067		SEA906072		TNH000998	
	FC cfu/100 ml	Conductivity	FC MPN/100 ml	Conductivity	FC MPN/100 ml	Conductivity	FC MPN/100 ml	Conductivity	FC MPN/100 ml	Conductivity	FC MPN/100 ml	Conductivity	FC MPN/100 ml	Conductivity
26-Apr-17	1300	65	49	4590	8	4550	13	4580	<2	4590	<2	4580	920	32
Historical FC data (2001-2016)														
No. of samples			87		85		84		86		87		87	
Min			1.8		1.8		1.8		0.9		0.9		80	
Max			900		300		500		300		300		9000	
Median			7.8		4		4		4		7.8		500	

Note: Where necessary, values of <1.8 have been transformed to 1.0 to calculate a median.

The 10 % guideline requirement could not be adequately assessed, as only one sample was collected at each site during the monitoring period. Faecal coliform counts were low at most seawater monitoring sites, except for the control site at Waihi (SEA906020), where the faecal coliform concentration of the receiving water sample exceeded 43 MPN/100 ml (Table 11). Although the conductivity value of the sample was similar to the values recorded at the other monitoring sites, the source of this contamination is likely to be from a nearby freshwater stream influence, located approximately 500 m away from the sample site.

The median guideline requirement could not be assessed either, due to the insufficient number of samples collected in the monitoring year; one sample was collected at each site.

A considerably higher faecal coliform concentration was recorded for the sample collected from the Tangahoe River, compared with the other monitoring sites. The historical median for this site is also considerably higher in comparison, which is likely due to runoff from the extensively farmed land in the catchment. This indicates that the main source of faecal contamination in the area is likely from the river, rather than from the outfall.

There has been a tendency for the higher faecal coliform results found at the shoreline to coincide with elevated counts in the nearby Tangahoe River, particularly following flooding events. Conductivity data support this, as lower conductivities (indicative of increased freshwater influence) have often coincided with increased bacterial counts. However, such a pattern is not evident in the 2016-2017 monitoring results.

A comparison of all monitoring data from before and after the connection of the HWWTP discharge to the outfall in 2001 is provided in Figure 12.

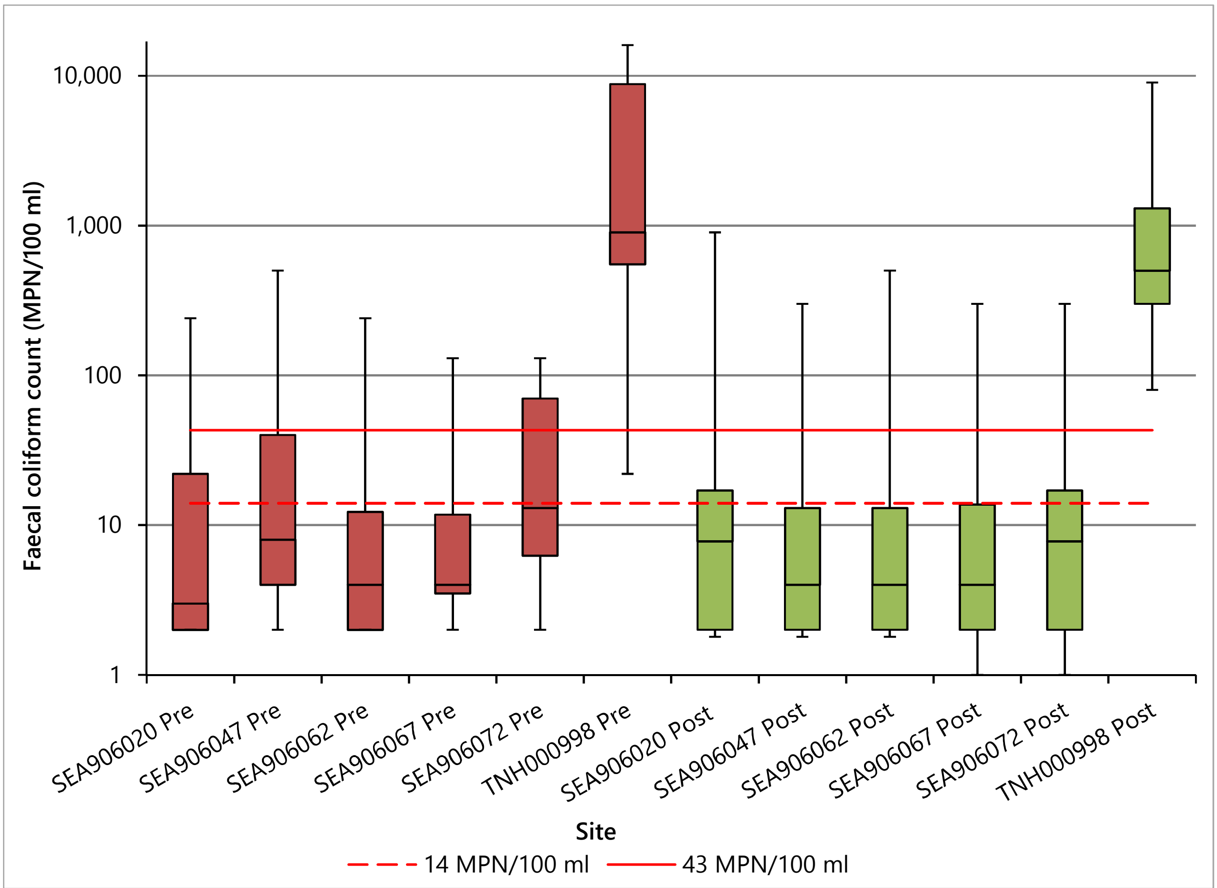

Figure 12 Box and whisker plot of faecal coliform counts (MPN/100ml) at shoreline sites and in the Tangahoe River before (1993-2000) and after (2001-2017) the connection of the HWWTP discharge to the outfall

2.4 Additional reporting requirements

Consent 5079-1 contains six special conditions relating to reporting and approval requirements.

Condition 6 required that STDC advises and consults with the Council if trade wastes are accepted into the wastewater system for which it may be appropriate or necessary to place limits on concentrations of any toxic or hazardous contaminants. This condition was not exercised during the 2016-2017 season.

Condition 8 required STDC to provide, within three months of granting of the consent (i.e. by 20 March 2008), a contingency plan outlining measures and procedures to be undertaken to prevent spillage or accidental discharge of contaminants in the event of a breakdown, including measures to avoid, remedy or mitigate the environmental effects of such a discharge. The consent condition requires that this plan is updated annually. A management and contingency plan for the site was produced in May 2008, and this was up-to-date as of August 2017.

Condition 9 required STDC to supply an annual report on its waste treatment system, including the performance of the outfall and compliance with the consent, by 31 August each year. This report, dated 25 October 2017, was received. The delay in reporting was relating to ongoing discussion regarding discharge volume issues and requirements requested within 14 day letters. Its contents are discussed further in Section 3.1.

Condition 10 required that STDC supply a report reviewing the best practicable option for treatment and disposal of wastewater generated at Hawera and Eltham, due by 31 December 2009. This was carried out by consultants, and after initial discussions with iwi and Council in October 2008, was presented to iwi in December 2008. A further presentation was made in March 2009, and no feed-back from iwi was received. The report was submitted to the Council in December 2009.

Condition 11 outlined the four main actions required to complete the project. Condition 12 required that reports on the implementation of condition 11 are provided to the Council by 31 March, 30 June, 30 September and 15 December of each year until implementation is complete. Implementation was complete by 30 June 2011; therefore reports are no longer required to be submitted.

Condition 13 requires that the consent holder and staff of the Council meet with representatives various iwi, other submitters to the consent and any other interested party to discuss any matters relating to the consent and facilitate ongoing consultation. In addition, condition 15 requires that the scope and detail of the monitoring programme (as required by condition 14) is developed in consultation with submitters. The Annual Stakeholder Liaison Meeting was held on 27 September 2017 at Fonterra Whareroa. The design of the shellfish monitoring programme was considered which included discussion of shellfish norovirus monitoring and results.

2.5 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 STDC. During the year matters may arise which require additional activity by the Council, for example provision of advice and information, or investigation of potential or actual causes of non-compliance or failure to maintain good practices. A pro-active approach that in the first instance avoids issues occurring is favoured.

The Council operates and maintains a register of all complaints or reported and discovered excursions from acceptable limits and practices, including non-compliance with consents, which may damage the environment. The incident register includes events where the 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).

In the 2016-2017 period, the Council was required to undertake significant additional investigations and interventions, or record incidents, in association with STDC's conditions in resource consents or provisions in Regional Plans.

Self notification was received from STDC on 18 May 2017 regarding the exceedance of discharge volume (>12,000 m3 per day based on the seven day average) from the HWWTP to the Outfall (see Section 2.2.4). Investigation found that the discharge was undertaken under the emergency works provisions of the Resource Management Act 1991 after all other options had been considered. The exceedance occurred due to unusually high rainfall during the months prior to the discharge.

Two 14 day letters were issued in relation to the incident and a number of meetings were held with the Council, STDC and Taranaki District Health Board. STDC were required to provide a report on inflow and infiltration and undertake additional shellfish monitoring in response to the discharge volume exceedances. Mussels were tested for norovirus on 8 June, 25 July and 6 October 2017. All samples came back with either low or not detectable levels of norovirus. As only low concentrations of norovirus are required to pose a high risk of infection in humans health warning signs were erected to the main access points to shellfish gathering reefs in the vicinity of the outfall discharge. It is uncertain whether the low positive results occurred as a result of increased discharge volume, prolonged onshore winds or a combination of the two.

Date	Site Code	Site Description	Mussel flesh norovirus	
			GI	GII
8 June 2017	SEA906049	350 m NW of outfall	Low	Low
	SEA906067	Pukeroa Reef	Negative	Negative
25 July 2017	SEA906049	350 m NW of outfall	Low	Low
	SEA906067	Pukeroa Reef	Low	Low
6 Oct 2017	SEA906049	350 m NW of outfall	Negative	Negative
	SEA906067	Pukeroa Reef	Negative	Negative
	SEA906072	Koutu	Negative	Low

Figure 13 Norovirus levels in mussel flesh

3 Discussion

3.1 Discussion of site performance

Regular inspections of the HWWTP found that odours, ranging from noticeable to strong, were often detected downwind of the anaerobic lagoon. Odours were never detected beyond the site boundary.

The consented level for the effluent discharge dissolved oxygen is 90 % minima of 2 g/m^3requirement. No permanent DO meter is installed on the effluent line however portable grab sampling of the maturation cells shows that the 2 g/m^3 limit was achieved for 97 % of the time. Pond 1 was above the minima for an average of 88.1% of the time and Pond 2 was above the 2 g/m^3 for 87.6% of the time.

There were no objectionable odours noted by the Council or STDC in the vicinity of the aerobic ponds during the 2016-2017 year. STDC is currently reviewing the aeration system in these ponds due to the sub-optimal performance of the current system and its associated costs.

The consent limit (12,000 m^3) on the volume of discharge from the HWWTP was exceeded on four occasions consisting of 40 days in total. These exceedances coincided with the prolonged and heavy rainfall over the year, with a particularly wet summer (Figure 4). Additional shellfish monitoring was undertaken the results of which are presented in Table 13 and discussed below in Section 3.2.

There were no overflows from the retention basin to the environment during the monitoring period. Therefore, consent 7520-1 to discharge to the stream in the event of high rainfall was not exercised in the 2016-2017 monitoring period.

Pond 1 and 2 inlets fouled on several of occasions during the year under review. This affected the flow split and loading portions for the ponds and the fault was rectified by cleaning. Control gates, to better divide the flow have now been installed and permanent flow monitoring for both pond inlets is being investigated.

The de-sludging trial in Pond 1 was ongoing during the monitoring period. Pond 2 sludge levels were measured and results indicate maintenance bacterial dosing will also be initiated in future.

3.2 Environmental effects of exercise of consents

During the 2016-2017 period, STDC discharged effluent from HWWTP to the Tasman Sea via the Outfall. The Council monitored the environmental effects of discharges by assessment of hard substrate communities in the intertidal zone, along with shoreline water and shellfish monitoring for microbiological quality and metals.

Impacts of the Outfall discharge on local intertidal communities were not evident in the two surveys undertaken during the monitoring period (Appendix II). An insufficient number of samples were collected to provide a robust representation of the microbiological quality of the receiving shoreline waters and shellfish during the year under review. This was the result of the unstable state of the cliffs following an extreme weather event in June 2015, making sampling unsafe for much of the year. The results from this year's faecal coliform monitoring of shoreline water and shellfish sampling results were comparable with those from previous years, however it must be recognised that these results provide only a snapshot.

Additional shellfish monitoring was undertaken in response to the discharge volume exceedances. Mussels were tested for norovirus on 8 June, 25 July and 6 October 2017. All samples came back with either low or not detectable levels of norovirus. As only low concentrations of norovirus are required to pose a high risk of infection in humans health warning signs were erected to the main access points to shellfish gathering reefs in the vicinity of the outfall discharge. It is uncertain whether the low positive results occurred as a result of increased discharge volume from the outfall, prolonged onshore winds or a combination of the two. It is recommended that norovirus monitoring of shellfish is introduced into the routine monitoring programme to determine the extent of health risks associated with eating mussels at different times if year and under varying meteorological/oceanographic conditions.

3.3 Evaluation of performance

A summary of the consent holder's compliance record for the year under review is set out in Tables 12 and 13.

Table 12 Summary of performance for consent 5079-1

Purpose: *To discharge up to 12,000 m³/day of treated municipal wastes through a marine outfall*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Maintenance and operation of system	Inspections and sampling	Yes
2. Maintenance of DO level in ponds ≥ 2 gm^{-3} for 90% time between hours of 11:00 and 14:00	Consent holder continuous recording; supply of data; and sampling	No
3. Limits on receiving water effects in Tasman Sea	Inspections and ecological surveys	Yes
4. Discharge not result in exceedance of shellfish-gathering microbiological guidelines	Bacteriological sampling	Yes
5. Provision of discharge volume records	Records supplied by consent holder	Yes
6. Consultation with Council re trade wastes	Liaison with consent holder	N/A
7. Management of system	Inspections and self monitoring data from STDC	Yes
8. Provision of contingency plan (annual review)	Up-to-date as of August 2017	Yes
9. Supply of annual report by 31 August	Supplied by consent holder	Yes
10. Supply of report reviewing options for treatment of wastewater	Previously supplied by consent holder	Yes
11. Schedule of works and upgrades to be completed	Works complete	N/A
12. Supply of reports on implementation of condition 11	Works complete	N/A
13. Annual meeting with interested parties	Held in September 2017	Yes
14. Establishment of coastal and ecological monitoring programmes	Implementation of tailored monitoring programmes	Yes

Purpose: *To discharge up to 12,000 m³/day of treated municipal wastes through a marine outfall*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
15. Monitoring programme to be developed in consultation with submitters	Liaison with consent holder and parties	Yes
16. Installation of screening	Inspections	Yes
17. Optional review provision re environmental effects		N/A
Overall assessment of consent compliance and environmental performance in respect of this consent		**Improvement required**
Overall assessment of administrative performance in respect of this consent		**Good**

N/A = not applicable

Table 13 Summary of performance for consent 7520-1

Purpose: *To discharge partially treated wastewater to an unnamed stream as a consequence of high rainfall*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
1. Discharge shall only occur as a consequence of high rainfall events	Notification and inspections	N/A
2. Temporary holding pond capacity shall be no less than 55,000 cubic metres	Inspections	Yes
3. No modifications to the treatment plant that may result in an increase in the frequency of the discharge.	Inspections	Yes
4. Provision of discharge timing and volume records	Records supplied by consent holder	N/A
5. Adopt the best practicable option	Inspections	Yes
6. Notification of Council immediately after a discharge.	Records supplied by consent holder	N/A no discharges
7. Provision of contingency plan	Up-to-date as of August 2017	Yes
8. Monitoring programme including physicochemical, bacteriological and ecological monitoring of the wastewater treatment system and receiving waters	Inspection and sampling	N/A no discharges
9. Optional review provision re environmental effects		N/A

Purpose: *To discharge partially treated wastewater to an unnamed stream as a consequence of high rainfall*		
Condition requirement	**Means of monitoring during period under review**	**Compliance achieved?**
Overall assessment of consent compliance and environmental performance in respect of this consent Overall assessment of administrative performance in respect of this consent		**High** **High**

N/A = not applicable

An improvement in STDC's environmental performance is required. DO concentrations in both ponds were, at times, not compliant with consent conditions. However no odour issues were recorded outside the boundary of the site. The consent limit (12,000 m^3) on the volume of discharge from the HWWTP was exceeded on four occasions consisting of 40 days. These exceedances coincided with prolonged and heavy rainfall over the year. During the period under review there were was one unauthorised incident reported at the HWWTP site that required considerable follow up in terms of two 14 day letters and several meetings. No further enforcement action was required within the reporting period.

3.4 Recommendations from the 2015-2016 Annual Report

In the 2015-2016 Annual Report, it was recommended:

1. THAT monitoring of the HWWTP, comprising inspection and effluent analysis in relation to the treatment system, and water quality and shellfish tissue analysis in relation to the receiving waters, be continued for the 2016-2017 monitoring period.
2. THAT the 2016-2017 monitoring programme continues to be integrated with and complementary to that for Fonterra's discharge through the same ocean outfall.
3. THAT regular maintenance of the waste treatment system is performed by the consent holder who shall maintain adequate records of the operation of the system.
4. THAT the consent holder liaises with the Council with respect to any proposed additional industrial waste discharge to the system in order that potential impacts may be addressed and if necessary, additional monitoring requirements formulated.
5. THAT the consent holder liaises with the Council with respect to any modifications to the ponds system, and its performance.
6. THAT the consent holder continues a bi-monthly schedule for reporting volumes discharged and continuous ponds' DO levels to the Council.
7. THAT the consent holder supply Council with an annual report on its waste treatment system, including the performance of the outfall and compliance with the consent by 31 August 2015, as required by condition 9 of consent 5079-1.
8. THAT a liaison meeting is held with iwi, submitters and other interested parties as per condition 13 of consent 5079-1.

3.5 Alterations to monitoring programmes for 2017-2018

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

- the extent of information already made available through monitoring or other means to date;
- its relevance under the RMA;
- the Council's obligations to monitor consented activities and their effects under the RMA;
- the record of administrative and environmental performances of the consent holder; and
- reporting to the regional community.

The Council also takes into account the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of industrial processes within Taranaki exercising resource consents.

It is proposed that for 2017-2018 the shellfish monitoring programme is reviewed in discussion will relevant parties and that the remainder of the monitoring programme remain unchanged.

It should be noted that the proposed programme represents a reasonable and risk-based level of monitoring for the site(s) in question. The Council reserves the right to subsequently adjust the programme from that initially prepared, should the need arise if potential or actual non-compliance is determined at any time during 2017-2018.

4 Recommendations

1. THAT in the first instance, monitoring of the HWWTP, comprising inspection and effluent analysis in relation to the treatment system, and water quality and shellfish tissue analysis in relation to the receiving waters, be continued for the 2017-2018 monitoring period.
2. THAT should there be issues with environmental or administrative performance in 2017-2018, monitoring may be adjusted to reflect any additional investigation or intervention as found necessary.
3. THAT the shellfish monitoring programme is reviewed.
4. THAT local Iwi and hapu are invited to join Council staff for shellfish sampling when safe to do so.
5. THAT the 2017-2018 monitoring programme continues to be integrated with and complementary to that for Fonterra's discharge through the same ocean outfall.
6. THAT regular maintenance of the waste treatment system is performed by the consent holder who shall maintain adequate records of the operation of the system.
7. THAT the consent holder liaises with the Council with respect to any proposed additional industrial waste discharge to the system in order that potential impacts may be addressed and if necessary, additional monitoring requirements formulated.
8. THAT the consent holder liaises with the Council with respect to any modifications to the ponds system, and its performance.
9. THAT the consent holder supply Council with an annual report on its waste treatment system, including the performance of the outfall and compliance with the consent by 31 August 2018, as required by condition 9 of consent 5079-1.
10. THAT a liaison meeting is held with iwi, submitters and other interested parties as per condition 13 of consent 5079-1.

Glossary of common terms and abbreviations

The following abbreviations and terms may be used within this report:

As*	Arsenic.
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.
Cr*	Chromium
Cd*	Cadmium
cfu	Colony forming units. A measure of the concentration of bacteria usually expressed as per 100 millilitre sample.
COD	Chemical oxygen demand. A measure of the oxygen required to oxidise all matter in a sample by chemical reaction.
Conductivity	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 20°C and expressed in mS/m.
Cu*	Copper.
DO	Dissolved oxygen.
DRP	Dissolved reactive phosphorus.
E.coli	Escherichia coli, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Ent	Enterococci, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre of sample.
F	Fluoride.
FC	Faecal coliforms, an indicator of the possible presence of faecal material and pathological micro-organisms. Usually expressed as colony forming units per 100 millilitre sample.
Fresh	Elevated flow in a stream, such as after heavy rainfall.
g/m^3	Grams per cubic metre, and equivalent to milligrams per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures.
Incident	An event that is alleged or is found to have occurred that may have actual or potential environmental consequences or may involve non-compliance with a consent or rule in a regional plan. Registration of an incident by the Council does not automatically mean such an outcome had actually occurred.
Intervention	Action/s taken by Council to instruct or direct actions be taken to avoid or reduce the likelihood of an incident occurring.

Investigation	Action taken by Council to establish what were the circumstances/events surrounding an incident including any allegations of an incident.
Incident Register	The Incident Register contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan.
L/s	Litres per second.
m^2	Square Metres.
mS/m	Millisiemens per metre.
Mixing zone	The zone below a discharge point where the discharge is not fully mixed with the receiving environment. For a stream, conventionally taken as a length equivalent to 7 times the width of the stream at the discharge point.
NH_4	Ammonium, normally expressed in terms of the mass of nitrogen (N).
NH_3	Unionised ammonia, normally expressed in terms of the mass of nitrogen (N).
Ni*	Nickel
NO_3	Nitrate, normally expressed in terms of the mass of nitrogen (N).
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water.
O&G	Oil and grease, defined as anything that will dissolve into a particular organic solvent (e.g. hexane). May include both animal material (fats) and mineral matter (hydrocarbons).
Pb*	Lead.
pH	A numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5.
Physicochemical	Measurement of both physical properties (e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment.
Resource consent	Refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15).
RMA	*Resource Management Act 1991* and including all subsequent amendments.
SS	Suspended solids.
SQMCI	Semi quantitative macroinvertebrate community index.
Temp	Temperature, measured in °C (degrees Celsius).
Turb	Turbidity, expressed in NTU.
UI	Unauthorised Incident.
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 STDC for the HWWTP

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

Appendix II

Intertidal Survey Memorandums Spring 2016 and Summer 2017

Appendix I

Resource consents held by STDC for the HWWTP

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

Coastal 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
Change To Conditions Date:	29 June 2010 [Granted: 22 March 1998]

Conditions of Consent

Consent Granted:	To discharge up to 12,000 cubic metres/day [seven day average discharge] of treated municipal wastes generated in the Hawera and Eltham townships, including treated meat processing and dairy industry wastes, through a combined marine outfall into the Tasman Sea near Hawera at or about (NZTM) 1710652E-5611568N
Expiry Date:	1 June 2015
Review Date(s):	June 2010
Site Location:	Rifle Range Road, Hawera
Legal Description:	Pt Lot 13 DP 2625 and Foreshore Blks IX & X Hawera SD
Catchment:	Tasman Sea

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 consent holder shall properly and efficiently maintain and operate the oxidation ponds system, with aerobic ponds maintained in an aerobic condition during daylight hours.

2. For 90% of the time <u>between the hours of 1100-1400</u> the dissolved oxygen level in the aerobic ponds, and in the wastewater immediately prior to discharge, shall be maintained at a level at or exceeding 2 gm^{-3} and that the consent holder shall monitor the dissolved oxygen levels in the aerobic ponds, on a continuous basis, and supply the results to the Chief Executive, Taranaki Regional Council, upon request.

3. The discharge authorised by this consent shall not give rise to any of the following effects in the Tasman Sea beyond a mixing zone of 200 metres from the centre line of the outfall diffuser:

   a) the production of conspicuous oil or grease films, scums or foams or floatable or suspended materials;
   b) any conspicuous change in the colour or visual clarity;
   c) any emission of objectionable odour;
   d) any significant effects on aquatic life.

4. The discharge shall not result in the guideline for shellfish-gathering waters, as specified in the document 'Provisional Microbiological Water Quality Guidelines for Recreational and Shellfish-Gathering Waters in New Zealand' [Department of Health 1992], being exceeded at the shoreline.

5. The consent holder shall monitor the volume of wastewater discharged on a continuous basis and shall supply this information to the Chief Executive, Taranaki Regional Council, upon request.

6. The consent holder shall undertake to advise and consult with the Taranaki Regional Council if trade wastes are accepted into the consent holder's wastewater system, for which it may be appropriate or necessary to place limits on the concentrations in the final discharge of any toxic or hazardous contaminants which may be contained in that trade waste. If such limits are considered necessary, the Chief Executive, Taranaki Regional Council, shall require a review of the consent conditions in accordance with s128 of the Resource Management Act 1991.

7. The consent holder shall manage the discharge so as to ensure compliance with special condition 3.

8. Within three months of the granting of this consent, the consent holder shall provide to the Chief Executive, Taranaki Regional Council, a contingency plan outlining measures and procedures undertaken to prevent spillage or accidental discharge of contaminants in the event of plant, including the wastewater pipeline and pumping system, breakdown or maintenance and measures to avoid, remedy or mitigate the environmental effects of such a spillage or discharge. The consent holder shall annually review and maintain the plan.

9. The consent holder shall supply to the Chief Executive, Taranaki Regional Council, an annual report on its waste treatment system, including the performance of the outfall and compliance with the consent; such report to be provided by 31 August each year.

10. The consent holder shall supply to the Chief Executive, Taranaki Regional Council, a report reviewing the best practicable option for treatment and disposal of wastewater generated at Hawera and Eltham, including the option of disposal to land, such report to be provided by 31 December 2009.

11. The consent holder shall, substantially in accordance with information submitted in support of application 2541, including the Eltham Sewage Disposal Project Schedule:

    a) Reduce stormwater infiltration to the Hawera wastewater system;
    b) Upgrade the Eltham wastewater treatment plant;
    c) Upgrade the Hawera wastewater treatment plant; and
    d) Construct a pipeline for the transfer of municipal sewage waste from Eltham to Hawera.

    Once the above works are complete, the consent holder shall discharge all Eltham wastewater, via the pipeline, to the Hawera wastewater treatment plant. The works shall be completed, and the discharge shall commence, by 31 July 2009.

12. The consent holder shall provide reports on implementation of condition 11 [including progress on the Eltham Sewage Disposal Project Schedule, and detailing changes to the schedule] to the Chief Executive, Taranaki Regional Council, by 31 March, 30 June, 30 September, and 15 December of each year until implementation is complete.

13. The consent holder and staff of the Taranaki Regional Council shall meet as appropriate and at least once per year, with representatives of Ngati Ruanui Iwi Authority, Inuawai/Okahu hapu and Kanihi/Umutahi hapu, other submitters to the consent, and any other interested party, at the discretion of the Chief Executive, Taranaki Regional Council, to discuss any matter relating to the exercise of this resource consent, in order to facilitate ongoing consultation.

14. The consent holder shall ensure that a monitoring programme is established to record and analyse effects of the exercise of this consent on the intertidal reefs and coastal water quality adjacent to the discharge to the satisfaction of the Chief Executive, Taranaki Regional Council.

15. The scope and detail of the monitoring programme established in special condition 14 shall be developed in consultation with submitters to applications 96/302 and 2541 in relation to this consent.

16. The consent holder shall install a screen prior to the influent reaching the southern aerobic oxidation pond for the purpose of preventing the discharge of undisintegrated solids into and from the oxidation pond.

17. 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 within six months of receiving a report prepared by the consent holder pursuant to condition 10 of this consent, or by giving notice of review during the month of June 2010, for the purposes of:

    a) dealing with any significant adverse effect on the environment arising from the exercise of the consent which was not foreseen at the time the application was considered or which it was not appropriate to deal with at the time; and/or
    b) requiring the consent holder to adopt the best practicable option for treatment and disposal of wastewater generated in Hawera and Eltham.

    In determining, whether such a review is undertaken, the Regional Council will take into account the views expressed by Ngati Ruanui Tahua Iwi Authority Inc., Inuawai/Okahu Hapu and Kanihi/Umutahi Hapu, and the consent holder.

Signed at Stratford on 29 June 2010

For and on behalf of
Taranaki Regional Council

Director-Resource Management

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:	4 November 2009

Conditions of Consent

Consent Granted:	To discharge, as a consequence of high rainfall, partially treated wastewater from the Hawera Wastewater Treatment Plant into Unnamed Stream 22 at or about (NZTM) 1708616E-5614555N
Expiry Date:	1 June 2027
Review Date(s):	June 2015, June 2017, June 2021
Site Location:	Beach Road, Hawera
Legal Description:	Lot 1 DP 382332 Lot 1 DP 16178 Blk IX Hawera SD
Catchment:	Unnamed Stream 22

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 temporary holding pond capacity shall be no less than 55,000 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 4 November 2009

For and on behalf of
Taranaki Regional Council

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Director-Resource Management

Appendix II

Intertidal Survey Memorandums Spring 2016 and Summer 2017

To	**Science Manager – Hydrology/Biology, Regan Phipps**
From	Scientific Officer, Emily Roberts and Technical Officer, Angela Smith
Document	1887304
Date	23 June 2017

Fonterra Whareroa/Hawera Municipal Combined Outfall – Marine Ecological Survey Summer 2016/17

Introduction

Consent 1450 allows the discharge of dairy factory wastewater from the Fonterra Whareroa factory via a marine outfall. The consent allowing this discharge was renewed in September 1995, requiring the Company to install a long outfall by 31 August 1997. Prior to the renewal of this consent, the wastewater was discharged via a short marine outfall at approximately mean low water spring (MLWS) level, which caused significant adverse effects on marine intertidal ecology to at least 1000 m southeast of the outfall.

In February 2001, wastewater from the Hawera Oxidation Ponds was connected to the long outfall by consent 5079, allowing a municipal wastewater discharge of 10,000 m^3/day. By comparison, the Fonterra Whareroa wastewater discharge limit was 26,000 m^3/day. As of 19 September 2006, the permitted volume of wastewater discharge increased to 40,000 m^3/day. The oxidation pond discharge was also increased to 12,000 m^3/day in December 2007.

Special condition 6 of consent 1450 and special condition 3 of consent 5079 requires there to be no significant visual, chemical or ecological impacts outside of a 200 m mixing zone or within the intertidal zone. Specifically, consent 5079 requires the consent holder to ensure that a monitoring programme is established to record and analyse the effects on the intertidal reefs and water quality adjacent to the discharge. By conducting two surveys a year (one in spring and one in summer) it is possible to capture information on the seasonal variation of the intertidal communities and any possible effects from the outfall. Accordingly, two surveys of the intertidal zone were carried out as part of the 2016-2017 monitoring programme for the combined marine outfall. The 2016-2017 summer survey was conducted at four sites between 27 March and 24 April 2017; the results are reported in this memo.

Methods

Of the four sites surveyed, three have been identified by NIWA as having shoreline contact with the wastewater discharged from the outfall (Palliser *et al.*, 2013): 350 m northwest of the outfall (SEA906049), 200 m southeast of the outfall (SEA906057) and 1.55 km southeast of the outfall on Pukeroa Reef (SEA906067) (Photos 1-3; Figure 1). The control site at Waihi Reef (Photo 4; Figure 1), approximately 4.5 km northwest of the outfall (SEA906025), has been identified by NIWA as unlikely to be impacted by the discharged wastewater (Palliser *et al.*, 2013).

Photo 1 Surveying the potential impact site 350 m northwest of the outfall (28 March 2017)

Photo 2 Surveying the potential impact site 200 m southeast of the outfall (28 March 2017)

Photo 3 The survey site at Pukeroa Reef (8 June 2017)

Photo 4 Surveying the site at Waihi Reef (27 March 2017)

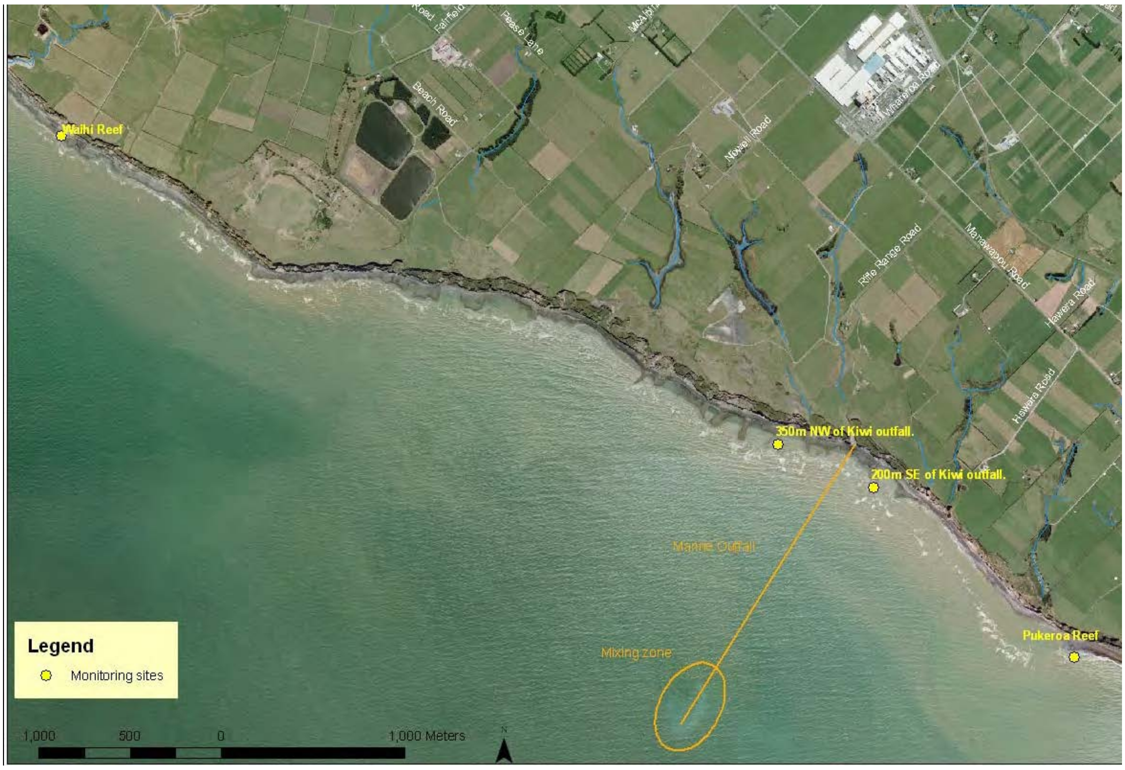

Figure 1   Map of sampling sites in relation to the outfall

At each site, a 50 m transect was used to establish five 5 m x 3 m blocks. Within each block, five random 0.25 m^2 quadrats were laid giving a total of 25 random quadrats (Photo 5). For each quadrat the percentage cover of algae and encrusting animal species was estimated using a grid. For all other animal species, individuals larger than 3 mm were counted. Under boulder biota was counted where rocks and cobbles were easily overturned.

Photo 5   Survey at the site located 200 m SE of the outfall, showing the transect in use

Results

Summary statistics, including the mean number of species per quadrat and the mean Shannon-Weiner indices, are shown in Table 1. Both the mean number of species and Shannon-Wiener index were highest at the site 350 m NW of the outfall, followed by Pukeroa Reef, Waihi Reef and then the site 200 m SE of the outfall.

Table 1 Mean results for the 2016-2017 summer survey

Site	Number of quadrats	Mean number of species per quadrat			Mean Shannon-Weiner indices per quadrat		
		Algae	Animals	Total Species	Algae	Animals	Total Species
Waihi Reef	25	2.88	7.6	10.48	0.25	0.66	0.76
350 m NW	25	4.96	9.40	14.36	0.58	0.75	0.93
200 m SE	25	1.48	4.96	6.44	0.15	0.41	0.49
Pukeroa Reef	25	2.96	9.60	12.56	0.41	0.79	0.90

Number of species per quadrat

Figure 2 shows the total number of species per quadrat as a box and whisker plot. The notched area of the box represents the median plus and minus a 95% confidence interval for the median. This form of graphical representation allows a quick comparison to be made between sites. Generally, if the notched areas of the boxes for the different sites do not overlap, one would expect to obtain a significantly different result with ANOVA.

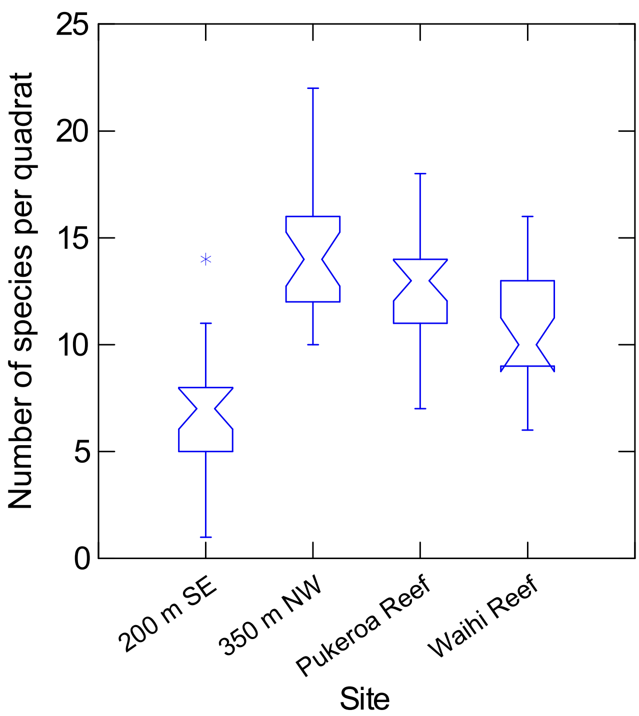

Figure 2 Box and whisker plots of the number of species per quadrat at each site

The data obtained from Waihi Reef, the site 200 m SE of the outfall and Pukeroa Reef conformed to the assumption of normal distribution. However, data from the site 350 m NW of the outfall significantly deviated from the normal distribution at the 95% confidence level (Lilliefors test, $n = 25$, $P < 0.05$). A natural logarithmic transformation was applied to the data. Only the data obtained from the Waihi Reef and the site 200 m SE of the outfall conformed to the assumption of normal distribution following this transformation. The data from the remaining two sites significantly deviated from the normal distribution at the 95% confidence level (Lilliefors test, n = 25, P < 0.05). As this ANOVA assumption could not be met, the remaining analyses were conducted using the raw data with non-parametric tests.

There was a significant difference in the number of species per quadrat between sites (Kruskal-Wallis, H = 52.08, degrees of freedom (df) = 3, P < 0.001). Significant differences between sites were determined using the Wilcoxon signed-ranks test, and are presented in Table 2. The total number of species found varied significantly between each site surveyed; in descending order of greatness, at the site located 350 m NW of the outfall, Pukeroa Reef, Waihi Reef and the site located 200 m SE of the outfall (n = 25, P < 0.05; Figure 2).

Table 2 Wilcoxon signed ranks test of number of species per quadrat

Site	Waihi	350 m NW	200 m SE
350 m NW	SIG		
200 m SE	SIG	SIG	
Pukeroa Reef	SIG	SIG	SIG

Key: SIG = significant difference at 95% confidence level

NS = no significant difference

Shannon-Weiner Diversity Index

Figure 3 shows the distribution of Shannon-Weiner Indices recorded at each site as box and whisker plots.

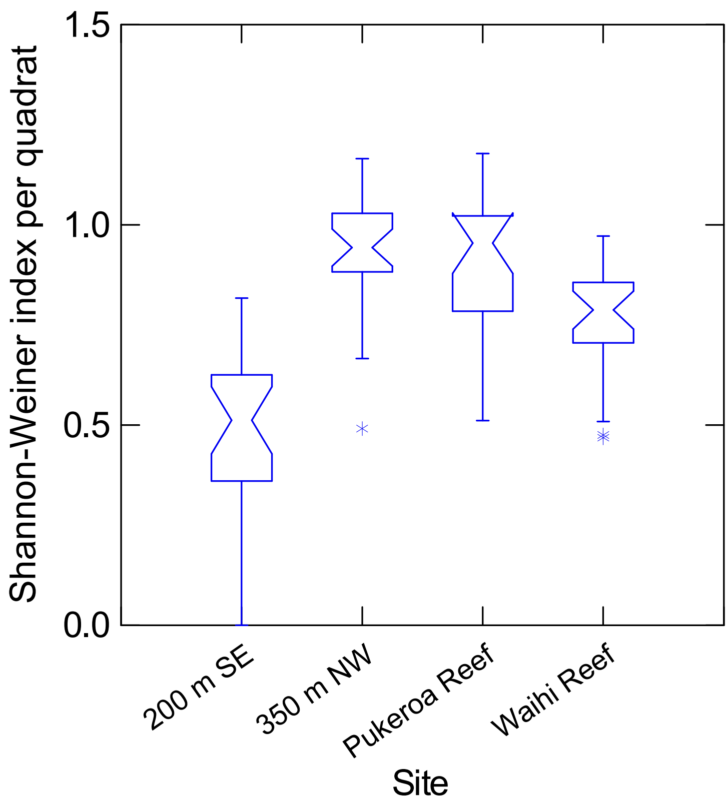

Figure 3 Box and whisker plots of Shannon-Weiner Indices at each site

The data obtained from each of the four surveys was found to be normally distributed (Lilliefors test, $n = 25$, $P > 0.05$). However the data variance at the site 200 m SE of the outfall was not homogeneous with the other sites (Figure 3). As this ANOVA assumption could not be met, the remaining analyses were conducted using the raw data with non-parametric tests.

There was a significant difference in the Shannon-Weiner Indices between sites (Kruskal-Wallis, $H = 51.08$, degrees of freedom (df) = 3, $P < 0.001$)[1]. Significant differences between sites were determined using the Wilcoxon signed-ranks test, and are presented in Table 3. The Shannon-Wiener Indices at Pukeroa Reef were not significantly different from those at the site 350 m NW of the outfall, and these two sites had significantly greater Shannon-Wiener Indices than the remaining two sites ($n = 25$, $P < 0.05$; Figure 3). The Shannon-Wiener Indices at the site 200 m SE of the outfall were significantly lower than at any other site ($n = 25$, $P < 0.05$; Figure 3).

Table 3 Wilcoxon signed ranks test with Shannon-Weiner index between sites

Site	Waihi	350 m NW	200 m SE
350 m NW	SIG		
200 m SE	SIG	SIG	
Pukeroa Reef	SIG	NS	SIG

Key: SIG = significant difference at 95% confidence level

NS = no significant difference

Sand coverage

The level of sand cover was low at the Pukeroa and Waihi Reef sites (Table 5, Figure 4). Sand cover was moderate at the two sites nearest the outfall. Abundance and diversity of intertidal species/communities can be significantly impacted by sand cover of 30% and higher.

Table 4 Mean sand coverage results for the 2017 summer survey

Site	Mean sand coverage (%)
Waihi Reef	0.60
350 m NW	15.84
200 m SE	4.33
Pukeroa Reef	0.64

Trends over time

Species number and diversity

Comparisons of the mean number of species per quadrat (Figure 4) and mean Shannon-Weiner diversity index per quadrat (Figure 5) for all summer surveys undertaken since January 1986 are shown below.

[1] The Kruskal-Wallis and Wilcoxon signed ranks tests are both non-parametric tests. This means they are not testing for differences in sample means (or medians) but rather they are testing for differences in the locations of sample distributions.

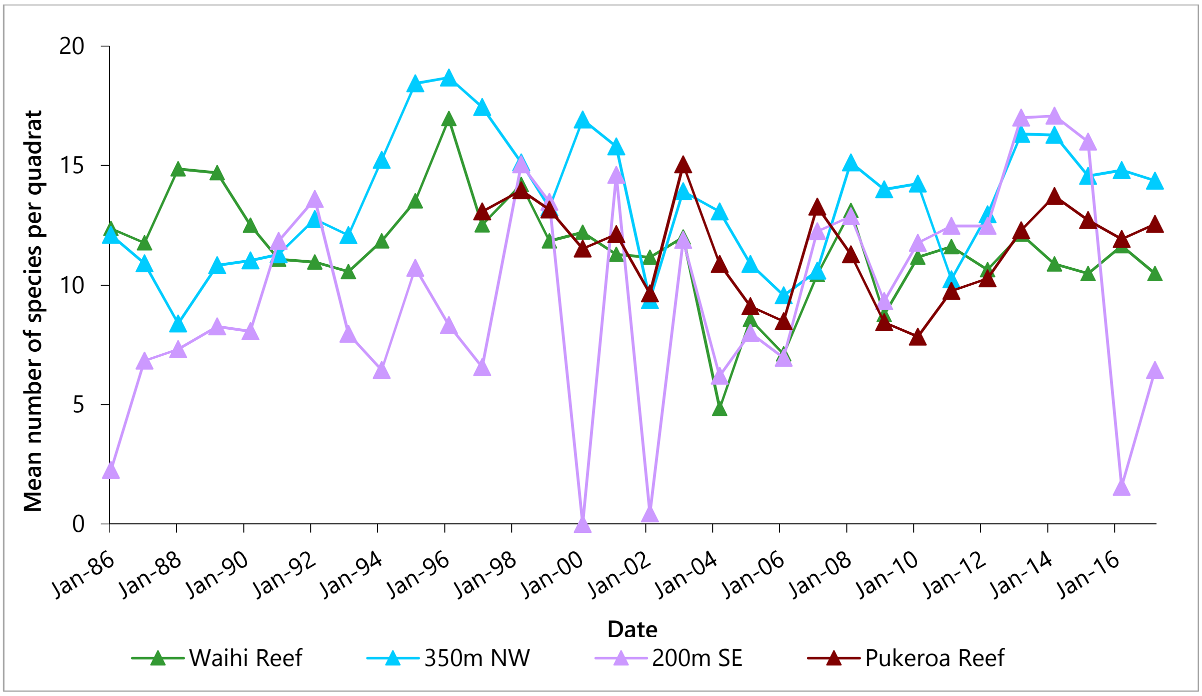

Figure 4 Mean number of species per quadrat for summer surveys (1986-2017)

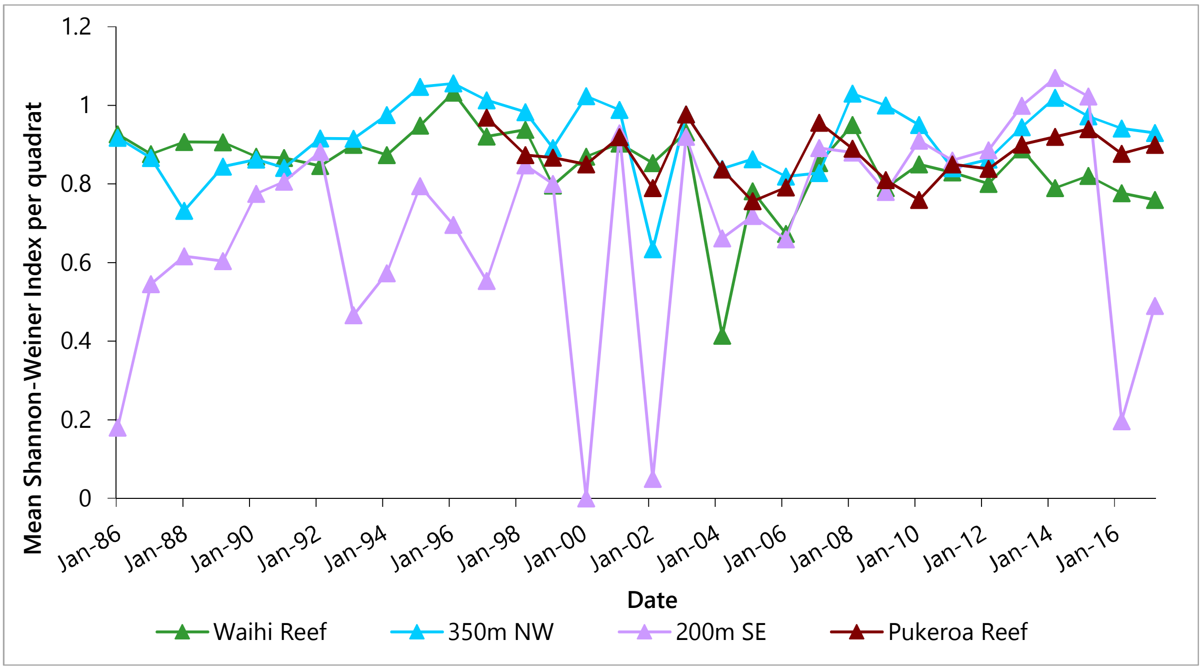

Figure 5 Mean Shannon-Weiner Indices per quadrat for summer surveys (1986-2017)

Prior to the installation of the long marine outfall in August 1997, both the number of species and the Shannon-Weiner Index per quadrat at the impact site 200 m SE were generally lower than at the control site at Waihi Reef (Figures 4 & 5). Since then (1997), sites have shown interannual variability in both number of species and Shannon-Weiner Index, but there has been no noticeable difference in trends between the impact site and the control sites over this period, with the exception of years with heavy sand inundation or slips (e.g. 2000, 2002 and 2016 at 200 m SE, Figures 4 & 5).

The results of the 2017 summer survey show a slight decrease in the mean number of species and the Shannon-Weiner index at Waihi Reef and 350 m NW when compared with the previous summer (Figures 4

& 5). The remaining two sites have shown an increase in the mean number of species and the Shannon-Weiner index from the previous summer.

Sand coverage

Over time, sand cover has generally remained low across the sites (Figure 6). Occasionally, however, the reefs experience events of sand inundation, where coverage increases substantially. Over the past ten years, the sites worst affected by inundation events have been those 200 m SE and 350 m NW of the outfall.

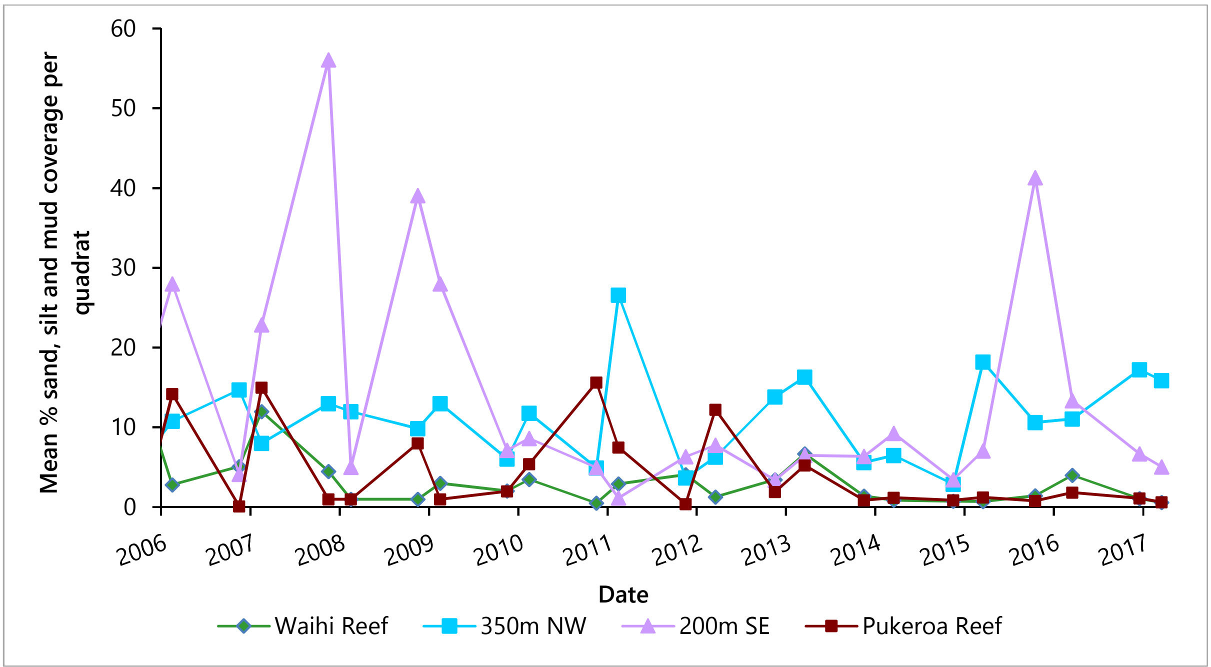

Figure 6 Mean percentage sand, silt and mud cover for summer and spring surveys (2006-2017)

Discussion

Previous surveys have shown that the dairy factory wastewater discharged through the near-shore outfall prior to 1997 (Photo 1) was having significant adverse effects on the local intertidal community. The adverse effects recorded included the coating of rocks and tidal pools with fats, significant coverage by filamentous bacterial growths and a significant decrease in ecological diversity. The nature and magnitude of adverse effects varied with distance from the outfall, and were most apparent at the sites 30 m and 200 m southeast of the outfall (note that the former site is no longer surveyed, as of 2007). In 1997 the dairy company installed a long outfall to discharge the wastewater nearly 2 km offshore in order to mitigate the adverse effects occurring along the coastline. Numerous spring and summer intertidal surveys have now been undertaken along the Hawera coastline subsequent to installation of the long outfall. Results show a general improvement in the health of intertidal communities following installation of the outfall. In February 2001, the Hawera Oxidation Ponds municipal wastewater was also connected to the long outfall.

Photo 6 Discharge from the dairy factory near-shore outfall prior to 1997

Impacts of the marine outfall discharge on the local intertidal communities were not evident from the 2017 summer survey results (Figures 4 & 5). Impact site 200 m SE, which was buried by a slip in the winter of 2015, had increased notably in terms of mean number of species (species richness) and Shannon-Wiener Index (diversity) compared to the previous survey; evidence of ongoing recovery. Compared with the previous survey, Pukeroa Reef also marginally increased in terms of species richness and diversity, while slight decreases were observed at impact site 350 m NW of the outfall and at the control site, Waihi Reef. The impact site 350 m NW of the outfall had the greatest species richness and diversity recorded of all four sites, despite having the highest sand coverage. Long-term results do not indicate any differential trends between the impact sites and control sites regarding species richness or diversity.

No coverage of silt and mud was observed at any of the sites during the 2017 spring survey. Sand coverage at the site 350 m NW of the outfall had increased from that of the previous survey, while coverage had decreased at all three of the remaining sites. The slip material deposited at site 200 m SE in 2015 had largely washed away, facilitating the recovery of impacted intertidal communities. The moderate cover of sand at the site 350 m NW of the outfall suggests a degree of resilience on the reef, considering the high level of species richness and diversity that was recorded. Long-term monitoring of intertidal rocky reefs around the Taranaki coastline has shown that the abundance and diversity of these communities can be adversely affected when sand coverage exceeds 30%. High percentage sand cover (>30%) has previously been recorded at the site 200 m SE of the outfall (Figure 6).

The historical record of survey results (Figures 4 & 5) shows no obvious impact of the marine outfall discharge on local intertidal communities since the installation of the long outfall in 1997. Control and potential impact sites show interannual variability, and there are no obvious declining trends at the impact sites closest to the outfall relative to the control site. It must be noted that the high-energy receiving environment, combined with the effects of suspended sediments from nearby rivers/streams and eroding cliffs, prevents the development of stable biological communities along the South Taranaki coastline (Clark *et al.*, 2012). Such communities could potentially mask any subtle ecological effects from the outfall wastewater discharge. However, in spite of these limitations, the long-term record indicates that the intertidal surveys are useful for detecting more noticeable effects from the wastewater, as the impact on intertidal communities prior to installation of the outfall is clearly evident (Figures 4 & 5; Clark *et al.*, 2012).

The most notable change in species composition since the commissioning of the long outfall is the decline of *Chaetomorpha* sp. (Photo 7) and the absence of filamentous bacterial growths at the site 200 m SE of the outfall (Figures 7 & 8). The adverse effects recorded prior to the long outfall also included the coating of rocks and tidal pools with fats and a significant decrease in ecological diversity.

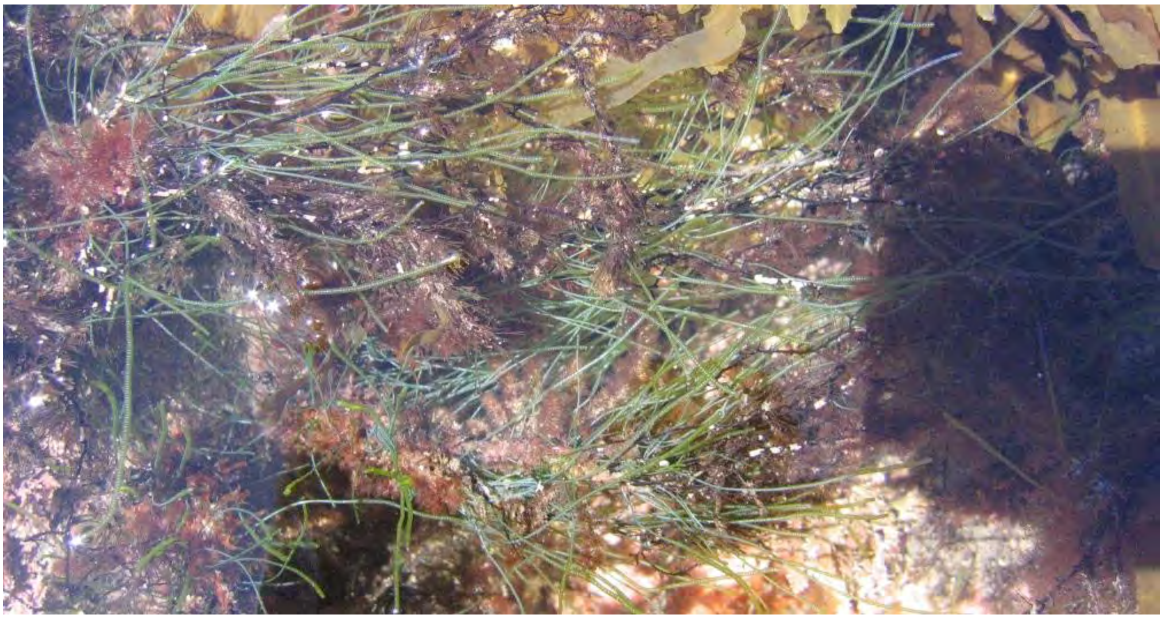

Photo 7 Green filaments of *Chaetamorpha*, an algal genus often associated with high nutrient concentrations (North Taranaki)

The inundation of earth, sand and silt resulting from cliff face erosion can be an important factor affecting species composition and diversity along the South Taranaki coastline. Indeed, the results presented here, and in recent surveys, have found land-based erosion to be the single most influential factor affecting the intertidal communities at these sites, following the burial of the 200 m SE reef site. The coast is in a constant state of erosion with layers of earth, sand and silt often deposited in the intertidal zone. Not only does fallen cliff material cripple marine communities through disturbance and burial, but observations indicate that freshly fallen earth provides a poor habitat for intertidal organisms. This factor could limit the resilience of reef communities encountering erosion events by deterring organisms from settling and ultimately prolonging the recovery timeframe. Another consequence of erosion is increased suspended sediment and restricted light availability in the seawater, which can impact on filter feeding organisms and algal growth respectively. In the current survey, it was noted that some species are starting to return to the 200 m SE Reef site, with much of the finer slip material having been washed away. The increased species richness and diversity recorded during this survey indicates that the gravels and rocks which remain on the reef are accommodating the settlement and recovery of the intertidal community (Photo 2).

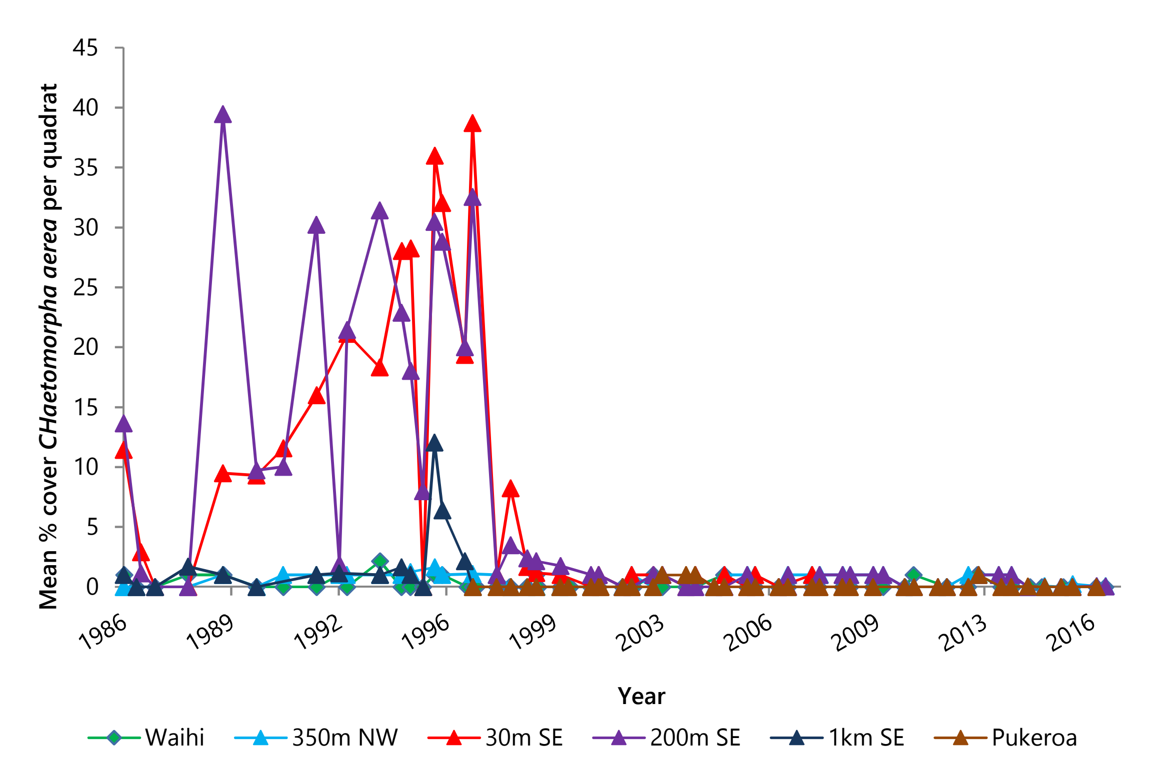

Figure 7 Mean percentage cover per quadrat of *Chaetomorpha aerea*, 1986-2017

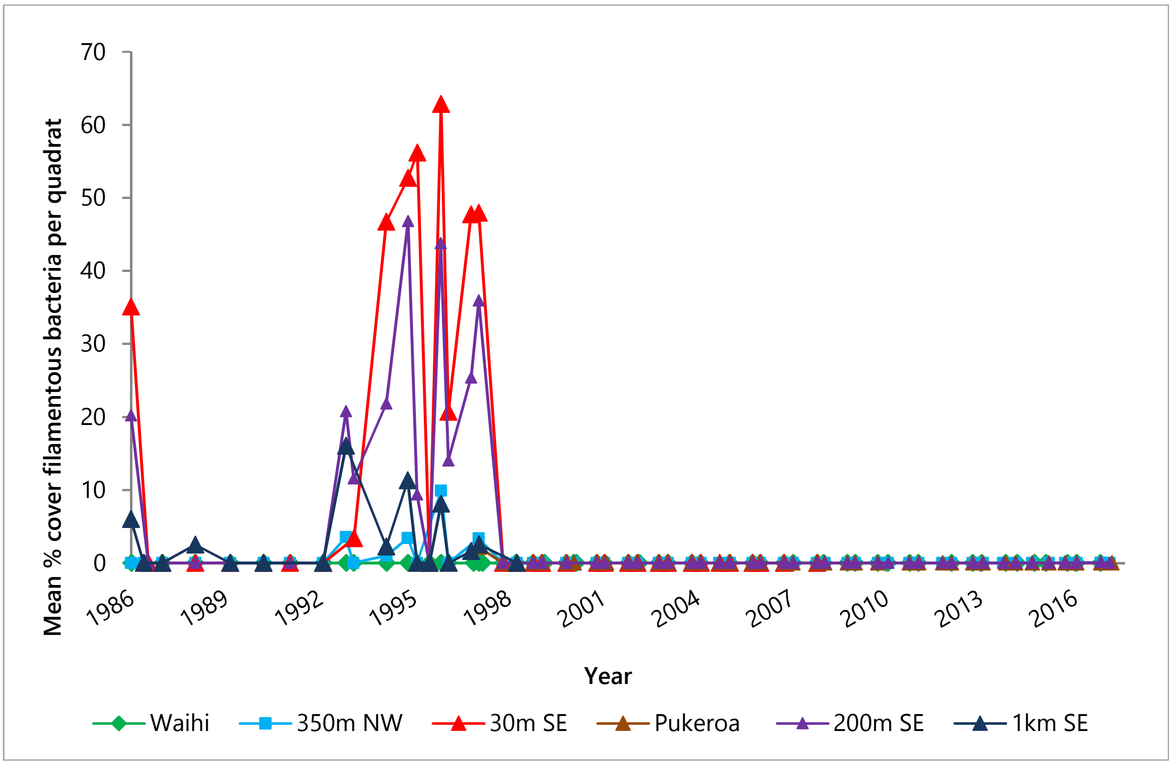

Figure 8 Mean percentage cover per quadrat of filamentous bacteria, 1986-2017

N.B. Since 2007, the sites 30 m SE and 1 km SE are no longer monitored as part of the Fonterra Whareroa intertidal survey.

Conclusions

In order to assess the effects of the Fonterra Whareroa and Hawera Waste Water Treatment Plant outfall discharge on the nearby intertidal communities, surveys were conducted between 27 March and 24 April 2017 at four sites. These surveys included three potential impact sites either side of the outfall (two southeast and one west) and one control site to the northwest. It was expected that adverse effects of the marine outfall discharge on the intertidal communities would have been evident as a significant decline in species richness and diversity at the potential impact sites relative to the control site.

None of the potential impact sites showed significant declines in species richness or diversity in relation to the control site. Instead, the potential impact sites 350 m NW of the outfall and Pukeroa Reef had significantly greater species richness and diversity than Waihi Reef (the control site). The remaining potential impact site located 200 m SE of the outfall showed signs of recovery after having been buried by a slip in 2015. Furthermore, there is no evidence of the potential impact sites declining in species richness or diversity over time, relative to the control site. These results indicate that the marine outfall discharge was not having detectable adverse effects on the intertidal reef communities of South Taranaki. Natural environmental factors, including coastal erosion, exposure and substrate mobility, appear to remain the dominant drivers of species richness and diversity at the sites surveyed.

Emily Roberts

Scientific Officer - Marine Ecologist

Angela Smith

Technical Officer

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To	**Science Manager – Hydrology/Biology, Regan Phipps**
From	Scientific Officer, Emily Roberts and Technical Officer, Thomas McElroy
Document	1915977
Date	18 January 2017

Fonterra Whareroa/Hawera Municipal Combined Outfall – Marine Ecological Survey Spring 2016/17

Introduction

Consent 1450 allows the discharge of dairy factory wastewater from the Fonterra Whareroa factory via a marine outfall. The consent allowing this discharge was renewed in September 1995, requiring the Company to install a long outfall by 31 August 1997. Prior to the renewal of this consent, the wastewater was discharged via a short marine outfall at approximately mean low water spring (MLWS) level which caused significant adverse effects on marine intertidal ecology to at least 1000 m southeast of the outfall.

In February 2001, wastewater from the Hawera Oxidation Ponds was connected to the long outfall by consent 5079, allowing a municipal wastewater discharge of 10,000 m^3/day. By comparison, the Fonterra Whareroa wastewater discharge limit was 26,000 m^3/day. As of 19 September 2006, the permitted volume of wastewater discharge increased to 40,000 m^3/day. The oxidation pond discharge was also increased to 12,000 m^3/day in December 2007.

Special condition 6 of consent 1450 and special condition 3 of consent 5079 requires there to be no significant visual, chemical or ecological impacts outside of a 200 m mixing zone or within the intertidal zone. Specifically, consent 5079 requires the consent holder to ensure that a monitoring programme is established to record and analyse the effects on the intertidal reefs and water quality adjacent to the discharge. By conducting two surveys a year (one in spring and one in summer) it is possible to capture information on the seasonal variation of the intertidal communities and any possible effects from the outfall. Accordingly, two surveys of the intertidal zone were carried out as part of the 2016-2017 monitoring programme for the combined marine outfall. The 2016-2017 spring survey was conducted at four sites between the 12th and the 14th of December 2016; the results are reported in this memo.

Methods

Of the four sites surveyed, three have been identified by NIWA as having shoreline contact with the wastewater discharged from the outfall (Palliser *et al.*, 2013): 350 m northwest of the outfall (SEA906049), 200 m southeast of the outfall (SEA906057) and 1.55 km southeast of the outfall on Pukeroa Reef (SEA906067) (Photographs 1-3, Figure 1). The control site at Waihi Reef (Photograph 4, Figure 1), approximately 4.5 km northwest of the outfall (SEA906025), has been identified by NIWA as unlikely to be impacted by the discharged wastewater (Palliser *et al.*, 2013).

Photo 1 Surveying the potential impact site 350 m northwest of the outfall (14 December 2016)

Photo 2 Surveying the potential impact site 200 m southeast of the outfall (14 December 2016)

Photo 3 Surveying Pukeroa Reef; a potential impact site (13 December 2016)

Photo 4 Surveying the control site at Waihi Reef (12 December 2016)

N.B. Due to the onshore winds and large swell on 12 December, the tide took longer to retreat. Therefore the transect line needed to be positioned 3 m higher on the shore in order to start the survey on time. The method was kept consistent by orientating the random quadrats downshore of the transect, rather than upshore.

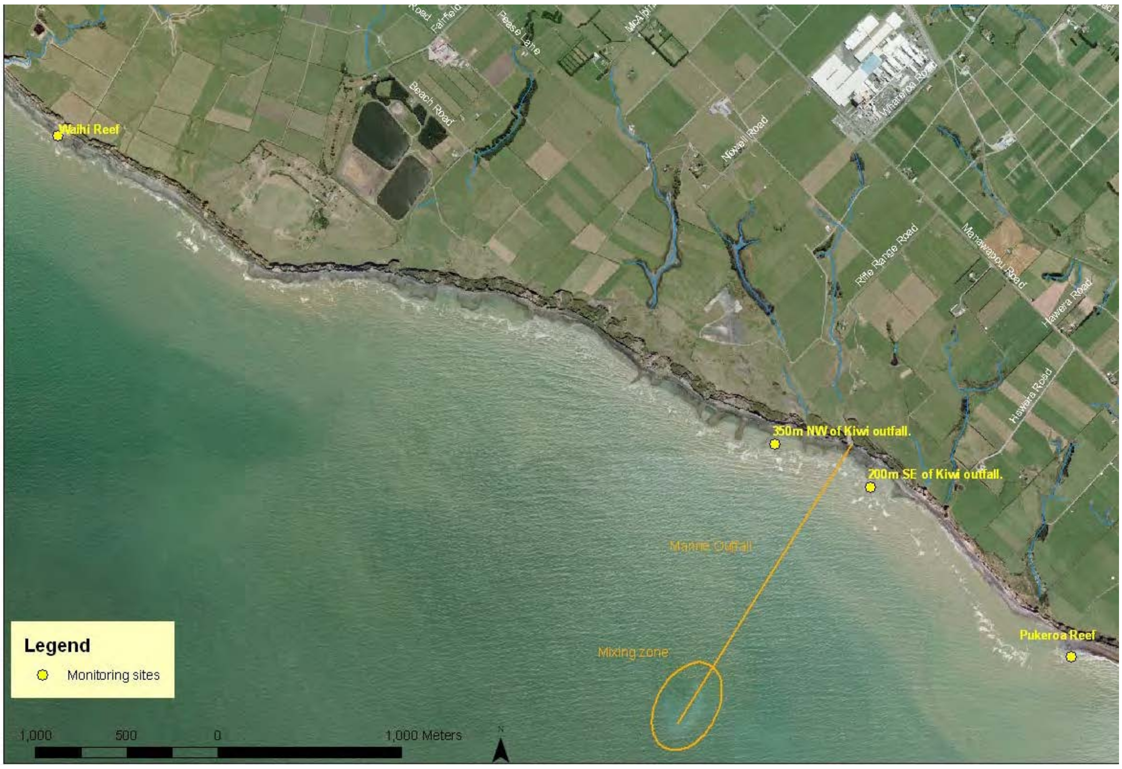


Figure 1 Map of sampling sites in relation to the outfall

At each site, a 50 m transect was used to establish five 5 m x 3 m blocks. Within each block, five random 0.25 m^2 quadrats were laid giving a total of 25 random quadrats (Photograph 5). For each quadrat the percentage cover of algae and encrusting animal species was estimated using a grid. For all other animal species, individuals larger than 3 mm were counted. Under boulder biota was counted where rocks and cobbles were easily overturned.

Photo 5 Survey at the site located 200 m SE of the outfall, showing the transect in use

Results

Summary statistics, including the mean number of species per quadrat and the mean Shannon-Weiner indices, are shown in Table 1. Both the mean number of species and Shannon-Wiener index were highest at the site 350 m NW of the outfall, followed by Pukeroa Reef, Waihi Reef and then the site 200 m SE of the outfall.

Table 1 Mean results for the 2016-2017 spring survey

Site	No. of quadrats	Mean number of species per quadrat			Mean Shannon-Weiner indices per quadrat		
		Algae	Animals	Total Species	Algae	Animals	Total Species
Waihi Reef	25	2.28	6.92	9.20	0.233	0.726	0.787
350 m NW	25	5.76	7.52	13.28	0.616	0.737	0.952
200 m SE	25	1.20	4.24	5.44	0.122	0.472	0.582
Pukeroa Reef	25	2.64	8.60	11.24	0.322	0.785	0.878

Number of species per quadrat

Figure 2 shows the total number of species per quadrat as a box and whisker plot. The notched area of the box represents the median plus and minus a 95% confidence interval for the median. This form of graphical representation allows a quick comparison to be made between sites. Generally, if the notched areas of the boxes for the different sites do not overlap, one would expect to obtain a significantly different result with ANOVA.

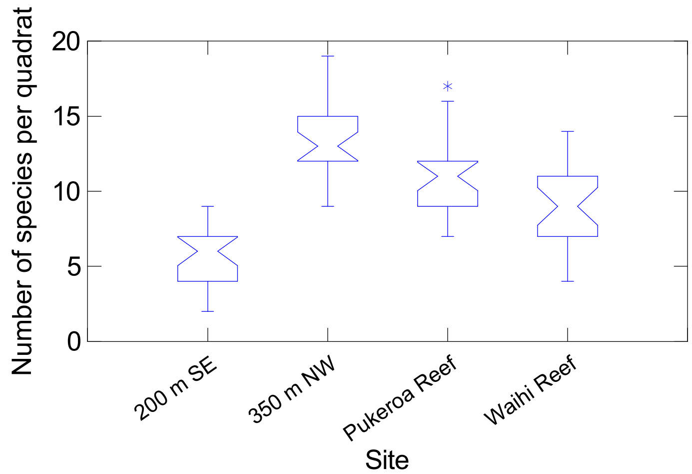


Figure 2 Box and whisker plots of the number of species per quadrat at the four sites

The data obtained from each of the four surveys was found to be normally distributed (Lilliefors test, $P > 0.05$). The boxplots in Figure 2 showed homoscedasticity across the four surveys. Given that the data was normally distributed and that there was even variance across surveys, the necessary assumptions for an ANOVA test had been met.

There was a significant difference in the number of species per quadrat between sites using ANOVA ($F_{3,96}$ = 45.36, $P < 0.001$). Significant differences between sites were determined using the Tukey test (Table 2). There were significantly fewer species per quadrat at the site 200 m SE of the outfall than at any of the other sites. There were significantly more species per quadrat at the site 350 m NW of the outfall than at any of the other sites. There were significantly more species per quadrat at Pukeroa Reef than at Waihi Reef.

Table 2 Tukey test with number of species per quadrat

Site	Waihi	350 m NW	200 m SE
350 m NW	SIG		
200 m SE	SIG	SIG	
Pukeroa Reef	SIG	SIG	SIG

Key: SIG = significant difference at 95% confidence level

NS = no significant difference

Shannon-Weiner Diversity Index

Figure 3 shows the distribution of Shannon-Weiner Indices recorded at each site as box and whisker plots.

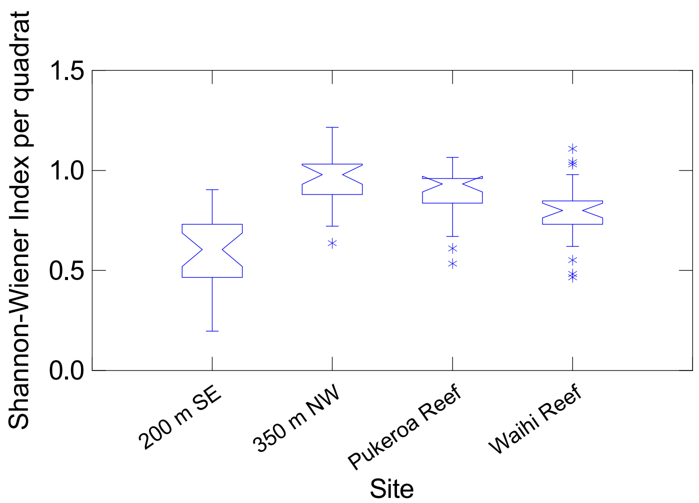


Figure 3 Box and whisker plots of Shannon-Weiner Indices at each site

The data obtained from each of the four surveys was found to be normally distributed (Lilliefors test, n = 25, $P > 0.05$). The data variance at the site 200 m SE was not even with the remaining sites (Figure 3). As both

ANOVA assumptions could not be met the remaining analyses were conducted using the raw data with non-parametric tests.

There was a significant difference in the Shannon-Weiner Indices between sites (Kruskal-Wallis, H = 42.32, degrees of freedom (df) = 3, P < 0.001)[1]. Significant differences between sites were determined using the Wilcoxon signed-ranks test (Table 2). The Shannon-Wiener Indices at the site 200 m SE of the outfall were significantly lower than at any other site. The Shannon-Wiener Indices at the site 350 m NW of the outfall were significantly greater than those at Waihi Reef. The Shannon-Wiener Indices at Pukeroa Reef were not significantly different from those at Waihi Reef or at the site 350 m NW of the outfall.

Table 2 Wilcoxon signed ranks test with Shannon-Weiner index between sites

Site	Waihi Reef	350 m NW	200 m SE
350 m NW	SIG		
200 m SE	SIG	SIG	
Pukeroa Reef	NS	NS	SIG

Key: SIG = significant difference at 95% confidence level

NS = no significant difference

Sand coverage

The level of sand cover was low at the Pukeroa and Waihi Reef sites (Table 5, Figure 4). Sand cover was moderate at the two sites nearest the outfall. Abundance and diversity of intertidal species/communities can be significantly impacted by sand cover of 30% and higher.

Table 3 Mean percentage sand cover per quadrat observed during the 2016 spring survey

Site	Mean sand coverage (%)	Mean silt coverage (%)	Total sand, silt and mud coverage (%)
Waihi Reef	1.08	0.00	1.08
350 m NW	17.24	0.00	17.24
200 m SE	6.63	0.08	6.71
Pukeroa Reef	1.10	0.00	1.10

[1] The Kruskal-Wallis and Wilcoxon signed ranks tests are both non-parametric tests. This means they are not testing for differences in sample means (or medians) but rather they are testing for differences in the locations of sample distributions.

Trends over time

Species number and diversity

Comparisons of the mean number of species per quadrat (Figure 4) and mean Shannon-Weiner diversity index per quadrat (Figure 5) for all spring surveys undertaken since 1992 are shown below.

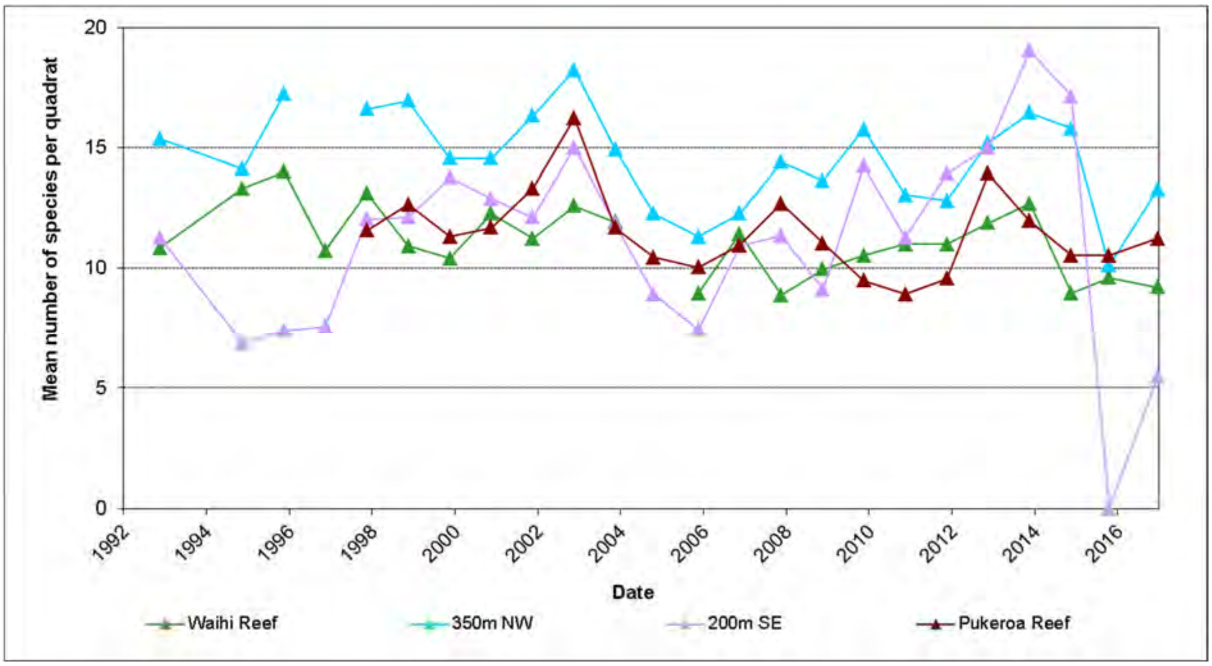


Figure 4 Mean number of species per quadrat for spring surveys 1992-2016

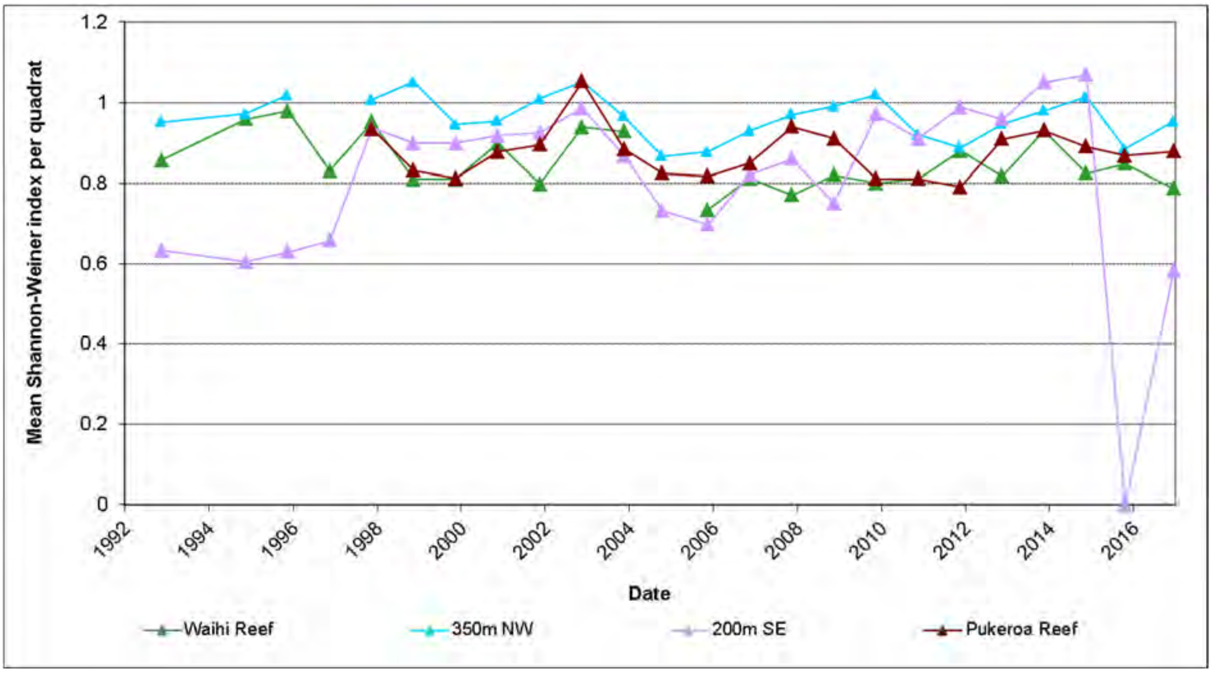


Figure 5 Mean Shannon-Weiner Indices per quadrat for spring surveys 1992-2016

The results from the 2016 spring survey show a small decrease in the mean number of species and Shannon-Wiener Index at Waihi Reef from the previous spring survey (Figures 4 and 5). These two measures increased at all three impact sites following the previous survey. Of these three sites, the most profound increase from the results of spring 2015 was recorded at the site 200 m SE of the outfall.

Prior to the installation of the long marine outfall in August 1997, both number of species and Shannon-Weiner Index per quadrat at the impact site 200 m SE were generally lower than at the control site at Waihi Reef (Figures 6 and 7). Since 1997, the survey sites have shown interannual variability in both number of species and Shannon-Weiner Index. However, there has been no noticeable difference in trends between the impact sites and the control site over this period, with the only exceptions being the years with heavy sand inundation (see summer survey memo's) or slips (e.g. 2016; Figures 4 and 5).

Sand coverage

Over time, sand cover has generally remained low across the sites (Figure 6). Occasionally, however, the reefs experience events of sand inundation, where coverage increases substantially. Over the past ten years, the sites worst effected by inundation events have been those 200 m SE and 350 m NW of the outfall.

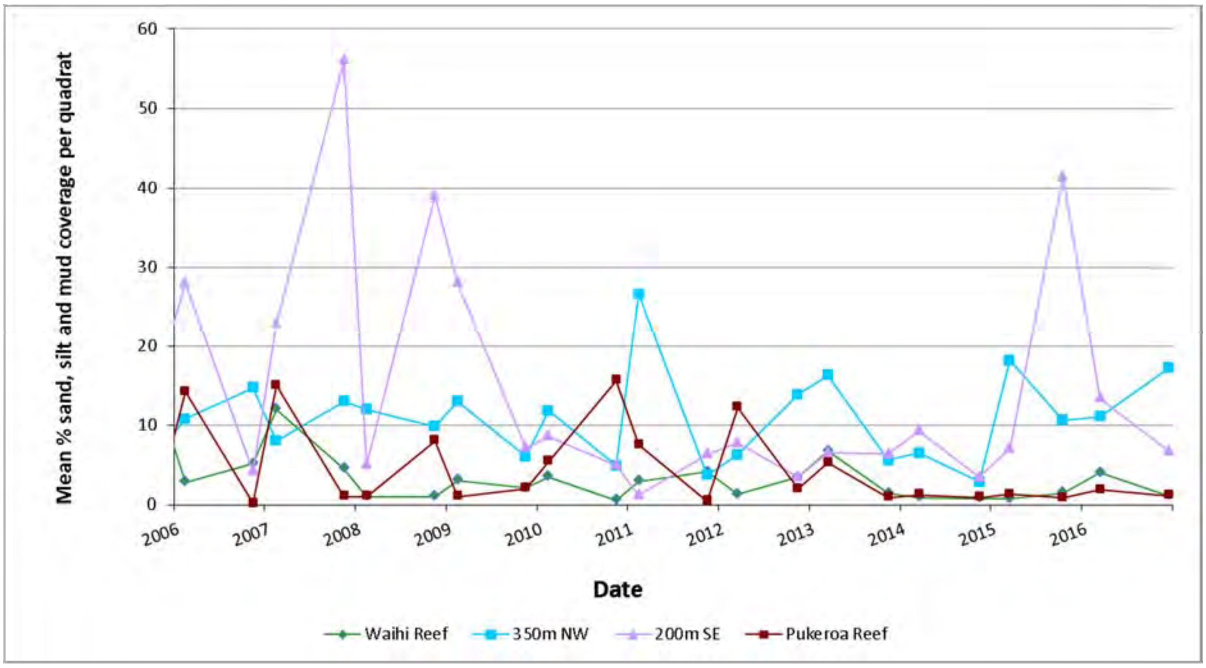


Figure 6 Mean percentage sand, silt and mud cover for summer and spring surveys (2006-2017)

Discussion

Previous surveys have shown that the dairy factory wastewater discharged through the near-shore outfall prior to 1997 (Photograph 1) was having significant adverse effects on the local intertidal community. The adverse effects recorded included the coating of rocks and tidal pools with fats, significant coverage by filamentous bacterial growths and a significant decrease in ecological diversity. The nature and magnitude of adverse effects varied with distance from the outfall, and were most apparent at the sites 30 m and 200 m southeast of the outfall (note that the former site is no longer surveyed as of 2007). In 1997 the dairy company installed a long outfall to discharge the wastewater nearly 2 km offshore in order to mitigate the adverse effects occurring along the coastline. Numerous spring and summer intertidal surveys have now been undertaken along the Hawera coastline subsequent to installation of the long outfall. Results show a general improvement in the health of intertidal communities following installation of the outfall. In February 2001 the Hawera Oxidation Ponds municipal wastewater was also connected to the long outfall.

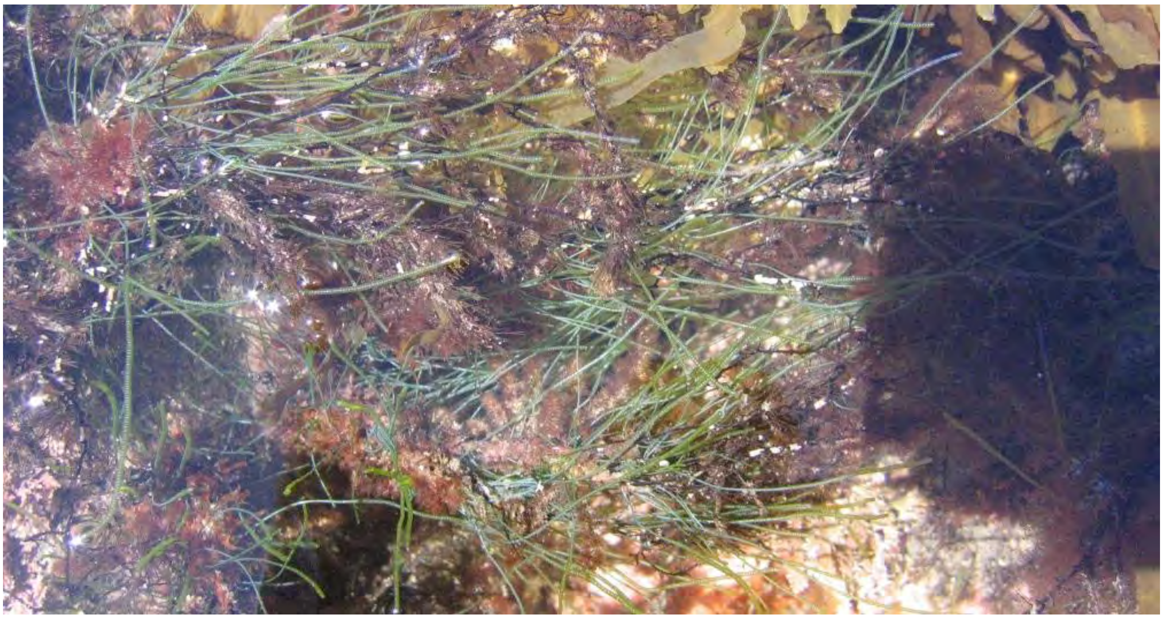
Photo 6 Discharge from the dairy factory near-shore outfall prior to 1997

Impacts of the marine outfall discharge on the local intertidal communities were not evident from the 2016 summer survey results (Figures 4 and 5). Impact site 200 m SE, which was buried by a slip in the winter of 2015, had increased notably in terms of mean number of species (species richness) and Shannon-Wiener Index (diversity) compared to the previous survey; evidence of ongoing recovery. The remaining two impact sites also increased in terms of species richness and diversity compared with the previous survey. The control site, Waihi Reef, was the only site at which species richness and diversity had decreased. The impact site 350 m NW of the outfall had the greatest species richness and diversity recorded of all four sites, despite having the highest sand coverage. Long term results do not indicate any differential trends between the impact sites and control sites regarding species richness or diversity.

The cover of sand, silt and mud was low (<5%) at Pukeroa and Waihi Reefs during the 2016 spring survey. The sites 200 m SE and 350 m NW of the outfall had relatively higher levels of cover (6.71% and17.24%, respectively). Coverage at the site 200 m SE of the outfall had decreased from that of the previous survey. During the survey it was evidence that the slip material had been subjected to ongoing erosion, where the finer material was continually being washed away, leaving the larger rocks and gravels behind on the reef. The moderate cover of sand at the site 350 m NW of the outfall suggests a degree resilience on the reef considering the high level of species richness and diversity that was recorded. Long term monitoring of intertidal rocky reefs around the Taranaki coastline have shown the abundance and diversity of these communities can be adversely affected when sand levels exceed 30% cover. High percentage sand cover (>30%) has previously been recorded at the site 200 m SE (Figure 6).

The historical record of survey results (Figures 4 and 5) show no obvious impact of the marine outfall discharge on the local intertidal communities since installation of the long outfall in 1997. Both control and potential impact sites show interannual variability and with no obvious declining trends at the impact sites closest to the outfall relative to the control site. It must be noted that the high energy receiving environment combined with the effects of suspended sediments from nearby rivers/streams and eroding cliffs prevent the development of stable biological communities along the South Taranaki coastline (Clark *et al*., 2012). Such communities could potentially mask any subtle ecological effects from the outfall wastewater discharge. However, in spite of these limitations, the long term record indicates that the intertidal surveys are useful for detecting more noticeable effects from the wastewater, as the impact on intertidal communities prior to installation of the outfall is clearly evident (Figures 5 and 6, Clark *et al*., 2012).

The most notable change in species composition since the commissioning of the long outfall is the decline of *Chaetomorpha* sp. (Photograph 7) and the absence of filamentous bacterial growths at 200 m SE (Figures 7 and 8). The adverse effects recorded prior to the long outfall also included the coating of rocks and tidal pools with fats and a significant decrease in ecological diversity.



Photograph 1 Green filaments of *Chaetamorpha*, an algal genus often associated with high nutrient concentrations (North Taranaki)

The inundation of earth, sand and silt resulting from cliff face erosion can be an important factor affecting species composition and diversity along the South Taranaki coastline. Indeed, the results presented here and in recent surveys have found land based erosion to be the single most influential factor affecting the intertidal communities at these sites, following the burial of the 200 m SE Reef site. The coast is in a constant state of erosion with layers of earth, sand and silt often deposited in the intertidal zone. Not only does fallen cliff material cripple marine communities through disturbance and burial, observations indicate that freshly fallen earth provides a poor habitat for intertidal organisms. This factor could limit the resilience of reef communities encountering erosion events by deterring organisms from settling and ultimately prolonging the recovery timeframe. Another consequence of erosion is increased suspended sediment in the seawater which can impact on filter feeding organisms and also algal growth through affecting light availability. In the current survey, it was noted that some species are starting to return to the 200 m SE Reef site with much of the finer slip material having been washed away. The increased species richness and diversity recorded during this survey indicates that the gravels and rocks which remain covering the reef are accommodating the settlement and recovery of the intertidal community (Photograph 2).

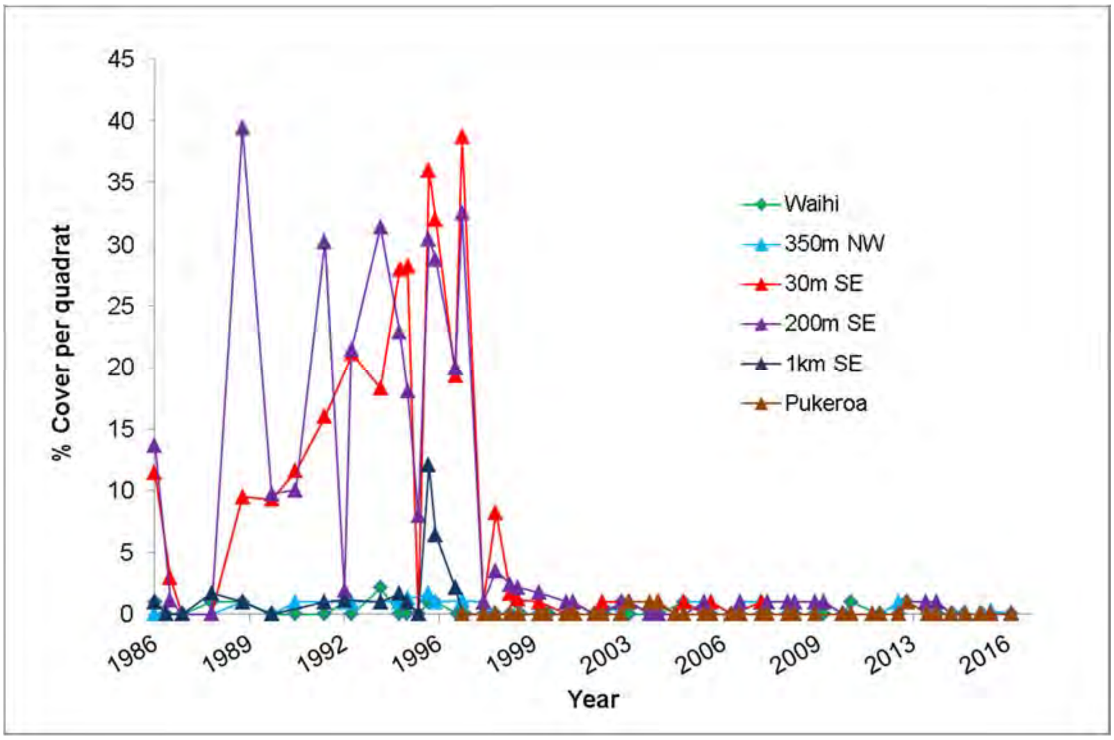


Figure 6 Percentage cover per quadrat of *Chaetomorpha*, 1986 – 2016

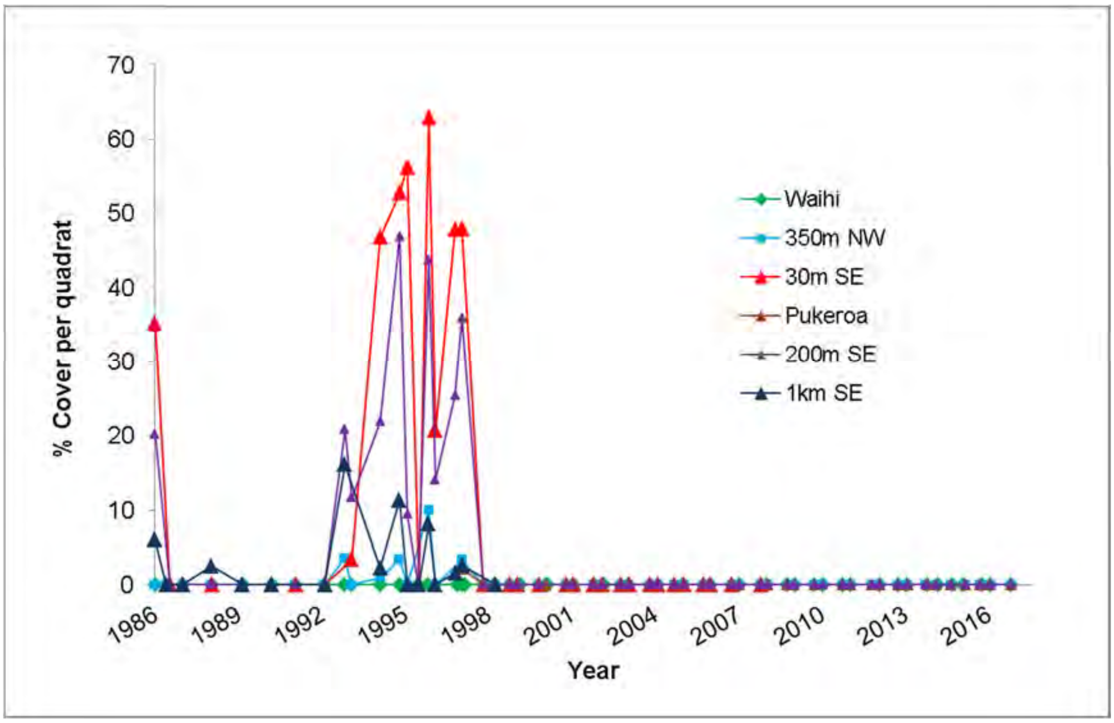


Figure 7 Percentage cover per quadrat of filamentous bacteria, 1986 - 2016

N.B. Since 2007, the sites 30 m SE and 1 km SE are no longer monitored as part of the Fonterra Whareroa intertidal survey.

Conclusions

In order to assess the effects of the Fonterra Whareroa and Hawera Waste Water Treatment Plant outfall discharge on the nearby intertidal communities, surveys were conducted between the 12th and 14th of December 2016 at four sites. These surveys included three potential impact sites either side of the outfall (two southeast and one west) and one control site to the northwest. It is expected that adverse effects of the marine outfall discharge on the intertidal communities would have been evident as a significant decline in species richness and diversity at the potential impact sites relative to the control site.

None of the potential impact sites showed significant declines in species richness or diversity in relation to the control site. Instead, the potential impact sites 350 m NW of the outfall and Pukeroa Reef had significantly greater species richness and diversity than Waihi Reef (the control site). The remaining potential impact site 200 m SE of the outfall showed signs of recovery after having been recently buried by a slip. Furthermore, there is no evidence of the potential impact sites declining in species richness or diversity over time, relative to the control site. These results indicate that the marine outfall discharge was not having detectable adverse effects on the intertidal reef communities of South Taranaki. Natural environmental factors, including coastal erosion, exposure and substrate mobility, appear to remain the dominant drivers of species richness and diversity at the sites surveyed.

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