Report

Picton Sewage Treatment Plant Annual Consent Compliance Report - July 2016 to June 2017

Prepared for Marlborough District Council

By CH2M Beca Limited

2 October 2017

Revision History

Revision Nº	Prepared By	Description	Date
A	Laura Thompson	Draft for client review	27 September 2017
B	Laura Thompson	Final	2 October 2017

Document Acceptance

Action	Name	Signed	Date
Prepared by	Laura Thompson		02/10/2017
Reviewed by	Sarah Burgess		02/10/2017
Approved by	Graeme Jenner		02/10/2017
on behalf of	CH2M Beca Limited		

Table of Contents

Appendices

1 Introduction

1.1 Background

The Picton Sewage Treatment Plant (Picton STP) is located off Graves End Place, Picton. Treated effluent from the STP is discharged via an approximately 150m long pipeline into Picton Harbour. Marlborough District Council (MDC) was granted a 35-year consent (Consent U100802) in June 2011 to construct and operate the new outfall which is located on the western side of the harbour, north of the entrance to the Port Marlborough log yard. The new outfall replaced an under-capacity, above-ground pipeline and short outfall that was located at the harbour entrance (Kaipupu Point).

The new harbour outfall was commissioned on 7 December 2012. The above-ground pipeline to Kaipupu Point and the submarine portion of the decommissioned outfall were then removed.

A copy of Consent U100802 is included in **Appendix A.**

A plan showing the outfall location and consented discharge mixing zone is shown in Drawing 6513000-C-K47 (see **Appendix B**). A map showing the shellfish gathering sites required to be monitored under the consent is attached in **Appendix C.**

1.2 Purpose of this Report

Condition 3 of Consent U100802 requires MDC to submit an Annual Monitoring Report to the Team Leader Compliance, Marlborough District Council on or before 31 August in each year of the consent. This report assesses the compliance of activities authorised under Consent U100802, for the period from 1 July 2016 to 30 June 2017. Note that Consent U100802 has been subdivided into conditions relating to the outfall discharge and conditions related to the outfall pipeline.

Some of the current consent conditions do not have on-going monitoring requirements, and are not covered in this report. Only those conditions that have a numerical or qualitative monitoring requirement are assessed. For clarity, text from the relevant consent conditions and standards are quoted in *italics*, with other commentary in normal font.

1.3 Consent U960798

MDC was also granted Consent U960798 in February 1997 for land use activities. Compliance with the conditions of Consent U960798 was assessed separately in the report entitled *Picton Sewage Treatment Plant Consent Compliance Report - Discharge to Land - June 2016 to May 2017* dated July 2017.

2 Consent U100802-Coastal Permit (discharge to seawater)

2.1 Condition 3 – Annual Monitoring Report

The applicant must provide to the Team Leader, Compliance, Marlborough District Council, on or before 31 August in each year of the term of this consent, an Annual Monitoring Report (AMR) which must contain the following:

a. *An analysis of the extent to which the applicant has, in exercising these consents, complied with consent conditions and the extent and cause of any non-compliance, in each case with a summary of the environmental effects arising from the operation of the pipeline, surge chamber and outfall/diffuser, during the preceding 12 month period from 1 July to 30 June inclusive (the reporting period).*

b. *An identification and discussion of any operational difficulties, changes or improvements made to the Picton Sewage Treatment Plant and other operating processes, which may cause any material difference in environmental outcomes from the previous reporting period.*

c. *An identification of any maintenance works needed, proposed or undertaken to ensure compliance with these conditions of consent.*

d. *An identification of any improvements or changes required and the timetable for implementation.*

e. *A summary of all the effluent monitoring data collected pursuant to this consent during the reporting period.*

f. *A summary of all receiving environment monitoring data collected pursuant to this consent during the reporting period.*

g. *An analysis of the data summarised under Condition 3 (e and f) above in terms of consent compliance and environmental effects during the reporting period.*

h. *A comparison of results with previous years and a discussion of any trends during the reporting period.*

i. *Any complaints received in regard to the discharge of treated effluent from the outfall.*

It is considered that the requirements of Condition 3 are fulfilled by the submission of this report.

No operational difficulties at the Picton STP were noted in the reporting period, nor were any maintenance works required to comply with the conditions of this consent.

No complaints regarding the discharge of treated effluent from the outfall were recorded during this monitoring period.

2.2 Condition 10 – Maximum Flow

The discharge of treated effluent through the outfall, as authorised by this consent, must not exceed a maximum flow rate of 400 litres per second.

The consent authorises the discharge of treated effluent from the Picton STP, which includes the future screened and disinfected wet weather flows from the proposed Dublin Street Pump Station Bypass Treatment facility. These combined flows would result in a maximum flow rate of approximately 400L/s through the outfall. Until the pump station upgrade is completed, only treated flows from the Picton STP can be discharged through the outfall. Flows in excess of the pump station's current capacity overflow untreated to the Waitohi Stream.

The design of works to allow the bypassed treated flows to be added to the outfall is currently being undertaken, as part of an overall upgrade of the Picton/Waikawa Sewerage System. Construction of Stages 2 – 3 of the works (including the Dublin Street Pump Station, new pump stations at Surrey Street and Fishermans Reserve, replacement of approximately 3.75km of gravity/pressure sewers and new overflows pipes and structures), is currently underway, having commenced in May 2017. Construction of this phase of works is expected to be completed by May 2018. Stage 4 of the upgrade (including upgrading work at the Beach Road and Waikawa Wharf pump stations), is expected to be completed in 2019.

The maximum flow that can be discharged from the Picton STP to the outfall is 130L/s. There is also a flow meter on the discharge to record actual daily flows. The highest flow measured was 97.9 L/s on 15 November 2016, and so the discharge complies with this condition.

2.3 Condition 12 – Effluent Effects in Mixing Zone

The discharge of treated effluent through the outfall must not cause any of the following effects outside the mixing zone described in Condition 11:

a. *The natural temperature of the receiving water shall not be changed by more than 3 degrees Celsius;*

b. *Any conspicuous change in colour or clarity of the receiving water such that visual clarity is reduced by more than 33% as per the Water Quality Guidelines No. 2 (Ministry for the Environment, 1994);*

c. *Any significant adverse effects on aquatic life; and*

d. *The concentration of dissolved oxygen on the receiving water shall be greater than 80% of the saturation concentration.*

The outfall mixing zone is shown in Drawing 6513000-C-K47 (**see Appendix B**).

The receiving water has not been specifically monitored for the effects noted in a - d above. However, the high effluent quality (see Section 2-6), coupled with the verified initial dilution after discharge (ie >200:1 at average flows), indicates that there is little potential for adverse effects, after mixing, on natural water temperature, colour or clarity, aquatic life or dissolved oxygen concentrations.

No visual effects from the discharge have been observed in surface waters surrounding the outfall.

2.4 Condition 13 – No Undesirable Biological Growths

There shall be no undesirable biological growths as a result of the discharge.

The receiving water has not been specifically monitored for undesirable growths. However, the high effluent quality (see Section 2.6), coupled with the verified initial dilution after discharge ie (>200:1 at average flows), indicates that there is little potential for undesirable biological growths after reasonable mixing.

The Annual Outfall Inspection Report (N-Viro Mooring Systems, 2017) (see **Appendix D)** did not identify any sign of undesirable biological growth along the pipeline. However, there has been an increase of marine growth on the clamps.

2.5 Condition 14 – Effluent Quality Monitoring

The consent holder must carry out effluent monitoring at the outlet of the Picton Sewage Treatment Plant using the sampling method and frequency shown below. Samples will be analysed for the following parameters:

Parameter	*Reported as*	*Frequency*	*Sampling Method*
Carbonaceous Biochemical Oxygen Demand (cBOD)	*g/m^3*	*Monthly*	*24 Hour Composite*
Total Suspended Solids (TSS)	*g/m^3*	*Monthly*	*24 Hour Composite*
pH	*No units*	*Monthly*	*24 Hour Composite*
Ammoniacal Nitrogen	*g/m^3*	*Monthly*	*24 Hour Composite*
Faecal coliforms and Enterococci	*Number/100mls*	*Monthly*	*24 Hour Composite*
Dissolved Reactive Phosphorus (DRP)	*g/m^3*	*Quarterly*	*24 Hour Composite*
Copper, Lead, Mercury and Zinc	*g/m^3*	*Quarterly*	*24 Hour Composite*
Arsenic, Cadmium, Chromium and Nickel	*g/m^3*	*Annually*	*24 Hour Composite*
Semi-Volatile Organic Compounds (SVOC)	*g/m^3*	*Annually*	*24 Hour Composite*

All parameters were sampled in the final effluent at the frequency indicated above, with the exception of the April 2017 results for Ammoniacal Nitrogen, DRP, Copper, Lead and Mercury. These parameters would normally be included in the April sampling and analysis programme, but there was a mix-up with the April 2017 sampling and only the monthly analysis was done, (which excluded the quarterly parameters) . Therefore, the requirements of Condition 14 have not been completely fulfilled.

Table 2-1 shows parameters that were measured as required by Condition 14 (but do not have consent limits).

Table 2-1 – Effluent Sampling Results for Parameters without Consent Limits

Parameter	Unit	Statistical Basis	Results of Analysis
Ammoniacal Nitrogen	g/m^3	Annual Median	4
Arsenic	g/m^3	Single Measurement	<0.003
Cadmium	g/m^3	Single Measurement	<0.00011
Chromium	g/m^3	Single Measurement	<0.0011
Nickel	g/m^3	Single Measurement	<0.0011
Semi-Volatile Organic Compounds (SVOC)	g/m^3	Single Measurement	See results in Appendix E

Figure 2-1 shows the 2016/2017 effluent trace metal concentrations (arsenic, cadmium, chromium and nickel) compared to the historical monitoring results (no consent limits are applicable). The results show that effluent concentrations of these metals are low and consistent with previous monitoring results.

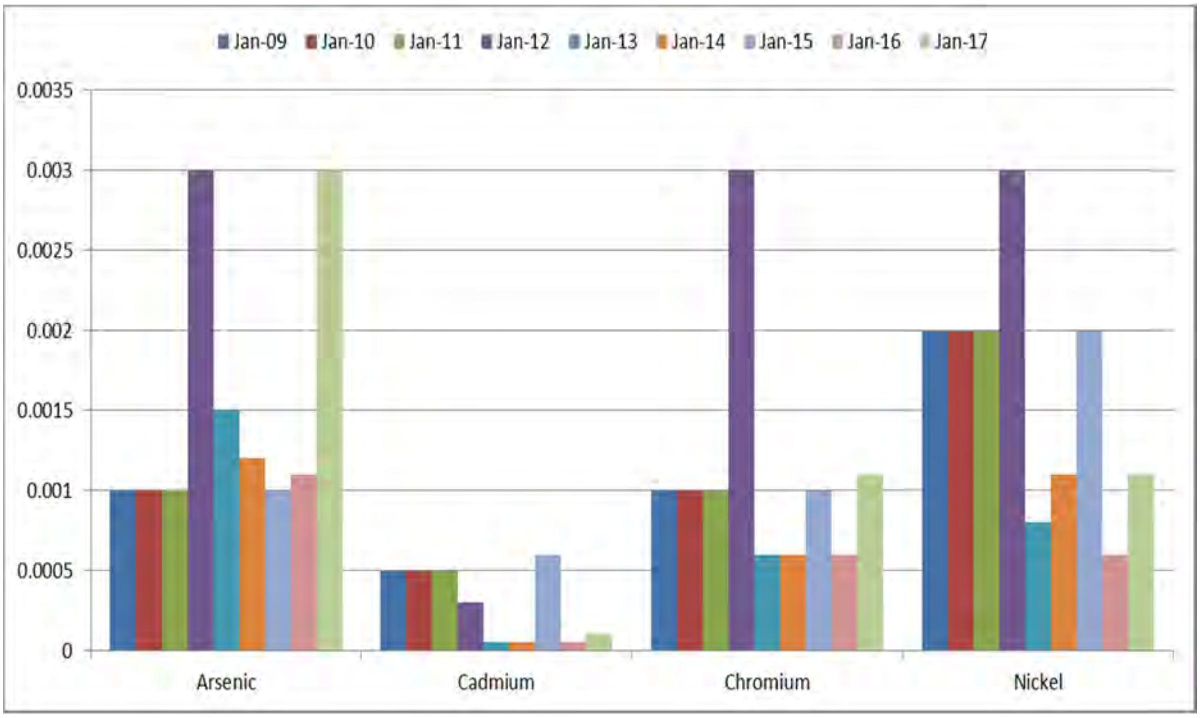


Figure 2-1 - Effluent Trace Metal Concentrations

Figure 2-2 shows effluent ammoniacal nitrogen concentrations for the period 2016/2017. The concentration measured in September 2016 was much higher than in subsequent months. Higher ammonia concentrations would generally be expected in the cooler months, as nitrification (the process which converts ammonia into nitrates), occurs more slowly with lower temperatures

Summer results in 2016/17 (November to March), were well below the high ammonia result (ie 18g/m^3) recorded in the January 2015 sampling. Nitrification requires dissolved oxygen (DO) values greater than 2 ppm. In the 2014/15 report, a comparison of the ammonia monitoring results with DO concentrations at the aeration basin outlet suggested that the organic loading is increasing over the summer period. This trend was also seen in the 2015/16 period but to a lesser extent. The inlet load and outlet ammonia concentrations, during the summer period, should continue to be monitored.

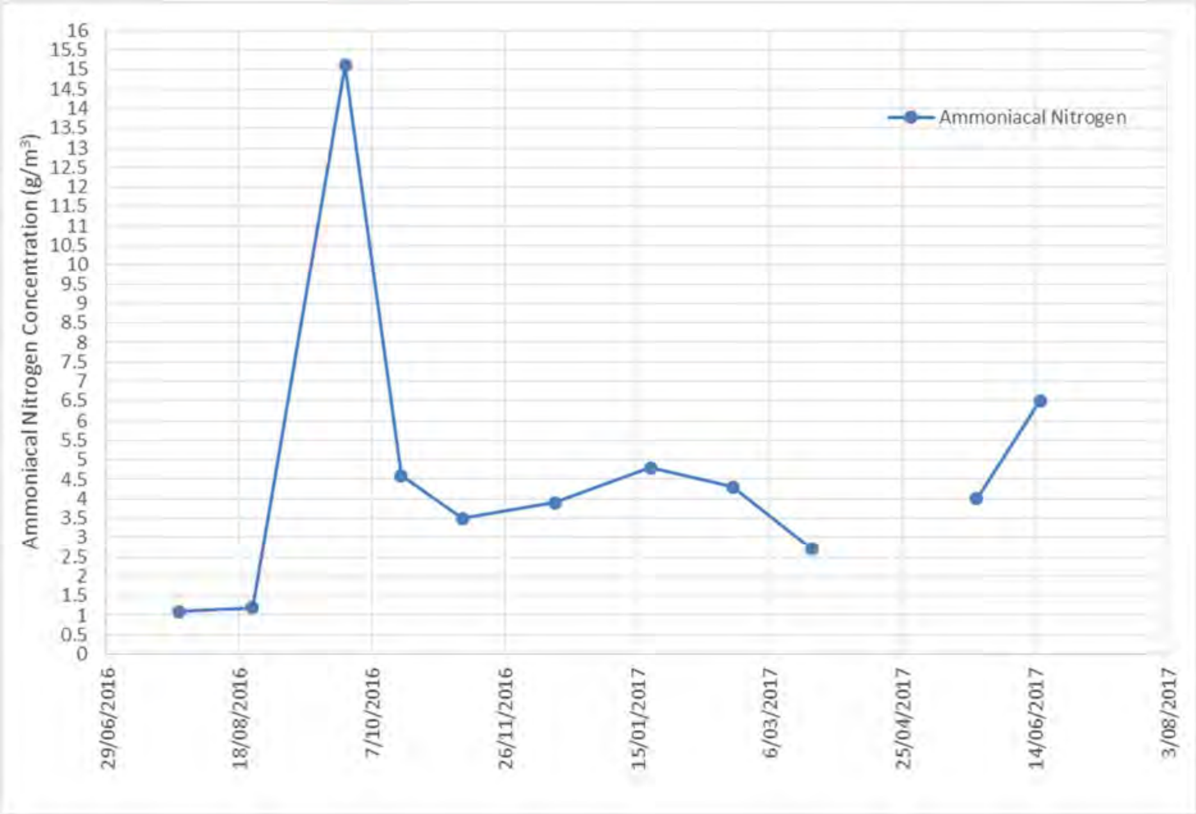


Figure 2-2 – Effluent Ammoniacal Nitrogen Concentrations

2.6 Condition 15 – Effluent Quality Consent Limits

The effluent discharged from the Picton Sewage Treatment Plant must meet the following standards (see Table 2-2):

Table 2-2 – Test Parameters, Consent Limits and Monitoring Results (2016/17)

Parameter	*Reported as*	*Statistical Basis*	*Consent Limit*	Results of Analysis
cBOD	*g/m³*	*Annual Median*	*30*	5.5
TSS	*g/m³*	*Annual Median*	*40*	12
pH	*No units*	*Range*	*6.0-8.5*	6.6 – 7.4
Faecal Coliforms [1]	*Number/100mls*	*Annual Geometric Mean*	*700*	20.8
	Number/100mls	*Annual 90th Percentile*	*4,300*	164
Enterococci	*Number/100mls*	*Annual Geometric Mean*	*500*	17.6
Dissolved Reactive Phosphorus	*g/m³*	*Rolling median of last 8 samples*	*20*	3.35
Copper [2]	*g/m³*	*Rolling median of last 8 samples*	*0.065*	0.0081
Lead [2]	*g/m³*	*Rolling median of last 8 samples*	*0.22*	0.00037
Mercury [2]	*g/m³*	*Rolling median of last 8 samples*	*0.02*	<0.00008
Zinc [2]	*g/m³*	*Rolling median of last 8 samples*	*0.75*	0.0325

1. Back-calculated from shellfish gathering guideline values in Section F2 of Ministry for Environment (2003) Bacteriological Water Quality Guidelines for Marine and Freshwater Recreational Areas (2003) of 14 MPN/100ml times a dilution factor of 50:1 and 43 MPN/100ml times a dilution factor of 100:1.

2. Back-calculated from 95th percentile level of ecosystem protection guideline values in Table 3.4.1 of the Australian and New Zealand Guidelines for Marine and Freshwater Quality (ANZECC, 2000) times a dilution factor of 50:1.

The final column (see "Results of Analysis") in Table 2-2 shows the results of the effluent monitoring for the reporting period. As can be noted from the table, all of these measured values fall within the consent limits. Where a rolling median of the last eight samples, or an annual average was required, some data from the previous monitoring period was used to compensate for the missing April 2017 values that were not taken due to the reasons stated above.

Table 2-3 shows the results of monitoring of the concentrations of effluent Dissolved Reactive Phosphorus (DRP) in 2016/2017 compared with the eight-sample rolling median.

Figure 2-3 shows that effluent DRP concentrations, measured since the consent was granted in 2010, have been well below the consent limit of 20g/m³.

Table 2-3 – Effluent Dissolved Reactive Phosphorus Concentrations (2016/17)

Date	Value (g/m³)	8 Sample Rolling Median (g/m³)
July 2016	1.81	3.35
October 2016	3.7	3.35
January 2017	3.6	3.35
April 2017	No data available	
Consent Limit	-	**20**

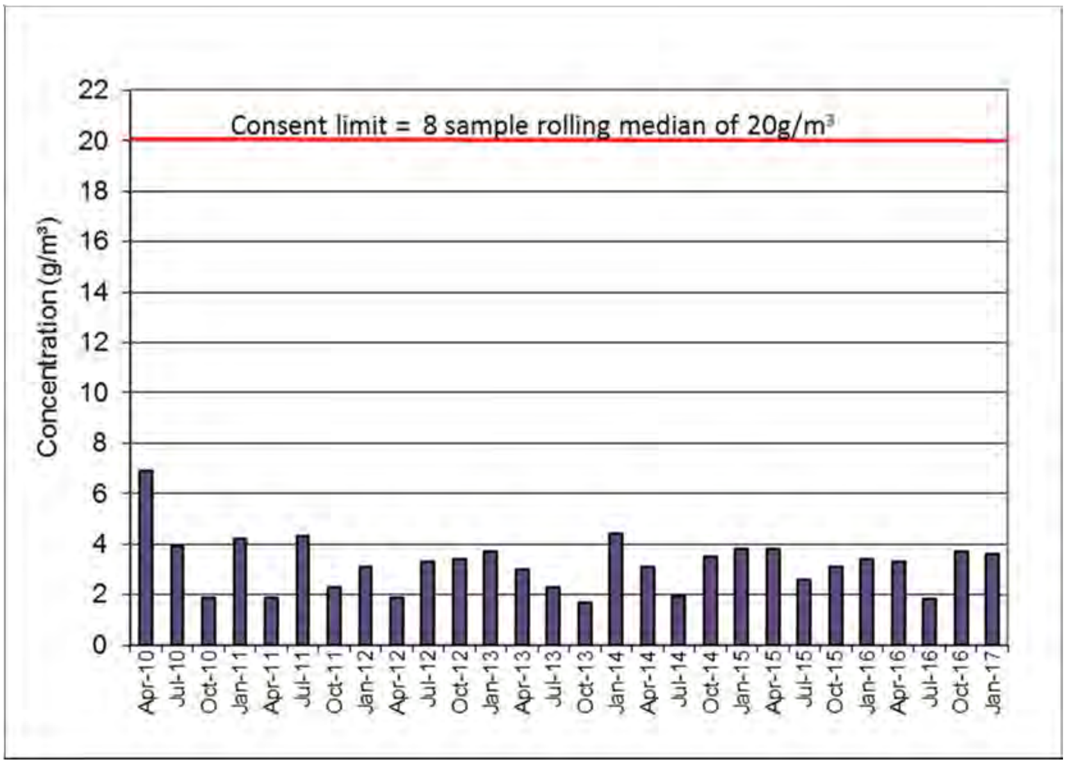


Figure 2-3 - Effluent Dissolved Reactive Phosphorus Concentrations (2010-17)

Tables 2-4 to 2-7 show the concentrations and rolling medians for effluent metals (copper, zinc, lead and mercury). The results show that effluent concentrations of these metals in 2016/17 are well below consent limits. Figure 2-4 shows that results in 2016/17 were consistent with results for previous years.

Table 2-4 – Effluent Copper Concentration

Date	8 Sample Rolling Median (g/m^3)
July 2016	0.00945
October 2016	0.0098
January 2017	0.0081
April 2017	No data available
Consent Limit	**0.065**

Table 2-5 – Effluent Zinc Concentration

Date	8 Sample Rolling Median (g/m^3)
July 2016	0.0345
October 2016	0.0375
January 2017	0.0325
April 2017	No data available
Consent Limit	**0.75**

Table 2-6 – Effluent Lead Concentration

Date	8 Sample Rolling Median (g/m^3)
July 2016	0.0004
October 2016	0.0005
January 2017	0.00037
April 2017	No data available
Consent Limit	**0.22**

Table 2-7 – Effluent Mercury Concentration

Date	**8 Sample Rolling Median (g/m^3)**
July 2017	0.00008
October 2017	0.00008
January 2017	0.00008
April 2017	No data available
Consent Limit	**0.02**

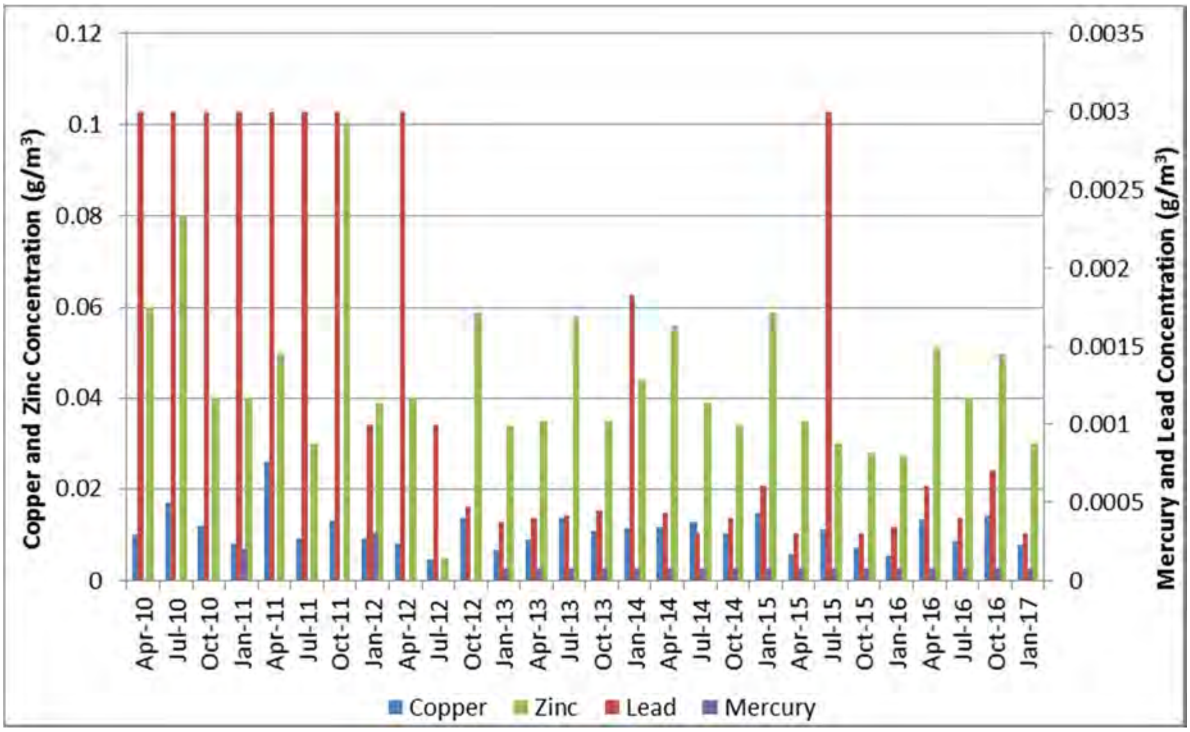


Figure 2-4 - Three-Monthly Effluent Copper, Zinc, Lead and Mercury Concentrations

2.7 Condition 16 - Validation of Initial Dilution

The consent holder must carry out a one-off study within 12 month of the commissioning of the outfall to validate the predicted initial dilution of the diffuser.

A study to validate outfall initial dilution was carried out by Cawthron in 2013. The results of the one-off study were described in the 2013/14 monitoring report and showed that the outfall dilution levels predicted in the consent application and pre-commissioning modelling (ie 200:1) were generally being exceeded.

No further reporting is therefore required under this condition.

2.8 Condition 17- Benthic Survey

The Consent holder must carry out a survey of benthic ecology and sediments in the vicinity of the diffuser prior to the commissioning of the outfall, followed by a survey 2 years after commissioning and thereafter at 5 yearly intervals for the duration of the consent. Monitoring must be carried out in accordance with the following:

a) Samples must be collected from a minimum of four locations to include sites close to the outfall, at the mixing zone boundary, outside the mixing zone and a control site.

b) Four replicate samples must be collected at each sampling location from cores driven approximately 100mm into the sediment.

c) All samples must be sieved to 0.5mm for identification and enumeration of benthic infaunal taxa (including mean density, species richness (j) and Shannon Weiner diversity (H) indices calculated for each location.

d) Infaunal community changes at each location between surveys must be assessed.

e) Prior to chemical analyses, all core samples must be examined to determine texture, colour (black indicating an anoxic layer) and odour ("rotten egg" smell indicating anaerobic conditions). Photographs shall be taken of each core to document the relative degree of enrichment.

f) All samples must be analysed for Total kjeldahl nitrogen, particle grain size percentage of organic content (as either ash free dry weight or total organic carbon), total organic carbon and trace metals (mercury, chromium, copper, lead and zinc).

g) Sediment chemistry changes at each location between surveys must be assessed.

h) Summarise the data collected as required under this condition (including graphical presentation and statistical summations of data) and analyse the information in regard to meeting the provisions of section 107(1)(g) of the Resource Management Act 1991.Specifically, whether or not the discharge is causing significant adverse effects on aquatic life.

i) Highlight and discuss the environmental trends in the results.

j) Compare results obtained during the survey with results obtained during previous surveys and provide an interpretation of any significant differences, changes or trends.

Cawthron carried out a post-commissioning benthic survey in 2014 in accordance with consent requirements. This report, entitled "*Benthic Survey for the Relocated Picton Wastewater Treatment Plant Outfall 2014*" (Cawthron Institute, 2015), is included in **Appendix F**.

The Cawthron survey report noted that there had been little change in the benthic environment, in the vicinity of the outfall, in the two years since commissioning. It was concluded that the operation of the Picton STP is not causing significant adverse effects on seabed habitat or aquatic life at any of the stations sampled and is therefore meeting the requirements of Condition 17.

Another benthic survey will be carried out early in 2019 (ie 5 years after the post-commissioning survey in accordance with consent requirements).

2.9 Condition 18 – Shellfish Quality

The consent holder must carry out annual monitoring of shellfish quality in Picton Harbour in accordance with the following programme:

a) *Samples of the blue mussel (Mytilus edulis galloprovincialis) shall be collected from the following shoreline locations: Mabel Island, Kaipupu Point, Bobs Bay, Westshore and Picton Wharf. Note: these shellfish gathering locations were agreed with the Picton Sewage Consultative Working Group and the Senior Public Health Protection Officer, Nelson/Marlborough District Health Board and used by NIWA Ltd during the preparation of the Quantitative Microbial Risk Assessment for the consenting of the new Picton outfall (June 2009).*

b) *All samples must be analysed for Faecal coliforms and trace metals (copper, mercury and zinc).*

c) *Results of analysis of samples must be assessed against the following standards: Faecal coliforms (Ministry of Health (MOH) Reference Criteria for Food 2005); and trace metals (Australia New Zealand Food Standards Code (ANZFSC) 2002).*

The results of monitoring shellfish quality are shown in Table 2-8.

Table 2-8 - Shellfish Monitoring Standards and 2016/17 Results

Source	Faecal coliforms (MPN/100g)	Copper (mg/kg)	Mercury (mg/kg)	Zinc (mg/kg)
Standard				
*ANZFSC/MOH**	*230*	-	*0.5*	-
Median International Standard for Trace Elements in Shellfish (MIS)	-	*30*	*0.5*	*40*
Results				
Mabel Island	36	0.68	<0.01	19.5
Kaipupu Point	<30	0.91	<0.01	18
Bob's Bay	<30	0.79	<0.01	27
Westshore	<30	0.62	<0.01	24
Picton Wharf	4600	1.49	<0.01	33

**: Means MPN/100g in a minimum of 12 shellfish.*

Shellfish monitoring was carried out at all of the required locations (see map in **Appendix C**). The faecal coliforms sample at Picton's wharf significantly exceeded ANZFSC/MOH standards. All other shellfish samples in 2017/16 are well within the ANZFSC/MOH standards and were also below the MIS trace element in shellfish standards. The high value at the wharf is likely to be due to other sources such as stormwater runoff.

It should be noted that the consent does not require that the shellfish samples comply with these standards. However this information is useful in advising the public where (or where not to), gather shellfish.

2.10 Conclusions

This assessment is based solely on the physical, chemical and microbiological monitoring as required by Consent U100802. While monitoring of effluent and the receiving environment is only carried out at specific times, it is assumed that the results from this monitoring are representative of effluent and water quality at other times, unless specifically stated otherwise.

Effluent quality has been consistently good since the commissioning of the Picton STP in September 1999. The results of effluent quality monitoring, during 2016/17, were within the limits set by the conditions in Consent U100802. No effects from the discharge have been observed, within or outside the outfall mixing zone specified by the consent.

All parameters were sampled in the final effluent at the required frequency, with the exception of the April 2017 samples for Ammoniacal Nitrogen, DRP, Copper, Lead and Mercury which were not taken due to testers taking monthly samples on this date rather than the required quarterly samples. Thus, the requirements of Condition 14 were not completely fulfilled.

The results of the one-off study in 2013/14 showed that the outfall dilution levels predicted in the consent application and pre-commissioning modelling (ie 200:1) were generally being exceeded.

An outfall post-commissioning benthic ecology survey carried out by Cawthron in 2014 showed that the outfall discharge is not causing significant adverse effects on the seabed habitats, or aquatic life, at any of the stations sampled. The next benthic survey will be carried out in 2019.

Shellfish samples were taken at the required locations, analysed for microbiological parameters and trace elements, and assessed against the required standards in accordance with Condition 18. Compliance with the standards is not a consent requirement, but with the exception of the Picton Wharf sample (which is influenced by land-based activities), all sample results were within the required limits.

Apart from the requirements to sample effluent monthly (noting problem with April 2017 analyses), the requirements of Consent U100802 were met in the 2016/17 monitoring period.

3 Consent U100802-Coastal Permit (Outfall Pipeline)

3.1 Condition 10 – Inspection of Outfall and Diffuser

At yearly intervals following the commissioning of the outfall and diffuser, the consent holder must submit to the Resource Consents Manager at Marlborough District Council, a report detailing the findings of a visual inspection of the diffuser structure, to include at least the following matters:

a) The date and time of the inspection

b) The condition of the outfall diffuser structure

c) A description of any maintenance work and, if required, a programme for completion of the maintenance work.

N-Viro Mooring Systems carried out an inspection of the outfall on 7th February 2017 (see report in **Appendix D**).

This inspection found that the outfall pipe including anodes, ports and thrust block were in good condition. There was no change in the seabed and no debris found under the pipe. The clamps are in good condition however have an increase in marine growth. Following a full bolt tightness check at the last inspection, the bolts was randomly checked in February 2017 and were found to be all tight.

3.2 Conclusions

The outfall inspection carried out in February 2017 fulfils the outfall pipeline inspection requirements of Consent U100802.

4 Bibliography

Cawthron Institute. (2017, March 5). *Benthic Survey for the Relocated Picton Wastewater Treatment Plant Outfall 2014.* Nelson.

N-Viro Mooring Systems. (2017). *Diving Inspection Report Picton Sewerage Pipeline - February 2017.*

Appendix A

Resource Consent U100802

U100802

Coastal Permit – Discharge to Seawater

1. This consent shall be exercised in a manner which is consistent with the proposal and methodologies described in the documents, information and analysis provided by the Applicant in support of this application and held on Council file U100802.

2. This consent shall expire on 1 June 2046.

3. The applicant shall provide to the Team Leader, Compliance, Marlborough District Council, on or before 31 August in each year of the term of this consent, an Annual Monitoring Report (AMR) which must contain the following:

   a) An analysis of the extent to which the applicant has, in exercising these consents, complied with consent conditions and the extent and cause of any non-compliance, in each case with a summary of the environmental effects arising from the operation of the pipeline, surge chamber and outfall/diffuser, during the preceding 12 month period from 1 July to 30 June inclusive (the reporting period).

   b) An identification and discussion of any operational difficulties, changes or improvements made to the Picton Sewage Treatment Plant and other operating processes, which may cause any material difference in environmental outcomes from the previous reporting period.

   c) An identification of any maintenance works needed, proposed or undertaken to ensure compliance with these conditions of consent.

   d) An identification of any improvements or changes required and the timetable for implementation.

   e) A summary of all the effluent monitoring data collected pursuant to this consent during the reporting period.

   f) A summary of all receiving environment monitoring data collected pursuant to this consent during the reporting period.

   g) An analysis of the data summarised under Condition 3 (e and f) above in terms of consent compliance and environmental effects during the reporting period.

   h) A comparison of results with previous years and a discussion of any trends during the reporting period.

   i) Any complaints received in regard to the discharge of treated effluent from the outfall.

4) Any laboratory carrying out analysis required under these conditions shall be accredited for those analyses to NZS/ISO/IEC 17025 or equivalent, or to any other comparable standard approved by the consent authority.

5) The consent authority may review any conditions of this consent in September or October of any year for the life of the consent, for any of the following purposes:

   a) To deal with any adverse effect on the environment which may arise from the exercise of this consent;

   b) To require the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment;

   c) To address any matters raised in the AMR required by Condition 3; and

   d) To comply with the relevant requirements of a Marlborough District Council resource management plan.

6. The consent holder shall be responsible for all costs associated with the monitoring required by these consent conditions as required by section 36 of the Resource Management Act 1991 and the Marlborough District Council's Schedule of Fees.

7. The consent holder shall be responsible for all costs incurred by the consent authority associated with the review of requested changes to any management plan which forms part of this consent.

8. Following the commissioning of the new landline, surge chamber, outfall pipeline and diffuser structure, the consent holder shall be required to apply the conditions that follow in exercising this consent.

9. The consent holder shall provide for a backup power supply for the UV disinfection system at the Picton Sewage Treatment Plant in case of a power outage.

10. The discharge of treated effluent through the outfall, as authorised by this consent, shall not exceed a maximum flow rate of 400 litres per second.

11. The mixing zone for the discharge to Picton Harbour from the outfall shall be as shown in Drawing 6513000-C-K47.

12. The discharge of treated effluent through the outfall shall not cause any of the following effects outside the mixing zone described in Condition 11:

    a. The natural temperature of the receiving water shall not be changed by more than 3 degrees Celsius;

    b. Any conspicuous change in colour or clarity of the receiving water such that visual clarity is reduced by more than 33% as per the *Water Quality Guidelines No. 2* (Ministry for the Environment, 1994);

    c. Any significant adverse effects on aquatic life; and

    d. The concentration of dissolved oxygen on the receiving water shall be greater than 80% of the saturation concentration.

13. There shall be no undesirable biological growths as a result of the discharge.

14. The consent holder shall carry out effluent monitoring at the outlet of the Picton Sewage Treatment Plant using the sampling method and frequency shown below. Samples will be analysed for the following parameters:

Parameter	**Reported as**	**Frequency**	**Sampling Method**
Carbonaceous Biochemical Oxygen Demand	g/m^3	Monthly	24 Hour Composite
Total Suspended Solids	g/m^3	Monthly	24 Hour Composite
pH	No units	Monthly	Grab
Ammoniacal Nitrogen	g/m^3	Monthly	Grab
Faecal Coliforms and Enterococci	Number/100mls	Monthly	Grab
Dissolved Reactive Phosphorus	g/m^3	Quarterly	Grab

Copper, Lead, Mercury and Zinc	g/m^3	Quarterly	Grab
Arsenic, Cadmium, Chromium and Nickel	g/m^3	Annually	Grab
Semi-Volatile Organic Compounds	g/m^3	Annually	Grab

15. The effluent discharged from the Picton Sewage Treatment Plant shall meet the following standards:

Parameter	**Reported as**	**Statistical Basis**	**Consent Limit**
Carbonaceous Biochemical Oxygen Demand	g/m^3	Annual Median	30
Total Suspended Solids	g/m^3	Annual Median	40
pH	No Units	Range	6.0-8.5
Faecal Coliforms [1]	Number/100mls	Annual Geometric Mean	700 MPN
	Number/100mls	Annual 90th Percentile	4,300
Enterococci	Number/100mls	Annual Geometric Mean	500
Dissolved Reactive Phosphorus	g/m^3	Rolling median of last 8 samples	20
Copper, [2]	g/m^3	Rolling median of last 8 samples	0.065
Lead, [2]	g/m^3	Rolling median of last 8 samples	0.22
Mercury, [2]	g/m^3	Rolling median of last 8 samples	0.02
Zinc, [2]	g/m^3	Rolling median of last 8 samples	0.75

[1] Back-calculated from shellfish gathering guideline values in Section F2 of Ministry for Environment (2003) *Bacteriological Water Quality Guidelines for Marine and Freshwater Recreational Areas* (2003) of 14 MPN/100ml times a dilution factor of 50:1 and 43 MPN/100ml times a dilution factor of 100:1

[2] Back-calculated from 95th percentile level of ecosystem protection guideline values in Table 3.4.1 of the *Australian and New Zealand Guidelines for Marine and Freshwater Quality* (ANZECC, 2000) times a dilution factor of 50:1.

16. The consent holder shall carry out a one-off study within 12 months of the commissioning of the outfall to validate the predicted initial dilution of the diffuser.

17. The consent holder shall carry out a survey of benthic ecology and sediments in the vicinity of the diffuser prior to the commissioning of the outfall, followed by a survey 2 years after commissioning and thereafter at 5 yearly intervals for the duration of the consent. Monitoring will be carried out in accordance with the following:

    a) Samples shall be collected from a minimum of four locations to include sites close to the outfall, at the mixing zone boundary, outside the mixing zone and a control site.

b) Four replicate samples shall be collected at each sampling location from cores given approximately 100mm into the sediment.

c) All samples shall be sieved to 0.5mm for identification and enumeration of benthic infaunal taxa (including mean density, species richness(j), and Shannon Weiner diversity(H) indices calculated for each location).

d) Infaunal community changes at each location between surveys shall be assessed.

e) Prior to chemical analysis, all core samples shall be examined to determine texture, colour (black indicating an anoxic layer) and odour ("rotten egg" smell indicating anaerobic conditions). Photographs shall be taken of each core to document the relative degree of enrichment.

f) All samples shall be analysed for Total Kjeldahl Nitrogen, particle grain size, percentage of organic content (ash free dry weight), total organic carbon and trace metals (mercury, chromium, copper, lead and zinc).

g) Sediment chemistry changes at each location between surveys shall be assessed.

h) Summarise the data collected as required under this Condition (including graphical presentation and statistical summations of data) and analyse the information in regard to meeting the ecological provisions of section 107(1)(g) of the Resource Management Act 1991. Specifically, whether or not the discharge is causing significant adverse effects on aquatic life.

i) Highlight and discuss environmental trends in the results.

j) Compare results obtained during the survey with results obtained during previous surveys and provide an interpretation of any significant differences, changes or trends.

18. The consent holder shall carry out annual monitoring of shellfish quality in Picton Harbour in accordance with the following programme:

a) Samples of the blue mussel (*Mytilus edulis galloprovicialis*) shall be collected from the following shoreline locations: Mabel Island, Kaipupu Point, Bobs Bay, Westshore and Picton Wharf. *Note: these shellfish gathering locations were agreed with the Picton Sewage Consultative Working Group and the Senior Public Health Protection Officer, Nelson/Marlborough District Health Board and used by NIWA Ltd during the preparation of the Quantitative Microbial Risk Assessment for the new Picton outfall (June 2009)*.

b) All samples shall be analysed for Faecal coliforms and trace metals (copper, mercury and zinc).

c) Results of analysis of samples shall be assessed against the following standards: Faecal coliforms *(Ministry of Health Reference Criteria For Food 2005)*; and trace metals *(Australia New Zealand Food Standards Code 2002)*.

Coastal Permit – Outfall Pipeline

1. This resource consent shall expire on 1 June 2046.

2. Except insofar as required to comply with other conditions of this consent, the outfall pipeline and diffuser structure shall be constructed and maintained to accord with the Application for Resource Consent U100802 received by Council 21 December 2010.

3. Not later than one month prior to the commencement of site works, the consent holder shall submit to the Resource Consents Manager, Marlborough District Council, a construction management plan detailing the construction methodology and the measures which will be taken to avoid, remedy and mitigate adverse environmental effects arising from the construction phase. At minimum, the plan shall address all of the matters set out in the draft plan submitted as Appendix I to the resource consent application U100802. No works shall commence until the plan has been approved in writing by the Resource Consents Manager.

4. Following the approval of the construction management plan referred to in condition 2 above, all work associated with this resource consent shall be undertaken in accordance with that approved plan.

5. Not later than one week prior to the commencement of site works, the consent holder shall give the Resource Consents Manager, Marlborough District Council, written notice of the start date of works on the development site.

6. Following construction, the consent holder shall ensure that the outfall pipeline, diffuser structure and all associated structures are at all times maintained in a structurally sound condition and efficient working order.

7. Prior to the first use of the outfall pipeline, the consent holder shall erect and maintain a marker sign on the shoreline as close as possible to the diffuser location, marked with the words “Treated Wastewater Outfall”. The sign shall be sufficiently clear to enable passing boat users to read the sign at a distance of 50 metres.

8. As soon as practicable following completion of the structures, the consent holder shall notify the Harbourmaster and Resource Consents Manager at Marlborough District Council and the Director of Maritime Safety of the precise location and extent of the outfall pipeline and diffuser, together with appropriate coordinates.

9. Within three months of the commissioning of the outfall and diffuser, the consent holder shall provide the Resource Consents Manager at Marlborough District Council with certification from a suitably experienced chartered professional engineer to confirm that the structures have been designed and constructed in accordance with generally accepted best engineering practice.

10. At yearly intervals following the commissioning of the outfall and diffuser, the consent holder shall submit to the Resource Consents Manager at Marlborough District Council, a report detailing the findings of a visual inspection of the diffuser structure, to include at least the following matters:

    a. The date and time of the inspection.

    b. The condition of the outfall diffuser structure.

    c. A description of any maintenance work and if required programme for completion of the maintenance work.

11. The consent holder shall ensure that any maintenance or repairs identified by the yearly inspection referred to above, or identified at any other time, are carried out as soon as practicable. The consent holder shall provide written confirmation to the Resource Consents Manager that the repairs have been undertaken within 1 month of the completion of those repairs.

Land Use Consent – Surge Chamber and Pipeline

1. Except insofar as required to comply with other conditions of this consent, the activity must be undertaken in accordance with the Application for Resource Consent U100802 received by Council 21 December 2010.

2. Not later than one month prior to the commencement of site works, the consent holder shall submit to the Resource Consents Manager, Marlborough District Council, a construction management plan detailing the construction methodology and the measures which will be taken to avoid, remedy and mitigate adverse environmental effects arising from the construction phase. At minimum, the plan shall address all of the matters set out in the draft plan submitted as Appendix I to the resource consent application U100802. No works shall commence until the plan has been approved in writing by the Resource Consents Manager.

3. Following the approval of the construction management plan referred to in condition 2 above, all work associated with this resource consent shall be undertaken in accordance with that approved plan.

4. Not later than one week prior to the commencement of site works, the consent holder shall give the Resource Consents Manager, Marlborough District Council, written notice of the start date of works on the development site.

Land Use Consent – Removal of Existing Pipeline

1. Except insofar as required to comply with other conditions of this consent, the activity must be undertaken in accordance with the Application for Resource Consent U100802 received by Council 21 December 2010.

2. Not later than one month prior to the commencement of site works, the consent holder shall submit to the Resource Consents Manager, Marlborough District Council, a management plan detailing the deconstruction methodology and the measures which will be taken to avoid, remedy and mitigate adverse environmental effects arising from the deconstruction phase. At minimum, the plan shall address all of the matters set out in the draft plan submitted as Appendix I to the resource consent application U100802. No works shall commence until the plan has been approved in writing by the Resource Consents Manager.

3. Following the approval of the management plan referred to in condition 2 above, all work associated with this resource consent shall be undertaken in accordance with that approved plan.

4. Not later than one week prior to the commencement of site works, the consent holder shall give the Resource Consents Manager, Marlborough District Council, written notice of the start date of works on the development site.

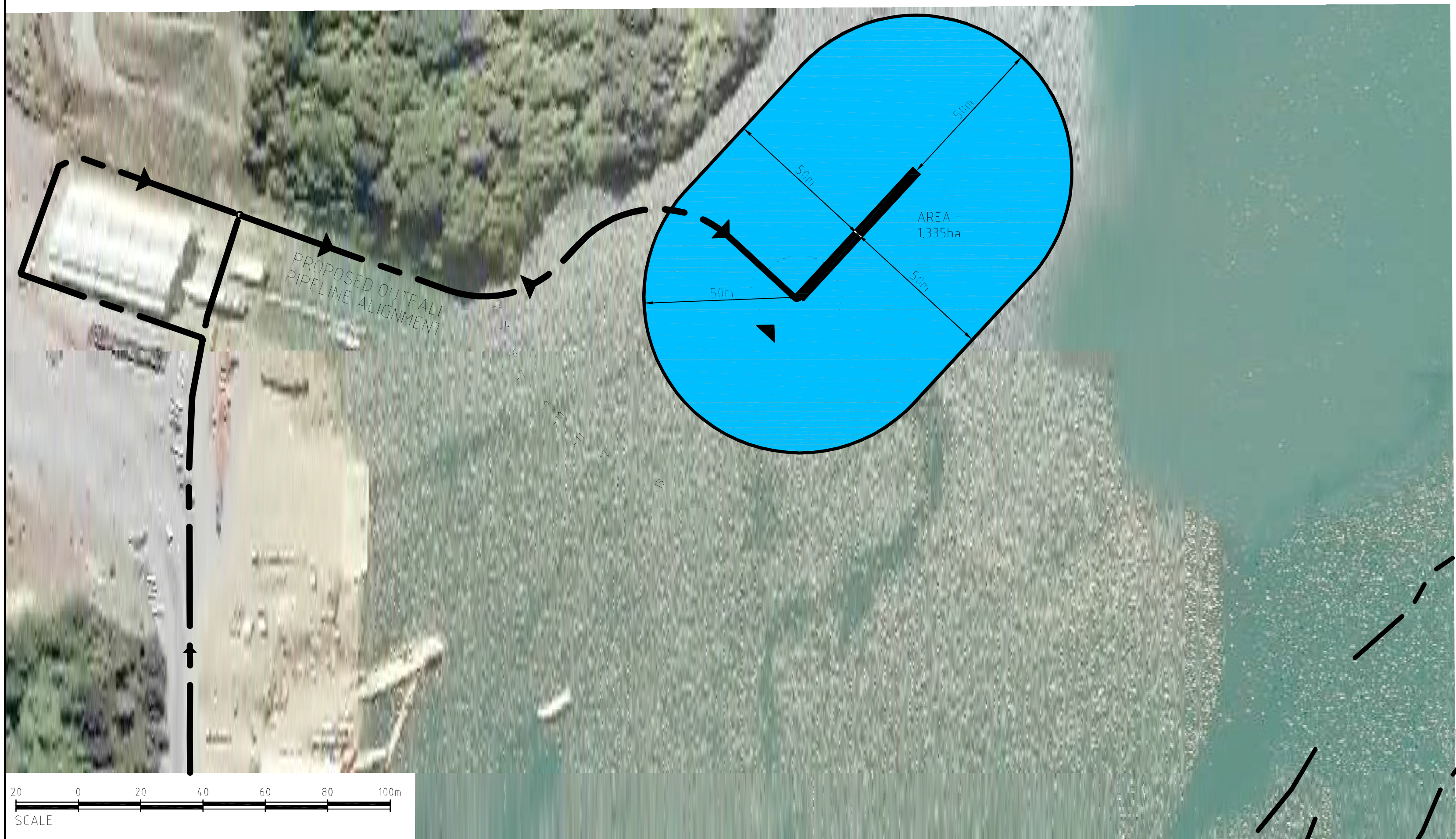
5. The consent holder shall ensure that the works authorised by this consent are carried out within 6 months following the commissioning of the new outfall pipeline and diffuser structure.

6. The consent holder shall ensure that all constituent materials of the existing pipeline and support structures are removed from the site and disposed of at a cleanfill or sealed landfill, as appropriate to the nature of the material. In no circumstances shall any material be disposed of in the coastal marine area or on public conservation land. Following removal of the pipeline, the land beneath it shall be remediated to as natural an appearance as practicable.

7. Within one month of the removal of the pipeline and support structures, the consent holder shall provide the Resource Consents Manager at Marlborough District Council with written and photographic confirmation that condition 6 above has been complied with.

Appendix B

Mixing Zone Drawing



FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	CAL			24.03.10

Beca

Scale as drawn (A4): 1:2000

Client: MARLBOROUGH DISTRICT COUNCIL

Designed	GJJ	24.03.10	Dsg Verifier	
Drawn	CAL	24.03.10	Dwg Check	

Project: PSTP OUTFALL AEE

Approved for Construction *

Date:

* Refer to Revision 1 for Original Signatures

Title: PROPOSED OUTFALL MIXING ZONE

Discipline: CIVIL

Drawing No.: 6513000-C-K47

Rev.: A

DO NOT SCALE

IF IN DOUBT ASK

Appendix C

Figure 5 - Shellfish Sampling Locations

Figure 3 - Map Showing Shellfish Monitoring Sites.

Appendix D

N-Viro Mooring Systems Outfall Inspection Report

12 Kent Street PICTON 7220 New Zealand

Phone: 03 573 8045 Website: www.n-viro.com
Fax: 03 573 8991 Email: donna@nviro.com

Diving Inspection Report
Picton Sewerage Pipeline – February 2017

ON: 037980JST1

3rd February 2017:- Worksafe Permit lodged

7th February 2017:

- Mobilise Work vessel 'Soundz Image' and SSBA:- Surface Supplied Breathing Apparatus
- Contact Picton Harbour Radio and the Harbour Master to notify them of pending Diving Operations
- Contact Ferry Operators for Arrival/Departure times to enable us to dive in between berthing
- Carry out Tool Box meeting on site
- Carry out Pre Start meeting on site

- **Diver carried out inspection of Diffuser pipeline**
- All of the anodes are active but showing approximately 35-40% wastage
- All discharge Duckbill Ports are clear of fouling and uninhibited but have slight marine growth on the outside
- All clamps are in good condition with no sign of corrosion but have an increase of marine growth
- A random check on the tightness of the nuts & bolts was carried out –found to be under correct tension
- No change in the seabed condition since the last survey – it is in good condition with no debris under the pipe
- A random check on the tightness of the flange bolts - they are all tight

- **Diver carried out inspection of the main pipeline from the Thrust Block back to the burial area inshore**
- The Thrust Block is in good condition with no debris around it
- All anodes are active they are approximately 35-40% wasted
- All clamps are in good condition with no sign of corrosion

Overall, everything is in good operating condition.

Demobilised ‘Soundz Image’ and equipment

Thank you for contracting N-Viro Ltd to carry out this project.

Regards

Donna Baker
N-Viro Ltd

Appendix E

SVOC Lab Results

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
1 Clyde Street Hamilton 3216
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

ANALYSIS REPORT

Client:	Marlborough District Council	**Lab No:**	1711427 SPv1
Contact:	C Hutchison	**Date Received:**	20-Jan-2017
	C/- Marlborough District Council	**Date Reported:**	02-Feb-2017
	PO Box 443	**Quote No:**	50185
	Blenheim 7240	**Order No:**	51493Chu
		Client Reference:	Picton Sewage, Consent, Annual
		Submitted By:	C Hutchison

Sample Type: Aqueous

Sample Name:		20165339 - 24 Hr Sampling Outlet -Effluent LOC1038 20-Jan-2017 11:00 am	20165339 - Grab Samples Outlet -Effluent LOC1038 20-Jan-2017 11:00 am			
Lab Number:		1711427.1	1711427.2			
Individual Tests						
pH	pH Units	7.4	-	-	-	-
Total Suspended Solids	g/m³	16	-	-	-	-
Total Recoverable Mercury	g/m³	< 0.00008	-	-	-	-
Total Ammoniacal-N	g/m³	4.8	-	-	-	-
Dissolved Reactive Phosphorus	g/m³	3.6	-	-	-	-
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	g O_2/m³	8	-	-	-	-
Faecal Coliforms	MPN / 100mL	-	20	-	-	-
Enterococci	MPN / 100mL	-	10 #1	-	-	-
Heavy metals total recoverable, trace As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	g/m³	< 0.003	-	-	-	-
Total Recoverable Cadmium	g/m³	< 0.00011	-	-	-	-
Total Recoverable Chromium	g/m³	< 0.0011	-	-	-	-
Total Recoverable Copper	g/m³	0.0076	-	-	-	-
Total Recoverable Lead	g/m³	0.0003	-	-	-	-
Total Recoverable Nickel	g/m³	< 0.0011	-	-	-	-
Total Recoverable Zinc	g/m³	0.031	-	-	-	-
Haloethers in SVOC Water Samples by GC-MS						
Bis(2-chloroethoxy) methane	g/m³	< 0.010	-	-	-	-
Bis(2-chloroethyl)ether	g/m³	< 0.010	-	-	-	-
Bis(2-chloroisopropyl)ether	g/m³	< 0.010	-	-	-	-
4-Bromophenyl phenyl ether	g/m³	< 0.010	-	-	-	-
4-Chlorophenyl phenyl ether	g/m³	< 0.010	-	-	-	-
Nitrogen containing compounds in SVOC Water Samples by GC-MS						
2,4-Dinitrotoluene	g/m³	< 0.02	-	-	-	-
2,6-Dinitrotoluene	g/m³	< 0.02	-	-	-	-
Nitrobenzene	g/m³	< 0.010	-	-	-	-
N-Nitrosodi-n-propylamine	g/m³	< 0.02	-	-	-	-
N-Nitrosodiphenylamine + Diphenylamine*	g/m3	< 0.02	-	-	-	-
Organochlorine Pesticides in SVOC Water Samples by GC-MS						
Aldrin	g/m³	< 0.010	-	-	-	-
alpha-BHC	g/m³	< 0.010	-	-	-	-
beta-BHC	g/m³	< 0.010	-	-	-	-
delta-BHC	g/m³	< 0.010	-	-	-	-

Sample Type: Aqueous						
Sample Name:		20165339 - 24 Hr Sampling Outlet -Effluent LOC1038 20-Jan-2017 11:00 am	20165339 - Grab Samples Outlet -Effluent LOC1038 20-Jan-2017 11:00 am			
Lab Number:		1711427.1	1711427.2			
Organochlorine Pesticides in SVOC Water Samples by GC-MS						
gamma-BHC (Lindane)	g/m^3	< 0.010	-	-	-	-
4,4'-DDD	g/m^3	< 0.010	-	-	-	-
4,4'-DDE	g/m^3	< 0.010	-	-	-	-
4,4'-DDT	g/m^3	< 0.02	-	-	-	-
Dieldrin	g/m^3	< 0.010	-	-	-	-
Endosulfan I	g/m^3	< 0.02	-	-	-	-
Endosulfan II	g/m^3	< 0.02	-	-	-	-
Endosulfan sulfate	g/m^3	< 0.02	-	-	-	-
Endrin	g/m^3	< 0.02	-	-	-	-
Endrin ketone	g/m^3	< 0.02	-	-	-	-
Heptachlor	g/m^3	< 0.010	-	-	-	-
Heptachlor epoxide	g/m^3	< 0.010	-	-	-	-
Hexachlorobenzene	g/m^3	< 0.010	-	-	-	-
Polycyclic Aromatic Hydrocarbons in SVOC Water Samples by GC-MS						
Acenaphthene	g/m^3	< 0.005	-	-	-	-
Acenaphthylene	g/m^3	< 0.005	-	-	-	-
Anthracene	g/m^3	< 0.005	-	-	-	-
Benzo[a]anthracene	g/m^3	< 0.005	-	-	-	-
Benzo[a]pyrene (BAP)	g/m^3	< 0.010	-	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	g/m^3	< 0.010	-	-	-	-
Benzo[g,h,i]perylene	g/m^3	< 0.010	-	-	-	-
Benzo[k]fluoranthene	g/m^3	< 0.010	-	-	-	-
1&2-Chloronaphthalene	g/m^3	< 0.005	-	-	-	-
Chrysene	g/m^3	< 0.005	-	-	-	-
Dibenzo[a,h]anthracene	g/m^3	< 0.010	-	-	-	-
Fluoranthene	g/m^3	< 0.005	-	-	-	-
Fluorene	g/m^3	< 0.005	-	-	-	-
Indeno(1,2,3-c,d)pyrene	g/m^3	< 0.010	-	-	-	-
2-Methylnaphthalene	g/m^3	< 0.005	-	-	-	-
Naphthalene	g/m^3	< 0.005	-	-	-	-
Phenanthrene	g/m^3	< 0.005	-	-	-	-
Pyrene	g/m^3	< 0.005	-	-	-	-
Phenols in SVOC Water Samples by GC-MS						
4-Chloro-3-methylphenol	g/m^3	< 0.02	-	-	-	-
2-Chlorophenol	g/m^3	< 0.010	-	-	-	-
2,4-Dichlorophenol	g/m^3	< 0.010	-	-	-	-
2,4-Dimethylphenol	g/m^3	< 0.010	-	-	-	-
3 & 4-Methylphenol (m- + p-cresol)	g/m^3	< 0.02	-	-	-	-
2-Methylphenol (o-Cresol)	g/m^3	< 0.010	-	-	-	-
2-Nitrophenol	g/m^3	< 0.02	-	-	-	-
Pentachlorophenol (PCP)	g/m^3	< 0.2	-	-	-	-
Phenol	g/m^3	< 0.02	-	-	-	-
2,4,5-Trichlorophenol	g/m^3	< 0.02	-	-	-	-
2,4,6-Trichlorophenol	g/m^3	< 0.02	-	-	-	-
Plasticisers in SVOC Water Samples by GC-MS						
Bis(2-ethylhexyl)phthalate	g/m^3	< 0.04	-	-	-	-
Butylbenzylphthalate	g/m^3	< 0.02	-	-	-	-
Di(2-ethylhexyl)adipate	g/m^3	< 0.010	-	-	-	-
Diethylphthalate	g/m^3	< 0.02	-	-	-	-
Dimethylphthalate	g/m^3	< 0.02	-	-	-	-
Di-n-butylphthalate	g/m^3	< 0.02	-	-	-	-

Sample Type: Aqueous						
Sample Name:		20165339 - 24 Hr Sampling Outlet -Effluent LOC1038 20-Jan-2017 11:00 am	20165339 - Grab Samples Outlet -Effluent LOC1038 20-Jan-2017 11:00 am			
Lab Number:		1711427.1	1711427.2			
Plasticisers in SVOC Water Samples by GC-MS						
Di-n-octylphthalate	g/m^3	< 0.02	-	-	-	-
Other Halogenated compounds in SVOC Water Samples by GC-MS						
1,2-Dichlorobenzene	g/m^3	< 0.02	-	-	-	-
1,3-Dichlorobenzene	g/m^3	< 0.02	-	-	-	-
1,4-Dichlorobenzene	g/m^3	< 0.02	-	-	-	-
Hexachlorobutadiene	g/m^3	< 0.02	-	-	-	-
Hexachloroethane	g/m^3	< 0.02	-	-	-	-
1,2,4-Trichlorobenzene	g/m^3	< 0.010	-	-	-	-
Other compounds in SVOC Water Samples by GC-MS						
Benzyl alcohol	g/m^3	< 0.10	-	-	-	-
Carbazole	g/m^3	< 0.010	-	-	-	-
Dibenzofuran	g/m^3	< 0.010	-	-	-	-
Isophorone	g/m^3	< 0.010	-	-	-	-

Analyst's Comments

[#1] Please interpret this result with caution as the sample was > 8 °C on receipt at the lab. The sample temperature is recommended by APHA to be less than 8 °C on receipt at the laboratory (but not frozen). However, it is acknowledged that samples that are transported quickly to the laboratory after sampling, may not have been cooled to this temperature.

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Heavy metals total recoverable, trace As,Cd,Cr,Cu,Ni,Pb,Zn	Nitric/Hydrochloric acid extraction, ICP-MS, trace level. APHA 3125 B 22nd ed. 2012.	0.00005 - 0.0010 g/m^3	1
Semivolatile Organic Compounds Screening in Water by GC-MS	Liquid/Liquid extraction, GPC cleanup (if required), GC-MS FS analysis	-	1
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
Total Recoverable Extraction	Nitric/Hydrochloric acid extraction, 85°C, 2.75 hours. US EPA 1638.	-	1
pH	pH meter. APHA 4500-H^+ B 22nd ed. 2012. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field.	0.1 pH Units	1
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D 22nd ed. 2012.	3 g/m^3	1
Total Recoverable Mercury	Total recoverable extraction, bromine oxidation followed by atomic fluorescence. US EPA Method 245.7, Feb 2005.	0.00008 g/m^3	1
Total Ammoniacal-N	Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH_4-N = NH_4+-N + NH_3-N). APHA 4500-NH_3 F (modified from manual analysis) 22nd ed. 2012.	0.010 g/m^3	1
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 22nd ed. 2012.	0.004 g/m^3	1
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, dilutions, seeded. Analysed at Hill Laboratories - Microbiology; 1 Clow Place, Hamilton. APHA 5210 B (modified) 22nd ed. 2012.	2 g O_2/m^3	1
Thermotolerant (Faecal) Coliforms	MPN count in LT Broth at 35°C for 48 hours, EC Broth at 44.5° C for 24 hours Analysed at Hill Laboratories - Microbiology; Grovetown Park, State Highway 1, Blenheim. APHA 9221 B, 9221 E 22nd ed. 2012.	2 MPN / 100mL	2
Enterococci	MPN count using Enterolert, Incubated at 41°C for 24 hours. Analysed at Hill Laboratories - Microbiology; Grovetown Park, State Highway 1, Blenheim. MIMM 12.4, APHA 9230D.	1 MPN / 100mL	2

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

This report must not be reproduced, except in full, without the written consent of the signatory.

Peter Robinson MSc (Hons), PhD, FNZIC
Client Services Manager - Environmental

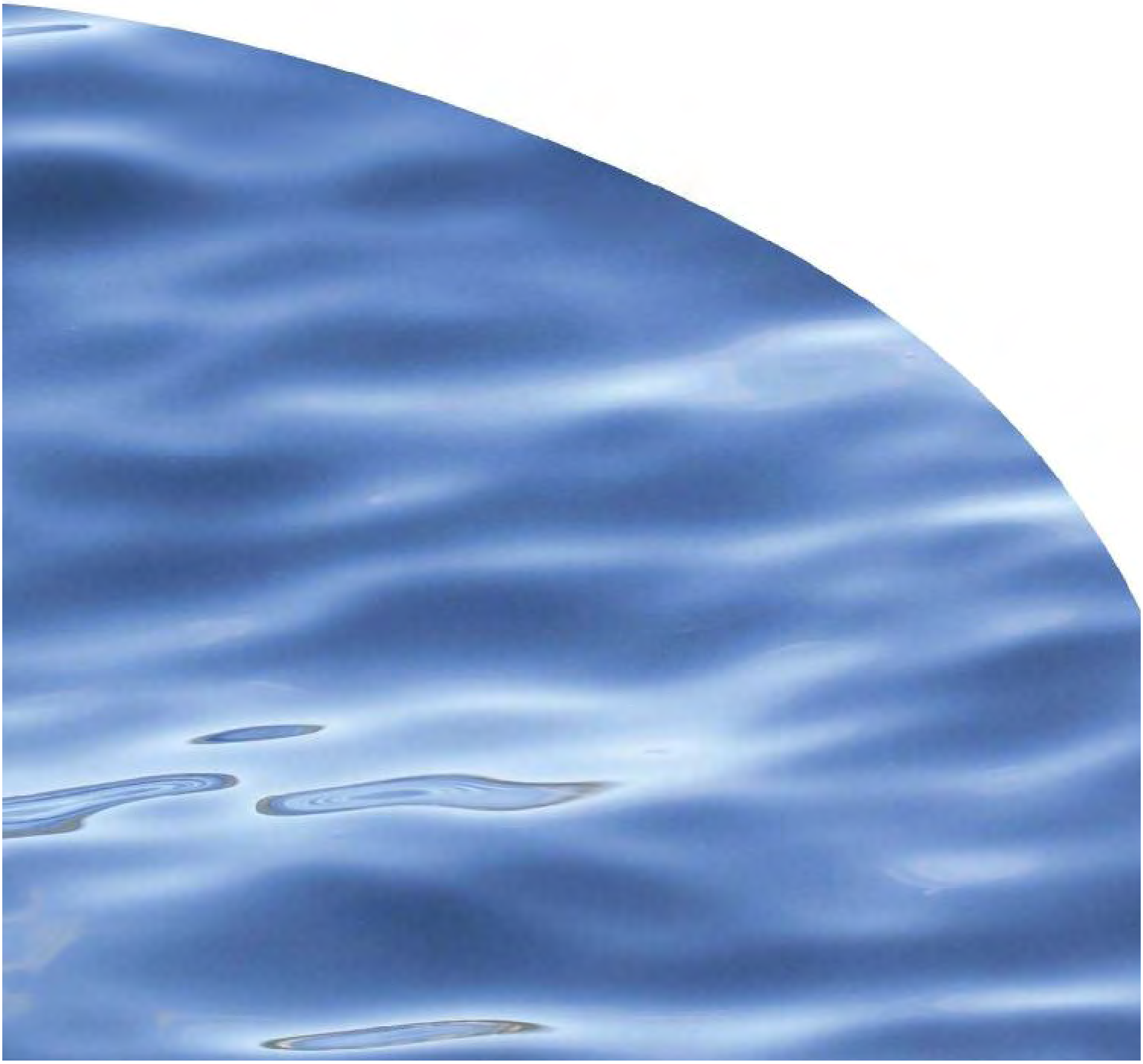
Appendix F

Cawthron Benthic Survey Report

CAWTHRON INSTITUTE

REPORT NO. 2662

BENTHIC SURVEY FOR THE RELOCATED PICTON WASTEWATER TREATMENT PLANT OUTFALL 2014



BENTHIC SURVEY FOR THE RELOCATED PICTON WASTEWATER TREATMENT PLANT OUTFALL 2014

LISA PEACOCK, ROSS SNEDDON, DON MORRISEY

Prepared for Marlborough District Council

CAWTHRON INSTITUTE
98 Halifax Street East, Nelson 7010 | Private Bag 2, Nelson 7042 | New Zealand
Ph. +64 3 548 2319 | Fax. +64 3 546 9464
www.cawthron.org.nz

REVIEWED BY:
Paul Barter

APPROVED FOR RELEASE BY:
Chris Cornelisen

ISSUE DATE: 5 March 2015

RECOMMENDED CITATION: Peacock L, Sneddon R, Morrisey D 2015. Benthic survey for the relocated Picton wastewater treatment plant outfall 2014. Prepared for Marlborough District Council. Cawthron Report No. 2662. 21 p. plus appendices.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

GLOSSARY

Item	Definition	Type
°C	Degrees Celsius	Unit
µm	Micron	Unit
AFDW	Ash-free dry weight	Acronym
ANZECC	Australia and New Zealand Environment and Conservation Council	Acronym
aRPD	Apparent redox potential discontinuity	Acronym
As	Arsenic	Abbreviation
Cd	Cadmium	Abbreviation
cm	Centimetre	Unit
Cr	Chromium	Abbreviation
Cu	Copper	Abbreviation
g	Grams	Unit
GPS	Global positioning system	Acronym
H'	Shannon-Weiner diversity index	Index
Hg	Mercury	Abbreviation
ICP-MS	Inductively coupled plasma-mass spectrometry	Acronym
ISQG	Interim Sediment Quality Guideline	Acronym
ISQG-Low	Interim Sediment Quality Guideline-Low trigger value	Acronym
J'	Pielou's evenness index	Index
m	Metre or metres	Unit
MDC	Marlborough District Council	Acronym
MDS	Multi-dimensional scaling	Acronym
mg/kg	Milligrams per kilogram (parts per million)	Unit
mm	Millimetres	Unit
MZE	Mixing zone edge	Acronym
N	Nitrogen, or North	Abbreviation
n	Number of individuals/replicates in a sample	Variable
NH_3	Ammonia	Abbreviation
NH_{4+}	Ammonium (ion)	Abbreviation
Ni	Nickel	Abbreviation
NO_2	Nitrite	Abbreviation
NO_3	Nitrate	Abbreviation
NZMG	New Zealand Map Grid (map projection)	Acronym
Pb	Lead	Abbreviation
PVC	Polyvinyl chloride	Acronym
S	Number of species (species richness)	Index
SCUBA	Self-contained underwater breathing apparatus	Acronym
SE	Standard error of the mean	Acronym
SIMPER	Similarity percentage	Abbreviation
TKN	Total Kjeldahl nitrogen	Acronym
TN	Total nitrogen	Acronym
TOC	Total organic carbon	Acronym
UV	Ultraviolet light	Acronym
WWTP	Wastewater treatment plant	Acronym
Zn	Zinc	Abbreviation

1. INTRODUCTION

The Picton wastewater treatment plant (WWTP) treats primarily domestic wastewater from the townships of Picton and Waikawa. Since 1999, treatment has been carried out to a tertiary level (activated sludge plus ultra-violet disinfection). Until the end of 2012, the treated effluent was conveyed via a shoreline pipeline to a submarine outfall at Kaipupu Point (Figure 1). Following an evaluation of several different options (Barter *et al.* 2008) and a resource consent hearing in 2011, a new Picton Harbour outfall was built in 2012 to the south of the previous outfall in water depths of 15 m.

Figure 1. Map of Picton Harbour indicating locations of current and previous benthic sampling stations and the current and decommissioned outfalls from the Picton wastewater treatment plant.

The Resource Consent for the discharge (Coastal Permit U100802, Appendix 1) required a baseline benthic survey, which was carried out prior to the commissioning of the outfall. Characterisation of physico-chemical and ecological aspects of the seabed was conducted by Cawthron Institute (Cawthron) in December 2012 (Sneddon & Barter 2013). Repeat surveys are required after two years and five-yearly thereafter. Cawthron was contracted to carry out the two-year survey, which was implemented on 25 November 2014 and is detailed in this report.

1.1. Scope

The scope of the work undertaken is defined by the requirements of the Coastal Permit. The methodology for the benthic survey is prescribed by condition 17, items a, b, c, e and f (Appendix 1). Required data analysis and interpretation is outlined in condition 17, items c, g, h, i and j.

2. METHODS

2.1. General

The baseline benthic survey in 2012 established four sampling stations in the vicinity of the outfall along an approximate isobath parallel to the Harbour's northern shoreline (Figure 1, Table 1). These stations were located at:

- A point approximately 5–10 m from the end of the outfall diffuser ('diffuser' station)
- A point on the consented mixing zone edge ('MZE' station), 50 m from the diffuser
- A point 50 m north-east of the MZE ('50m north' station)
- A control station approximately 400 m north-north-east of the outfall ('control' station).

The stations were located in 2014 using a portable GPS and marked with a shot-line prior to sample collection by a SCUBA diver.

Table 1. Geographic positions of the benthic sampling stations depicted in Figure 1.

Station	Position coordinates	
	NZMG-East	NZMG-North
Diffuser	2,594,379	5,991,542
MZE	2,594,398	5,991,566
50m North	2,594,432	5,991,601
Control	2,594,589	5,991,844

2.2. Sediment physico-chemistry

As specified in condition 17(b) of the Consent, four replicate 62 mm diameter core sediment samples were collected by divers at each station. This sampling was duplicated to provide sufficient sediment for multiple analyses. Corers were driven 100–150 mm into the seabed, carefully withdrawn and capped before ascent to the support vessel. The cores were examined and photographed, then sub-sampled (surficial 5 cm of each core), composited (duplicate cores combined) and dispatched to a laboratory for analysis of:

- particle grain-size distribution: percent composition of gravel, sands (very coarse, coarse, medium, fine) and silt/clay
- organic content (total organic carbon; TOC, ash-free dry weight; AFDW)

- nitrogen content (as total nitrogen; TN)
- trace metals: cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), mercury (Hg) and zinc (Zn).

Brief analytical method descriptions are listed in Table 2. Although the Resource Consent stipulates the measurement of total Kjeldahl nitrogen (TKN), at the time of the baseline survey this was not a sediment analysis offered by the laboratory and analysis for TN was substituted. Although not analogous, TKN is likely to be the major component of the measured TN value[1]. During the evaluation of options for relocation of the outfall in 2008, TKN was measured in sediments from a site close to the current control station ('mooring' station, Figure 1), yielding a value of 0.16 g/100 g. Since this value was comparable to the 2012 results for TN in sediments, this modification to methodology was considered acceptable for assessment purposes.

Table 2. Summary of analytical methods for Picton outfall sediments.

Analyte	Description
Total nitrogen	Catalytic combustion (900°C, O2), separation, Thermal conductivity detector [elementar analyser].
Particle grain size (extended)	Drying for 16 hours at 103°C, gravimetry (Free water removed before analysis). Wet sieved (Udden-Wentworth scale) to establish proportions of gravel (2 mm), five sand classes, silt & clay (< 63 µm)
Organic content as AFDW or loss on ignition	Sample air-dried at 35°C then ignition in muffle furnace at 550°C, 6hr, gravimetric. Organic content by difference.
TOC	Acid pre-treatment to remove carbonates if present, neutralisation, [elementar combustion analyser].
Trace metals–ICP-MS (Hg, Cd, Cr, Cu, Pb, Zn)	Dried sample, sieved (2 mm, as required). Nitric/hydrochloric acid digestion, ICP-MS, screen level.

2.3. Benthic macroinvertebrate communities

The consent requires assessment of changes in infaunal communities at each survey location. Benthic infauna were sampled by divers at each of the four stations using four replicate 130 mm internal diameter PVC tubes fitted with 0.5 mm nylon mesh bags for sieving. The PVC tubes were manually driven approximately 100 mm into the sediment, removed with the core intact, and the contents gently washed through the sieve. The residue containing the infauna was transferred to plastic containers, preserved with 70% ethanol containing 1% glyoxal as a fixative and submitted to the laboratory for analysis.

[1] Kjeldahl nitrogen is the sum of organic nitrogen, ammonia (NH_3) and ammonium (NH_4^+). In addition to these components, Total nitrogen also includes the inorganic forms of nitrate (NO_3) and nitrite (NO_2) which, in natural marine sediments, represent only a small fraction of the nitrogen present.

In the laboratory, the infauna samples were sorted, identified to the lowest practicable taxonomic level and counted using a binocular microscope. The raw count data were analysed to provide community indices of abundance, species richness, diversity and evenness for each sample (Table 3).

Table 3. Descriptors of macroinvertebrate community indices.

Descriptor	Equation	Description
No. species (S)	Count (taxa)	Total number of species in a sample.
No. individuals (N)	Sum (n)	Total number of individual organisms in a sample.
Evenness (J')	$J' = H'/Log_e(S)$	Pielou's evenness index: a measure of equitability, or how evenly the individuals are distributed among the different species. Values can theoretically range from 0.00 to 1.00, where a high value indicates an even distribution and a low value indicates an uneven distribution or dominance by a few taxa.
Diversity (H' log_e)	$H' = -SUM (Pi*log_e(Pi))$	Shannon-Wiener diversity index (log_e base): a diversity index that describes, in a single number, the different types and amounts of animals present in a collection. Varies with both the number of species and the relative distribution of individual organisms among the species. The index ranges from 0 for communities containing a single species (low community complexity) to high values for communities containing many species and each with a small number of individuals. The maximum value is dependent on the number of categories or species sampled for a given data set.

The infauna assemblages at each station were also contrasted using non-metric multi-dimensional scaling or MDS (Kruskal & Wish. 1978) and ordination and cluster diagrams based on Bray-Curtis similarities (Clarke & Warwick. 1994). Sample ordination, via multivariate analysis, attempts to represent samples in a 2-, 3- or multi-dimensional space according to their similarities and differences. If a 2-dimensional representation explains a sufficient proportion of the sample differences observed, these can be assessed spatially on a 2-dimensional plot, where the distance between sample points corresponds to the degree of difference observed between infauna assemblages. A stress statistic provides a measure of how well the plot represents the differences in the data overall.

Abundance data were fourth-root transformed to de-emphasise the influence of the dominant species (by abundance). The major taxa contributing to the similarities of each group (by station) were identified using analysis of similarities (SIMPER; Clarke & Warwick 1994). All multivariate analyses were performed with PRIMER v6 software.

3. RESULTS AND DISCUSSION

3.1. Field observations

The seabed substrate at all stations was relatively uniform soft mud, although some shell matter was noted in sediments from the control site. Core samples were light grey/brown in colour in the surface layers with a diffuse change to dark grey sediments beneath a variable apparent redox potential discontinuity (aRPD) layer[2] at 6–9 cm (see Appendix 2 for photographs of cores and estimates of aRPD layer depth). There was no notable odour of hydrogen sulphide for any samples, indicating no more than moderate organic enrichment.

3.2. Sediment physico-chemical characteristics

3.2.1. Sediment texture

Particle grain-size profiles for the four sampling stations are presented in Figure 2, along with results from the 2012 baseline survey. Full data sets are detailed in Appendix 3.

As in the baseline survey, all sediment cores collected in 2014 were dominated by the silt/clay fraction (< 63 µm) with progressively smaller proportions of larger grain-size classes. Samples collected from the diffuser, MZE and 50m north stations were very similar in grain-size distribution, with only a very slight increase in the proportion of silt and clay particles at MZE station. This pattern and the profiles for these stations are consistent with the 2012 baseline survey, indicating no significant change in sediment texture since the outfall was commissioned.

In 2012, the control station sediment profiles differed from treatment stations in that they contained slightly lower proportions of silt/clay particles (~55% *vs* 65–79%) and correspondingly higher fractions of coarser particles. Interestingly, the sediment profile for the control station in 2014 contained a significantly higher proportion of silt/clay particles than was detected in the baseline survey. The control station profile now more closely aligns with the treatment station profiles. While this alignment in fact improves comparability and the station's applicability as a reference, the cause for this shift is unknown. However, it may be related to variation over small spatial scales at the control station. The source of additional fine sediment is unlikely to be associated with the Picton WWTP discharge, since sediment profiles in the vicinity of the diffuser remain essentially unchanged.

[2] The apparent redox potential discontinuity depth (aRPD) refers to the often distinct colour change, between surface and underlying sediments, brought about by the changing redox environment with depth in the profile. This gradient of colour change is in reality continuous but may be reduced to an average transition point (sediment depth) for descriptive purposes.

3.2.2. Organic enrichment

Overall, the organic content of the sediment samples are considered moderate for coastal marine sediments, reflecting the inner harbour position and expected influence from terrestrial run-off. Samples from stations in the vicinity of the outfall were very similar, both in relation to each other and to baseline survey results (Figure 2). Samples from the control station indicated elevated enrichment relative to the baseline survey and to treatment stations. This pattern is likely to be a function of the increased fraction of silt and clay at this station, since the depositional conditions, which favour fine sediments, also facilitate the settlement and accumulation of organic matter.

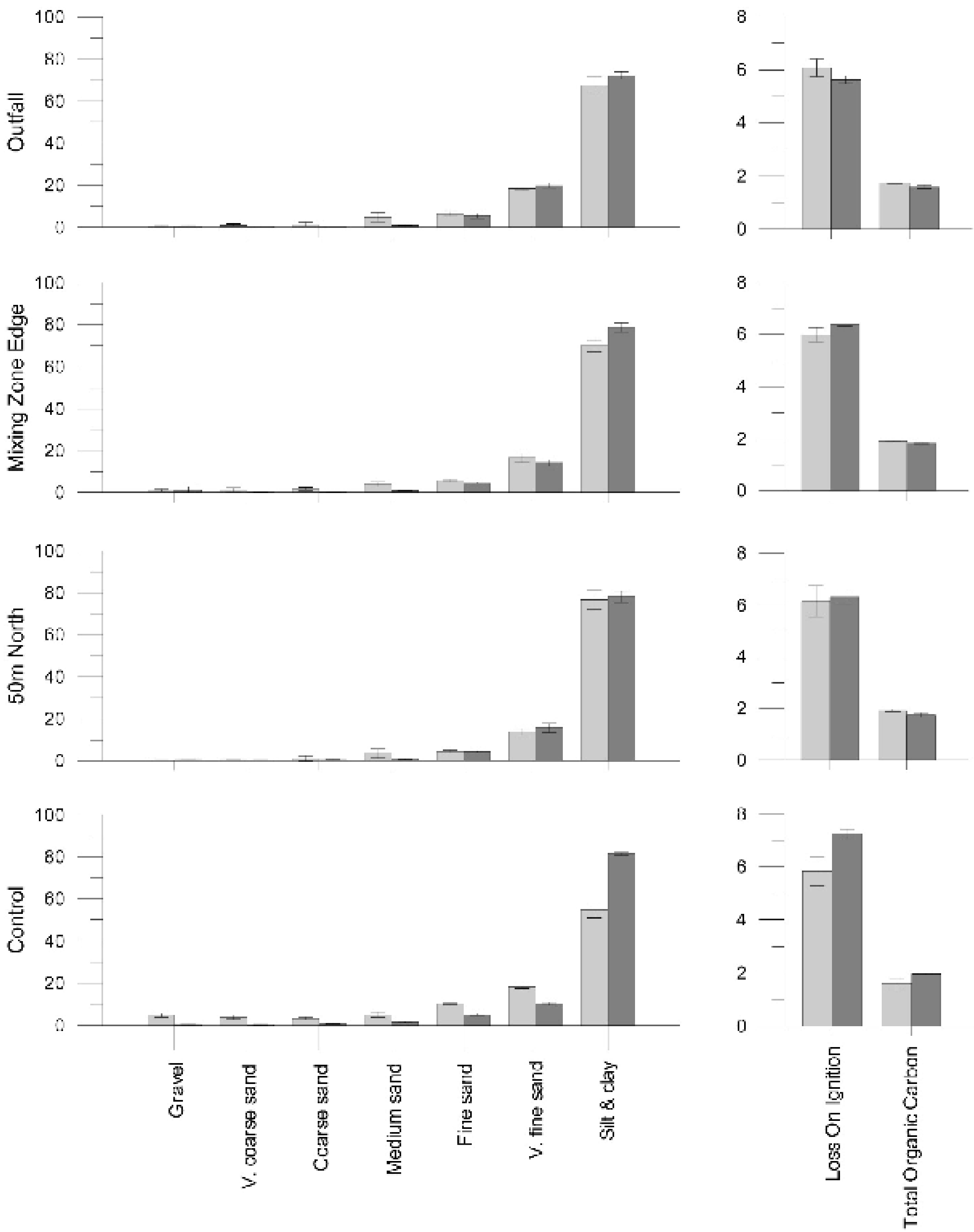


Figure 2. Sediment grain-size distribution and organic enrichment at each station for the baseline (2012; shown in pale grey) and present survey (2014; shown in dark grey). Grain-size classes and loss on ignition (or AFDW) are represented as percentages of the total sample. Total organic carbon units are g/100 g dry weight. Error bars represent ± 1 standard deviation (n = 4).

3.2.3. Nutrient and contaminant status

The results of sediment chemical analysis are shown graphically in Figure 3 and listed in Appendix 4.

Concentrations of all tested constituents were similar or slightly lower than for the 2012 baseline data, with the exception of samples collected at the control station. Increases in the concentrations of metals at the control station are to be expected based on their typically strong relationship to the fines fraction in sediments. Similarly, the increase in TN tends to mirror that of the organic content to which it is intrinsically related.

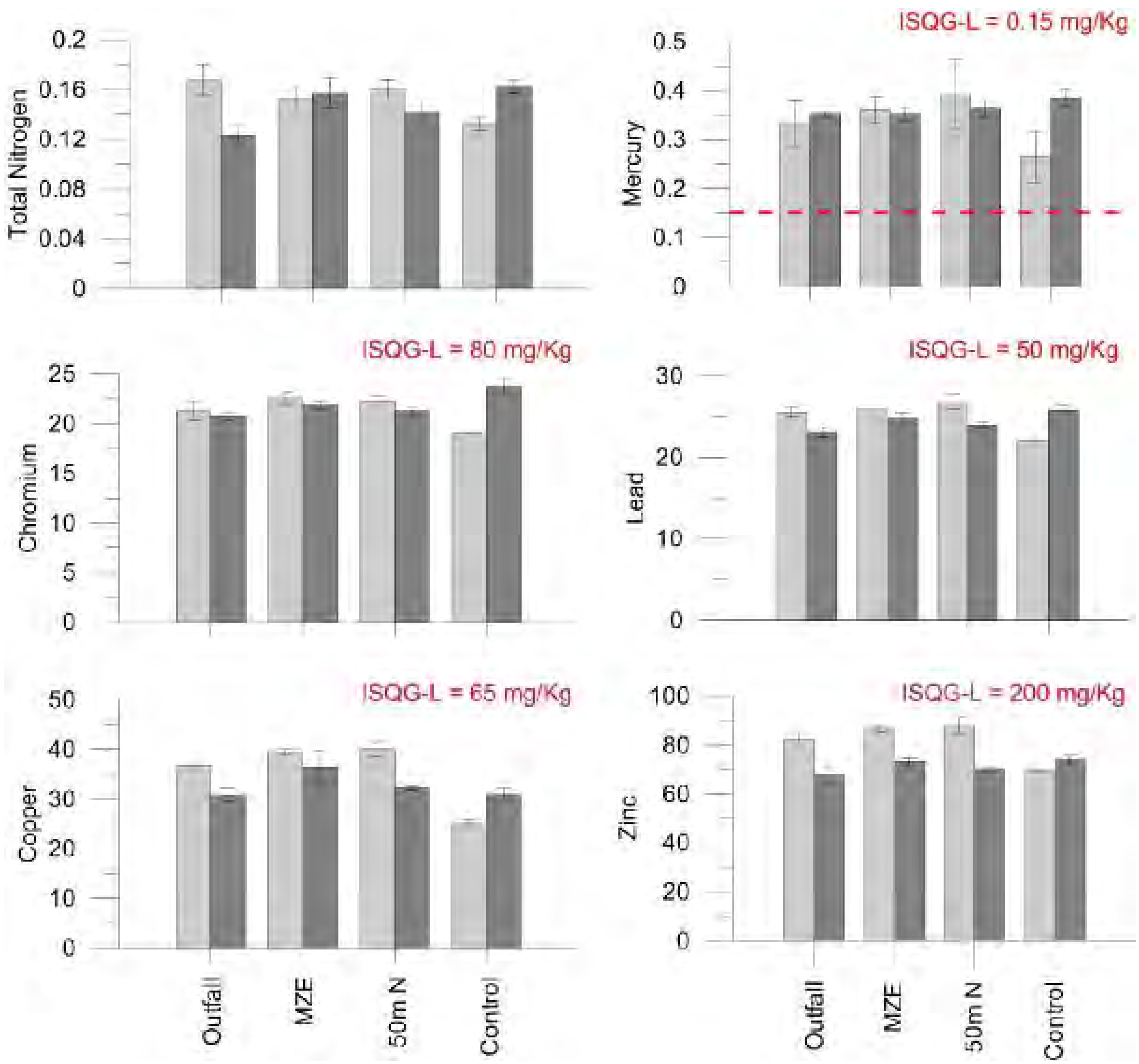


Figure 3. Total nitrogen (g/100 g dry wt) and metal contaminants (mg/kg) in sediments from the four Picton outfall benthic stations for the baseline (2012; shown in pale grey) and present survey (2014; shown in dark grey). Error bars represent ± 1 standard deviation (n = 4). ANZECC (2000) ISQG-Low trigger values are indicated for metals.

With the exception of mercury, all metal contaminants were detected at concentrations below the ANZECC (2000) ISQG-Low trigger values indicative of possible ecological effects[3]. Similar levels of mercury were reported in the baseline survey and also in earlier benthic assessments of this area (Barter *et al.* 2008). As discussed previously (Sneddon & Barter 2013), levels of contaminants that approach or exceed ISQG-Low trigger values (0.15 mg/kg for mercury) are likely to be associated with anthropogenic inputs. However, the observed spatial patterns of contaminant concentrations do not implicate the discharge from the Picton WWTP as a significant source, either from the previous Kaipupu Point (Barter *et al.* 2008) or current outfalls.

Although below the ISQG-Low trigger values, concentrations of trace metals at the sampling stations are higher than those considered typical of coastal sediments and observed in other similar locations within the Marlborough Sounds. Copper, lead and zinc in all samples collected in both the current and baseline surveys exceeded the range of trace metals concentrations reported in similar sediments from neighboring Shakespeare Bay (Conwell & Sneddon 2009, Sneddon 2014).

- Copper: 8–17 mg/kg
- Lead: 8–20 mg/kg
- Zinc: 37060 mg/kg

Previous benthic surveys conducted during consultancy for the outfall relocation also reported similar concentrations of all the trace metals tested in 2012 and 2014 (Barter *et al*. 2008). As discussed in the baseline report, the proximity of sampling stations to the Picton waterfront suggests historical exposure to contaminant inputs (*e.g.* wharves, vessels, maintenance facilities) and to urban run-off.

Concentrations of TN were very similar across stations and across surveys, with an increase at the control station which, as noted, was consistent with the change in organic content and sediment texture.

[3] The Interim Sediment Quality Guidelines (ISQG) -Low and -High levels represent the two threshold levels under which biological effects are predicted. The lower threshold indicates a *possible* biological effect while the upper threshold (ISQG-High) indicates a *probable* biological effect.

3.3. Macrofaunal community analysis

Count data for the sixteen benthic sediment samples collected at the four monitoring stations in 2014 is presented in Appendix 5. To ensure comparability between these data and 2012 baseline results, it was necessary to combine some species at genus level (*i.e*. polychaete worm: *Prionospio* spp., ostracods: *Cypridinodes* spp. and *Euphilomedes* spp.*)* or into broader taxonomic groups (*i.e*. Ostracoda, Amphipoda, Thyasiridae). In some cases, a number of species or families were grouped at a higher taxonomic level but where individuals were identified to lower levels in both years, this resolution was retained and these individuals were excluded from the higher level group (*e.g.* Amphipoda and Phoxocephalidae; Ostracoda and *Diasterope grisea*). The resultant decrease in taxonomic resolution made infaunal communities appear slightly more similar in multivariate analyses, but the differences were very small and are outweighed by the value of meaningful comparisons between years.

Communities sampled in 2014 contained a range of macrofauna considered characteristic of protected, soft sediment habitats. The principal taxonomic groups represented in the samples (average abundance across stations as % of total) were polychaete worms (32.2%), cumaceans (28.9%), ostracods (24.8%), amphipods (22.1%), tanaid shrimps (10.6%) and bivalves (8.8%). The most abundant taxa identified across stations are listed in Table 4.

Table 4. List of the most abundant macrofaunal taxa identified in sediment samples collected during the November 2014 survey. Taxa are sorted by mean total abundance across stations.

Group	Taxa	Common Name	Mean abundance
Cumacea	Cumacea	Cumaceans	28.9
Ostracoda	*Euphilomedes* spp.	Ostracod	19.3
Polychaeta	*Prionospio* spp.	Polychaete worm	12.8
Amphipoda	Amphipoda	Amphipod	11.6
Crustacea	Tanaidacea	Tanaid shrimp	10.6
Amphipoda	Phoxocephalidae	Amphipod	8.4
Ostracoda	*Diasterope grisea*	Ostracod	5.6
Bivalvia	*Theora lubrica*	Window shell	4.0
Ostracoda	*Cymbicopia hispida*	Ostracod	3.4
Ophiuroidea	Ophiuroidea	Brittle star	3.3
Ostracoda	*Parasterope quadrata*	Ostracod	3.1
Ostracoda	Ostracoda	Ostracod	2.8
Bivalvia	*Pratulum pulchellum*	Bivalve	2.8
Ostracoda	*Cypridinodes* spp.	Ostracod	2.8
Priapulida	Priapulida	Priapulid worm	2.5
Polychaeta	*Armandia maculata*	Polychaete worm	2.4
Amphipoda	Lysianassidae	Amphipod	2.1
Polychaeta	Cirratulidae	Polychaete worm	2.1

Community indices for the four benthic stations are plotted in Figure 4, for both the present and 2012 baseline surveys. Communities sampled in 2014 and 2012 were not clearly dominated by a single taxon, but rather comprised many different taxa. Individuals were spread fairly evenly among these groups. Samples collected in 2014 comprised more taxa and individuals than 2012 samples, with highest mean abundances at the diffuser station. However, the spread of individuals among the taxa resulted in relatively high evenness and diversity indices for all stations, similar to baseline indices. Refer to Section 3.4 for a more detailed comparison with 2012 results.

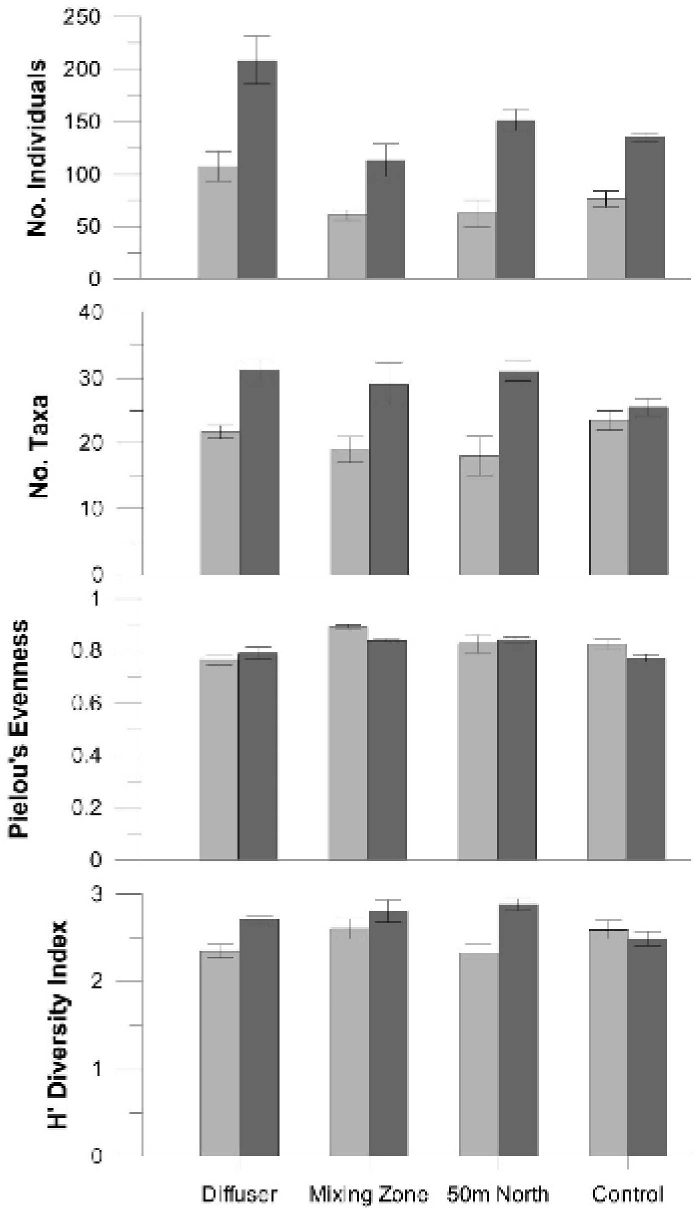


Figure 4. Macrofaunal community indices for the four benthic stations sampled during the baseline (2012; pale grey) and present survey (2014; dark grey). Values are averages of replicate samples at each station and error bars represent ± the standard error (SE), where n = 4.

Multivariate statistics were used to further investigate potential differences in community composition between stations. The multi-dimensional scaling (MDS) plot and associated dendrogram for the 2014 benthic survey data are presented in Figure 5. The stress value indicates how well the plot preserves the similarities and differences among samples in the original data set. Values less than 0.2 are considered acceptable, but a value of 0.2 suggests that the plot should be interpreted with caution. The plots show that infaunal community composition was very similar across samples and that there is no clear relationship with distance from the diffuser (*i.e*. station). Samples from the control site, however, form a discrete group.

Samples did not resolve into groups until tested for 60% similarity, at which point three groups (1–3 in Figure 5) were apparent:

- Group 1 comprised a mixture of samples from the three outfall-associated stations (diffuser, MZE, 50m north) and the control station,
- Groups 2 and 3 each contained a single MZE sample.

At 62% similarity, samples were divided among five groups (A–E in Figure 5).

- Group A contained three control station samples
- Group B contained one control station sample
- Group C contained all of the diffuser and 50m north station samples and two of the samples from the MZE station
- Groups D and E each contained a single MZE station sample.

The two MZE station samples (60% similarity Groups 2 and 3) that were not sufficiently similar to other samples to be incorporated into any group, differed from other samples in that they contained fewer cumaceans and no *Theora lubrica* bivalves. Group 3 did not contain any *Prionospio* spp. (polychaete worms), phoxocephalid amphipods or *Parasterope quadrata* (ostracod). Group 2 included the anemone *Arachnanthus* sp., the cushion star *Patiriella* sp. and the polychaete worm *Spiophanes kroyeri*. The main group (Group 1) was characterised by cumaceans (contributing to 8.7% of the similarity within the group), ostracods (21.3%; including 7.9% *Euphilomedes* spp.) and amphipods (12%; including 5.33% phoxocephalids), and also contained *Prionospio* spp. (5.9%), brittle stars (ophiuroidea; 4.3%), the bivalve *Pratulum pulchellum* (4.1%) and tanaid shrimps (4%).

At 62% similarity, the control station samples (Groups A and B) separated from the main group (Group C), due to very small differences in the abundances of many different taxa. Group A comprised fewer *Theora lubrica* and tanaid shrimps than Group C, and Group B contained oligochaete worms. Relative to samples in Group C, both groups contained fewer or no Lysianassidae (amphipods), *Armandia maculata,* *Pectinaria australis*, Hesionidae and Lumbrineridae (polychaetes), and the ostracods *Cypridinodes* spp. and *Diasterope grisea*.

The relatively weak grouping of samples and lack of clear station-related trends indicates that infaunal community composition is not influenced by proximity to the diffuser. Whilst minor differences were detected between groups of samples, these are more likely to be a result of small-scale spatial variability than due to potential adverse ecological effects that may be associated with wastewater input.

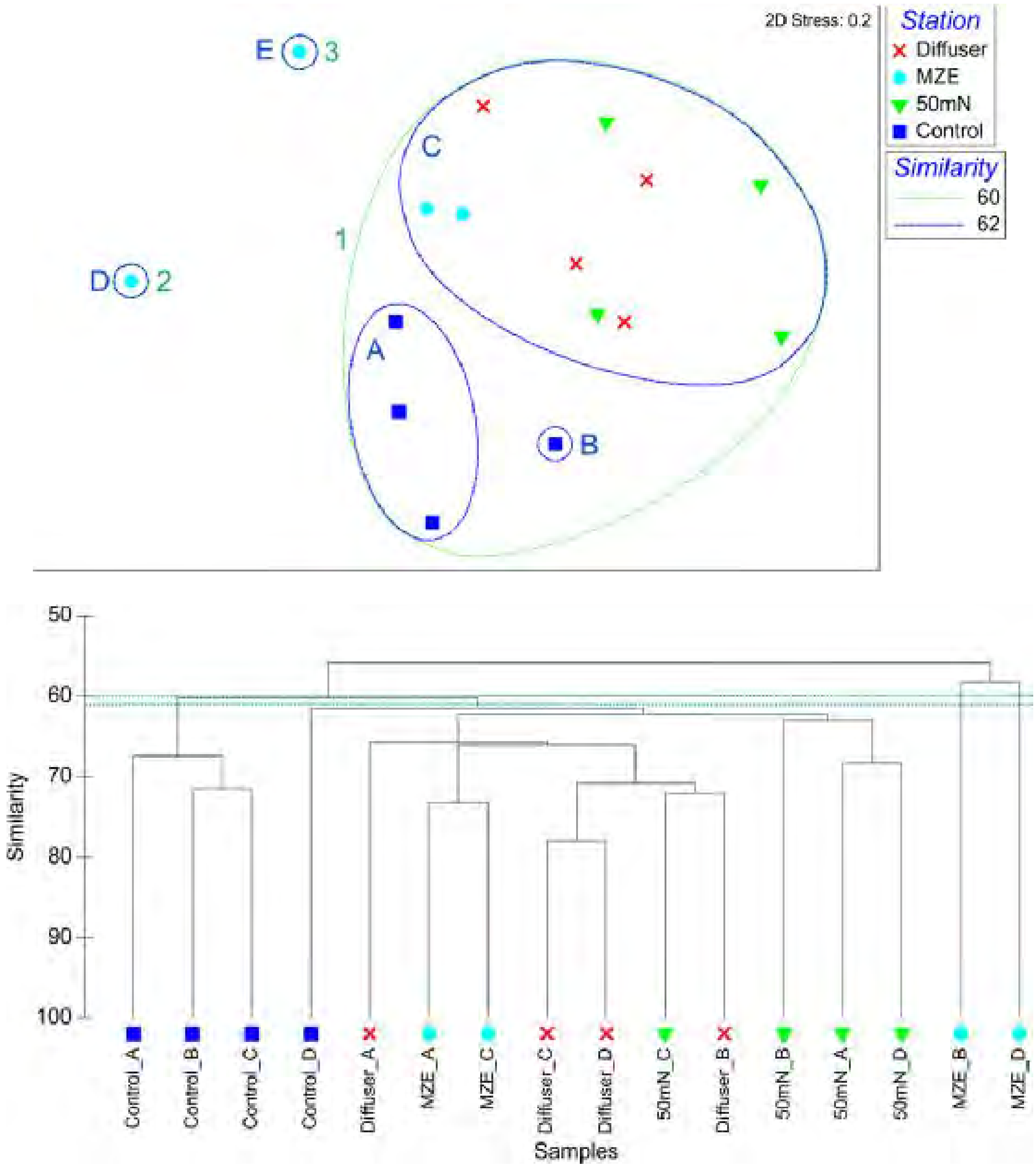


Figure 5. Multi-dimensional scaling (MDS; top) and dendrogram (bottom) plots from multivariate analysis of 2014 macroinvertebrate count data. Data were fourth root transformed and analyses based on S17 Bray-Curtis similarity. See text for explanation of sample groupings for the MDS plot.

3.4. Comparison to 2012 baseline data

In comparison to samples collected in 2014, communities sampled during the 2012 baseline survey contained more ostracods (37% of total mean abundance across stations) and bivalves (20%; predominantly *Theora lubrica*), but fewer polychaete worms (11.1%), cumaceans (13.5%), amphipods (8.3%) and tanaid shrimps (1.6%) (Table 5).

Table 5. Summary of differences between principal taxonomic groups of infauna in communities sampled in 2012 and 2014 (% of total mean abundance across stations)

Taxonomic group	Mean abundance (%)	
	2014	2012
Ostracoda	24.8	37.0
Bivalvia	8.8	20.0
Polychaeta	32.2	11.1
Cumacea	28.9	13.5
Amphipoda	22.1	8.3
Tanaidacea	10.6	1.6

Table 6 provides more detail at higher taxonomic resolution, with a comparison of the mean number of individuals across stations for the most abundant taxa identified in 2014, with baseline data. Small crustaceans (cumaceans, ostracods, amphipods and tanaids) account for most of the differences between surveys.

Table 6. Comparison of the most abundant taxa identified in the current survey with baseline 2012 data (mean abundance across stations).

Group	Taxa	Common name	Mean abundance	
			2014	2012
Cumacea	Cumacea	Cumaceans	28.9	10.4
Ostracoda	*Euphilomedes* spp.	Ostracod	19.3	8.3
Polychaeta	*Prionospio* spp.	Polychaete worms	12.8	0.3
Amphipoda	Amphipoda	Amphipods	11.6	3.4
Crustacea	Tanaidacea	Tanaid shrimp	10.6	1.6
Amphipoda	Phoxocephalidae	Amphipods	8.4	3.0
Ostracoda	*Diasterope grisea*	Ostracod	5.6	3.6
Bivalvia	*Theora lubrica*	Window shell	4.0	10.9
Ostracoda	*Cymbicopia hispida*	Ostracod	3.4	2.3
Ophiuroidea	Ophiuroidea	Brittle star	3.3	2.6
Ostracoda	*Parasterope quadrata*	Ostracod	3.1	2.4
Ostracoda	Ostracoda	Ostracods	2.8	1.1
Ostracoda	*Cypridinodes* spp.	Ostracod	2.8	10.9
Bivalvia	*Pratulum pulchellum*	Bivalve	2.8	2.6

As discussed in Section 3.3, evenness and diversity indices were similar across communities sampled in 2014 and the baseline survey (Figure 4). More taxa and individuals were occurred in 2014 samples however, the pattern across stations was similar to 2012 with highest mean abundance at the diffuser station. Similar community indices were reported for the evaluation survey site located close to the diffuser (‘Option 2’ station in Figure 1; Barter *et al.* 2008).

Several taxa contributed to differences between years in samples from the diffuser station, as summarised in Table 7. Fewer *T. lubrica* were detected in 2014, but samples contained more cumaceans, *Prionospio* polychaete worms, amphipods including phoxocephalids and tanaid shrimps. Ostracods were also slightly more abundant at this station in 2014, but represented by different species, primarily *Euphilomedes* spp.

Table 7. Summary of differences between taxa abundances identified at the diffuser station in the current (2014) and baseline (2012) surveys.

Taxa	**Common name**	**Mean abundance**	
		2014	**2012**
Theora lubrica	Window shell	4.25	20.0
Cumacea	Cumaceans	42.25	24.75
Prionospio spp.	Polychaete worms	33.5	0.5
Amphipoda	Amphipods	13.75	5.75
Phoxocephalidae	Amphipods	10.25	4.25
Tanaidacea	Tanaid shrimps	12.5	1
Euphilomedes spp.	Ostracod	23.25	10.5
Cypridinodes spp.	Ostracod	1.25	12.5
Diasterope grisea	Ostracod	11.5	3.75
Cymbicopia hispida	Ostracod	5.75	3.75

Faunal differences within and between surveys are likely to be related to small-scale spatial and/or temporal variability. For example, one 2014 diffuser station sample contained 17 tanaid shrimp, significantly more than was detected in either the other replicates or the 2012 samples. Samples were collection at the same time of year as the baseline survey to minimise any influence of seasonal variability, however temporal variability may contribute to community structure. Many small crustaceans such as cumaceans and ostracods have cyclical population patterns, with a lifespan of one year or less and generally two generations per year.

The combined 2012/2014 data set was also analysed using multi-dimensional scaling to contrast community composition between years and stations. The MDS plot and dendrogram (Figure 6) indicate a degree of separation for all 2014 samples from baseline samples, regardless of distance from the diffuser. Again, the stress level

(0.2) indicates that the plot should be interpreted with caution. Samples did not resolve into distinct groups until a relatively high level of similarity.

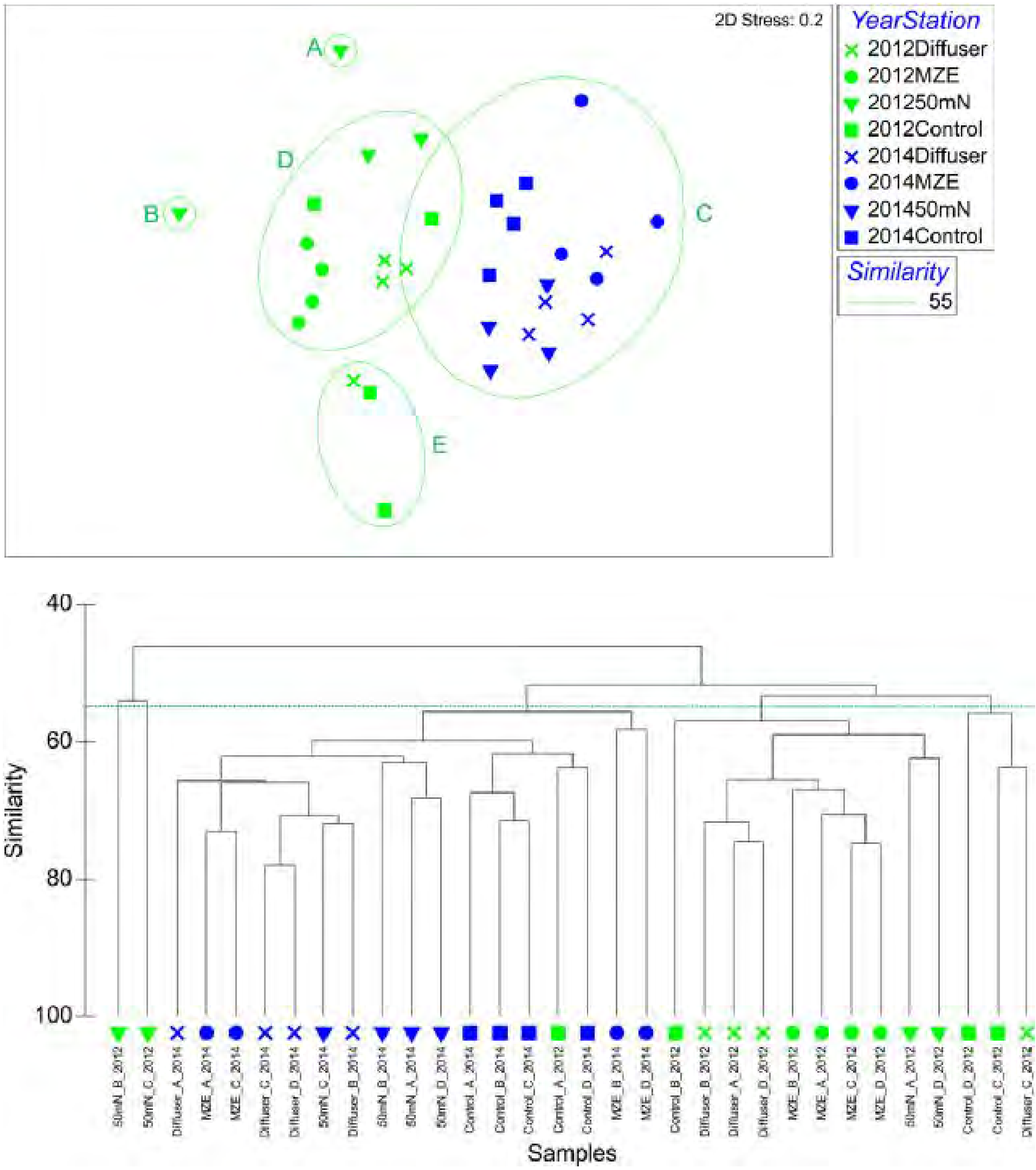


Figure 6. Multi-dimensional scaling (MDS; top) and dendrogram (bottom) plots from multivariate analysis of macroinvertebrate count data for a combined data set including 2014 and 2012.

At 55% similarity, samples were divided among five groups:

- Groups A and B each represent a single 50 m north station sample from 2012
- Group D contained most of the 2012 samples from a mixture of all stations
- Group E contained two control station and one diffuser station from 2012
- Group C comprised all the 2014 samples and one 2012 control station sample[4]

At 50% similarity Groups C, D and E were combined, indicating that the difference between Groups A and B and the rest of the samples was greater than the apparent difference between years suggested by the 55% groupings. Since Groups A and B represent baseline samples, it appears that background (*i.e*. before operation of the outfall) variation is as large, or larger, than any spatial differences among stations at different distances from the diffuser.

The separation between the two main groups at 55% similarity (C and D) were due to lots of small differences in community composition, rather than a clear proliferation of a few taxa. Samples in Group C (*i.e*. the 2014 samples and one 2012 control station sample) contained more ostracods (particularly *Euphilomedes* spp.; although fewer *Cypridinodes* spp.), cumaceans, polychaete worms (*Prionospio* spp., Polynoidae, Cirratulidae, *Armandia maculata* and *Pectinaria australis*; although fewer Sigalionidae), priapulid worms and tanaid shrimps, and fewer *Theora lubrica* bivalves.

The pattern of spread for samples within stations (*i.e*. within station variation) changed slightly between years. In 2014, samples from the control and 50m north stations were more similar to each other than in 2012. Samples from the MZE station were less clustered in 2014 than in 2012, while the spread of diffuser station samples was similar. Because this variation was present before the outfall began operation, it presumably represents natural, small-scale spatial and temporal variation in the faunal communities.

Whilst it appears that some degree of dissimilarity exists between samples collected in 2012 and 2014, the fact that the 2014 control station samples also separated from 2012 samples is significant. This pattern may indicate that the slight shift in community composition occurred across the whole system, suggesting that there is no trend associated with distance from the diffuser. However, it is possible that the change in the fauna at the control station between 2012 and 2014 is related to the increase in the proportion of fine grained sediment detected at this station in 2014. If so, the change appears to have made the fauna at the control station more like those at other stations. The observed difference between control samples and those from other stations in 2012 would compromise our ability to detect effects associated with

[4] Note that the grouping schematic in the MDS plot incorrectly indicates that this sample (Control_A_2012) also occurs in Group D. See dendrogram for correct grouping details.

the outfall. The reduction of this difference in 2014, apparently unrelated to operation of the outfall is, therefore, beneficial in terms of detecting any effects.

In summary:

- Samples from 2014 show some differences between control station samples and those from other stations. However, the variation among control samples was of similar magnitude to the differences between control and some samples from other stations. This suggests that, at present, there is no clear evidence that the observed differences are due to the outfall rather than to natural spatial variation.
- Comparison of samples from 2012 and 2014 confirm that small-scale spatial variation (among and within stations) existed prior to the commissioning of the outfall.
- Differences among stations within years and between 2012 and 2014 are due to small changes in relative abundance of several taxa, rather than major changes in presence or absence.
- The fauna at the control station has become more similar to the fauna at other stations between 2012 and 2014. This may be related to concurrent changes in the texture of the sediment at the control station that are presumably (because they occurred at the control) unrelated to the outfall. This change may improve our ability to detect any subsequent changes at sites close to the outfall relative to the control.

4. CONCLUSIONS

Analysis of sediment grain-size profiles and concentrations of organic content, trace metals and nutrients indicate that little change has occurred in the vicinity of the outfall in the two years since the its commission. Samples collected at the control station contained a significantly higher proportion of silt/clay particles than was detected in the baseline survey. Increases in organic enrichment and concentrations of metal contaminants and nitrogen at this site are likely to be a function of the shift in sediment texture, since these constituents are typically strongly associated with fine particles.

The composition of infaunal macroinvertebrate communities in the vicinity of the outfall was similar, both across stations sampled in 2014 and in comparison to baseline data collected in 2012. Slight differences between stations (control vs. other 2014 stations) and surveys were due to small changes in the relative abundance of several taxa, rather than a proliferation or loss of functional groups. Patterns in community structure did not appear to be influenced by proximity to the outfall discharge or its operation over the past two years, but are likely to be a function of small-scale spatial or temporal variation.

Based on these findings it can be concluded that the operation of the Picton WWTP is **not** causing significant adverse effects on seabed habitats or aquatic life at any of the stations sampled and is meeting the provisions of Section 107(1)(g) of the Resource Management Act (1991) and condition 17 (h) of the consent.

5. REFERENCES

ANZECC (2000). Australian and New Zealand guidelines for fresh and marine water quality 2000 Volume 1. National Water Quality Management Strategy Paper No. 4. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.

Barter, P., Sneddon, R., Conwell, C. (2008). Ecological Investigations into Discharge Options for the MDC Sewage Treatment Plant, Picton. Prepared for Marlborough District Council. Cawthron Report No. 1471. 72 p. plus appendices

Clarke, K.R., Warwick, R.M. (1994). Change in marine communities: An approach to statistical analysis and interpretation. Plymouth Marine Laboratory, United Kingdom.

Conwell, C., Sneddon, R. (2009). Shakespeare Bay Stormwater Consent Benthic Monitoring: 2009. Prepared for Port Marlborough New Zealand Ltd. Cawthron Report No. 1612. 29 p.

Kruskal, J.B., Wish, M. (1978). Multidimensional scaling. Beverly Hills, California, Sage Publications.

Sneddon, R. and P. Barter (2013). Baseline Benthic and Dispersion Surveys for the Relocated Picton Wastewater Treatment Plant Outfall. Prepared for Marlborough District Council. Cawthron Report No. 2283. 26 p. plus appendices.

Sneddon, R. (2014). Port Shakespeare stormwater consent benthic monitoring: 2014. Prepared for Port Marlborough New Zealand Ltd. Cawthron Report No. 2521. 27 p. plus appendices.

6. APPENDICES

Appendix 1. Condition 17 of Coastal Permit U100802 pertaining to the baseline benthic survey.

17. The consent holder must carry out a survey of benthic ecology and sediments in the vicinity of the diffuser prior to the commissioning of the outfall, followed by a survey 2 years after commissioning and thereafter at 5 yearly intervals for the duration of the consent. Monitoring must be carried out in accordance with the following:

a) Samples must be collected from a minimum of four locations to include sites close to the outfall, at the mixing zone boundary, outside the mixing zone and a control site.

b) Four replicate samples must be collected at each sampling location from cores given approximately 100mm into the sediment.

c) All samples must be sieved to 0.5mm for identification and enumeration of benthic infaunal taxa (including mean density, species richness(j), and Shannon Weiner diversity(H) indices calculated for each location).

d) Infaunal community changes at each location between surveys must be assessed.

e) Prior to chemical analysis, all core samples must be examined to determine texture, colour (black indicating an anoxic layer) and odour ("rotten egg" smell indicating anaerobic conditions). Photographs shall be taken of each core to document the relative degree of enrichment.

f) All samples must be analysed for Total Kjeldahl Nitrogen, particle grain size, percentage of organic content (as either ash free dry weight or total organic carbon), total organic carbon and trace metals (mercury, chromium, copper, lead and zinc).

g) Sediment chemistry changes at each location between surveys must be assessed.

h) Summarise the data collected as required under this Condition (including graphical presentation and statistical summations of data) and analyse the information in regard to meeting the ecological provisions of section 107(1)(g) of the Resource Management Act 1991. Specifically, whether or not the discharge is causing significant adverse effects on aquatic life.

i) Highlight and discuss environmental trends in the results.

j) Compare results obtained during the survey with results obtained during previous surveys and provide an interpretation of any significant differences, changes or trends.

Appendix 2. Sediment core samples collected from the four benthic stations (2014).

	**Station:** Diffuser **Date:** 25-Nov-2014 **Depth (m):** 15.2 **Depth to aRPD (cm):** approx. 8, indistinct **Sediment description:** soft mud with some consolidation below aRPD layer **Notes:** *Patiriella* sp., horse mussels, worm holes, patchy diatom/algal layer on surface, clumps of filamentous red algae on large shells **Image file:** Picton2014_Diffuser_SED015.bmp
	**Station:** Mixing zone edge **Date:** 25-Nov-2014 **Depth (m):** 16.2 **Depth to aRPD (cm):** approx. 6–7, indistinct **Sediment description:** soft mud **Notes:** *Patiriella* sp., horse mussels, whelks, diatom/algal layer on surface **Image file:** Picton2014_MixZone_SED010.bmp
	**Station:** 50m north **Date:** 25-Nov-2014 **Depth (m):** 16.0 **Depth to aRPD (cm):** approx. 7–8, indistinct **Sediment description:** soft mud, fine algal/diatom layer on sediment surface **Notes:** worm holes, horse mussels, hermit crabs **Image file:** Picton2014_50North_SED004.bmp

	**Station:** Control **Date:** 25-Nov-2014 **Depth (m):** 17.7 **Depth to aRPD (cm):** approx. 6–9, indistinct **Sediment description:** soft mud, shells **Notes:** horse mussels, tube worms **Image file:** Picton2014_Control_SED006.bmp

Appendix 3. Analytical results for sediment grain-size distribution and organic content of samples collected during the present (2014) and baseline (2012) benthic surveys.

Benthic survey (2014)

Station	Replicate	Gravel (>2 mm)	ery Coarse Sand (1–2 mm)	Coarse Sand (500 µm–1 mm)	Medium Sand (250–500 µm)	Fine Sand (125–250 µm)	ery Fine Sand (63–125 µm)	Silt& Clay (< 63 µm)	Total organic carbon (mg/kg)	AFDW (%)
Diffuser	A	0.4	0.5	0.6	1.2	6.9	20.6	69.8	1.61	5.74
	B	0.7	0.4	0.7	1.3	5.9	18.4	72.5	1.49	5.40
	C	0.6	0.6	0.5	0.7	4.7	19.0	73.8	1.66	5.72
	D	0.3	0.4	0.5	0.9	4.2	20.8	73.0	1.58	5.68
	Mean	**0.51**	**0.48**	**0.57**	**1.04**	**5.45**	**19.71**	**72.24**	**1.58**	**5.63**
MZE	A	2.2	0.1	0.3	0.8	5.2	14.8	76.4	1.86	6.39
	B	0.1	0.2	0.4	0.8	4.2	13.0	81.4	1.83	6.33
	C	0.1	0.2	0.3	0.7	4.2	15.9	78.5	1.84	6.32
	D	2.8	0.1	0.4	0.8	4.6	13.2	78.1	1.79	6.49
	Mean	**1.32**	**0.15**	**0.37**	**0.79**	**4.55**	**14.24**	**78.59**	**1.83**	**6.38**
50m north	A	0.3	0.3	0.3	0.7	4.8	19.0	74.7	1.73	6.30
	B	0.3	0.1	0.2	0.5	3.9	14.0	81.0	1.68	6.06
	C	0.4	0.2	0.5	1.0	4.8	15.6	77.5	1.86	6.20
	D	0.1	0.1	0.4	0.8	4.8	14.7	79.1	1.71	6.66
	Mean	**0.27**	**0.18**	**0.35**	**0.77**	**4.54**	**15.84**	**78.06**	**1.74**	**6.31**
Control	A	0.6	0.5	0.7	1.3	5.8	9.5	81.6	2.00	7.33
	B	0.4	0.3	0.7	1.5	5.3	9.8	82.0	1.92	7.06
	C	0.5	0.4	0.9	1.8	4.7	11.2	80.5	1.97	7.45
	D	0.4	0.5	0.6	1.5	4.7	10.4	81.9	1.98	7.13
	Mean	**0.48**	**0.42**	**0.75**	**1.51**	**5.13**	**10.24**	**81.49**	**1.97**	**7.24**

Baseline benthic survey (2012)										
Station	**Replicate**	**Gravel**	**ery Coarse Sand**	**Coarse Sand**	**Medium Sand**	**Fine Sand**	**ery Fine Sand**	**Silt & Clay**	**Total organic carbon**	**AFDW**
		(>2 mm)	(1–2 mm)	(500 µm–1 mm)	(250–500 µm)	(125–250 µm)	(63–125 µm)	(< 63 µm)	(g/100g)	(%)
Diffuser	A	0.9	1.8	2.6	4.6	7.4	17.8	65	1.75	6.4
	B	0.3	0.4	0.6	2.2	5.4	18.1	72.9	1.7	5.6
	C	0.4	1.2	1.6	7.7	7	18.3	63.9	1.7	6.2
	D	0.3	0.7	0.8	4.4	6.1	18.8	68.9	1.73	6.1
	Mean	**0.48**	**1.03**	**1.40**	**4.73**	**6.48**	**18.25**	**67.68**	**1.72**	**6.08**
MZE	A	0.7	2.7	2.8	5.1	6.4	14.9	67.5	1.93	6.1
	B	1.5	0.8	1.3	2.1	5.5	15.3	73.5	1.89	6
	C	1.7	1.3	1.5	4	5.2	16.1	70.3	1.87	5.6
	D	0.4	0.5	0.9	4.5	5.8	19.9	68	1.93	6.2
	Mean	**1.08**	**1.33**	**1.63**	**3.93**	**5.73**	**16.55**	**69.83**	**1.91**	**5.98**
50m north	A	<0.1	0.1	0.4	0.9	3.9	11.8	82.9	1.95	5.3
	B	0.2	0.3	2.9	6.5	5.1	13.7	71.2	1.93	6.5
	C	<0.1	0.2	0.3	2.9	5	14.7	76.9	1.88	6.6
	D	0.2	0.4	0.4	3.3	3.9	15.4	76.4	1.94	6.2
	Mean	**0.13**	**0.25**	**1.00**	**3.40**	**4.48**	**13.90**	**76.85**	**1.93**	**6.15**
Control	A	6.3	5.2	3.8	6.5	10.6	17.7	49.8	1.31	5.2
	B	4.6	3.5	2.9	4.6	9.6	18.9	56.0	1.82	6.5
	C	4.3	3.3	2.7	3.6	10.4	17.4	58.2	1.62	5.9
	D	4.1	3.5	3.6	5.6	10.2	18.4	54.6	1.61	5.7
	Mean	**4.83**	**3.88**	**3.25**	**5.08**	**10.20**	**18.10**	**54.65**	**1.59**	**5.83**

Appendix 4. Analytical results (in mg/kg, except for total nitrogen that is in g/100g) for sediment chemistry of samples collected during the present (2014) and baseline (2012) benthic surveys.

Benthic survey (2014)								
Station	**Rep**	**Total nitrogen**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Zinc**
Diffuser	A	0.14	0.07	21	32	24	0.35	70
	B	0.11	0.07	21	29	22	0.36	64
	C	0.12	0.07	20	31	23	0.34	68
	D	0.12	0.07	21	32	23	0.35	69
	Mean	**0.12**	**0.07**	**21**	**31**	**23**	**0.35**	**68**
MZE	A	0.17	0.06	22	34	24	0.34	72
	B	0.16	0.06	22	36	25	0.36	75
	C	0.15	0.06	22	41	25	0.37	74
	D	0.15	0.06	21	34	25	0.34	72
	Mean	**0.16**	**0.06**	**22**	**36**	**25**	**0.35**	**73**
50m north	A	0.15	0.06	21	32	24	0.38	69
	B	0.15	0.06	21	32	24	0.36	71
	C	0.13	0.06	22	33	24	0.37	70
	D	0.14	0.06	21	32	24	0.34	70
	Mean	**0.14**	**0.06**	**21**	**32**	**24**	**0.36**	**70**
Control	A	0.16	0.06	23	31	25	0.38	73
	B	0.16	0.07	23	29	25	0.36	73
	C	0.17	0.07	24	32	26	0.39	75
	D	0.17	0.06	24	31	27	0.40	76
	Mean	**0.16**	**0.07**	**24**	**31**	**26**	**0.39**	**74**

Baseline benthic survey (2012)								
Station	**Rep**	**Total nitrogen**	**Cadmium**	**Chromium**	**Copper**	**Lead**	**Mercury**	**Zinc**
Diffuser	A	0.17	< 0.10	22	37	26	0.29	84
	B	0.18	< 0.10	20	35	25	0.32	79
	C	0.17	< 0.10	21	37	25	0.32	81
	D	0.15	< 0.10	22	38	26	0.4	85
	Mean	**0.17**	**-**	**21.25**	**36.75**	**25.50**	**0.33**	**82.25**
MZE	A	0.14	< 0.10	22	40	26	0.34	86
	B	0.15	< 0.10	22	39	26	0.35	86
	C	0.16	< 0.10	23	40	26	0.40	88
	D	0.16	< 0.10	23	39	26	0.35	86
	Mean	**0.15**	**-**	**22.50**	**39.50**	**26.00**	**0.36**	**86.50**
50m north	A	0.15	< 0.10	22	39	27	0.37	87
	B	0.17	< 0.10	22	39	26	0.39	86
	C	0.16	< 0.10	22	40	26	0.32	86
	D	0.16	< 0.10	23	42	28	0.49	93
	Mean	**0.16**	**-**	**22.25**	**40.00**	**26.75**	**0.39**	**88.00**
Control	A	0.13	< 0.10	19	24	23	0.32	69
	B	0.13	< 0.10	19	25	21	0.25	69
	C	0.14	< 0.10	19	26	22	0.29	69
	D	0.13	< 0.10	19	25	22	0.20	70
	Mean	**0.13**	**-**	**19.00**	**25.00**	**22.00**	**0.27**	**69.25**

Appendix 5. Raw infauna count data for the November 2014 benthic survey. Shaded cells represent taxa which were recorded as present in the 2012 baseline survey but not identified in the current survey.

		Station_replicate															
General group	**Taxa**	**Diffuse -A**	**Diffuse -B**	**Diffuse -C**	**Diffuse -D**	**MZE-A**	**MZE-B**	**MZE-C**	**MZE-D**	**50m N-A**	**50m N-B**	**50m N-C**	**50m N-D**	**Control-A**	**Control-B**	**Control-C**	**Control-D**
Anthozoa	Anthozoa	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthozoa	*Arachnanthus* sp.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Anthozoa	*Edwardsia* sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Platyhelminthes	Platyhelminthes	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Nemertea	Nemertea	0	1	1	1	0	0	3	0	1	1	1	0	1	4	0	0
Nematoda	Nematoda	1	2	1	1	3	1	0	0	0	0	1	0	0	0	0	0
Priapulida	Priapulida	1	4	0	0	0	1	2	1	4	13	5	0	3	5	1	0
Sipuncula	Sipuncula	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Gastropoda	*Amalda (Baryspira) australis*																
Gastropoda	*Amalda mucronata*																
Gastropoda	*Aphelodoris luctuosa*																
Bivalvia	Thraciidae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Bivalvia	*Arthritica bifurca*	0	0	0	0	0	0	0	4	0	0	0	0	0	3	0	0
Bivalvia	*Diplodonta globus*																
Bivalvia	*Dosinia greyi*																
Bivalvia	*Dosinia lambata*	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0
Bivalvia	*Ennucula strangei*	0	1	0	1	2	0	0	0	0	0	3	1	0	0	0	0
Bivalvia	*Hunkydora novozelandica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Bivalvia	*Leptomya retiaria retiaria*	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	*Macomona liliana*	0	0	2	0	0	0	0	1	0	0	0	2	0	0	0	0
Bivalvia	*Mytilus edulis galloprovincialis*																

		Station_replicate															
General group	**Taxa**	**Diffuse -A**	**Diffuse -B**	**Diffuse -C**	**Diffuse -D**	**MZE-A**	**MZE-B**	**MZE-C**	**MZE-D**	**50m N-A**	**50m N-B**	**50m N-C**	**50m N-D**	**Control-A**	**Control-B**	**Control-C**	**Control-D**
Bivalvia	*Neilo australis*																
Bivalvia	*Nucula gallinacea*																
Bivalvia	*Pratulum pulchellum*	3	3	5	2	3	1	1	0	1	5	5	6	3	2	1	3
Bivalvia	*Ruditapes largillierti*	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Bivalvia	*Soletellina nitida*	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Bivalvia	*Theora lubrica*	1	1	11	4	5	2	0	3	0	7	10	15	0	3	0	2
Bivalvia	Thyasiridae	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Oligochaeta	Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Polychaeta: Ampharetidae	Ampharetidae																
Polychaeta: Spionidae	Polydorid	0	2	2	2	1	0	0	0	0	2	0	1	0	0	0	0
Polychaeta: Paraonidae	Paraonidae	2	0	0	0	0	0	1	1	0	1	0	0	0	1	1	0
Polychaeta: Cossuridae	*Cossura consimilis*	1	0	1	0	0	1	0	0	1	1	0	2	0	2	1	0
Polychaeta: Spionidae	*Paraprionospio coora*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta: Spionidae	*Prionospio* spp.	35	62	16	21	3	11	0	10	9	3	3	13	3	3	9	4
Polychaeta: Spionidae	*Spio* sp.	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta: Spionidae	*Spiophanes kroyeri*	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Polychaeta: Chaetopteridae	*Phyllochaetopterus socialis*																
Polychaeta: Capitellidae	*Barantolla lepte*	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0
Polychaeta: Capitellidae	*Capitella capitata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta: Capitellidae	*Heteromastus filiformis*	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1
Polychaeta: Maldanidae	Maldanidae	2	1	0	0	1	0	0	1	0	2	1	0	6	3	2	3
Polychaeta: Opheliidae	*Armandia maculata*	12	1	3	4	2	0	1	3	6	4	0	1	0	2	0	0
Polychaeta: Phyllodocidae	Phyllodocidae	0	2	0	0	0	0	0	0	0	1	2	0	0	0	0	0

		Station_replicate															
General group	**Taxa**	**Diffuse -A**	**Diffuse -B**	**Diffuse -C**	**Diffuse -D**	**MZE-A**	**MZE-B**	**MZE-C**	**MZE-D**	**50m N-A**	**50m N-B**	**50m N-C**	**50m N-D**	**Control-A**	**Control-B**	**Control-C**	**Control-D**
Polychaeta: Piligaridae	Pilargidae	1	0	0	0	0	1	0	0	2	0	0	0	1	0	0	0
Polychaeta: Polynoidae	Polynoidae	0	3	0	1	3	1	2	2	1	0	1	4	1	1	4	1
Polychaeta: Sigalionidae	Sigalionidae	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Polychaeta: Hesionidae	Hesionidae	1	3	1	2	0	2	0	2	0	1	2	0	0	0	1	0
Polychaeta: Syllidae	Syllidae	3	0	0	0	0	0	1	1	1	0	0	0	0	1	0	0
Polychaeta: Syllidae	*Sphaerosyllis* sp.	0	0	0	2	0	1	0	1	0	2	1	0	1	0	4	0
Polychaeta: Nereididae	Nereididae	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta: Glyceridae	Glyceridae																
Polychaeta: Goniadidae	Goniadidae	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polychaeta: Nephtyidae	*Aglaophamus* sp.	0	3	0	0	2	4	0	1	1	4	0	3	0	0	0	1
Polychaeta: Onuphidae	*Onuphis aucklandensis*	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0
Polychaeta: Lumbrineridae	Lumbrineridae	3	0	1	1	0	1	0	2	0	1	1	1	3	1	2	0
Polychaeta: Dorvilleidae	Dorvilleidae	2	1	0	1	0	1	1	1	0	0	0	0	0	1	0	3
Polychaeta: Oweniidae	*Myriochele* sp.	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0
Polychaeta: Oweniidae	*Owenia petersenae*	0	5	0	0	4	1	0	2	0	0	0	2	4	0	1	0
Polychaeta: Cirratulidae	Cirratulidae	1	0	0	2	0	3	1	5	3	0	2	2	3	4	7	0
Polychaeta: Pectinariidae	*Pectinaria australis*	5	2	4	1	0	3	4	2	0	0	2	0	0	0	0	1
Polychaeta: Terebellidae	Terebellidae	0	0	0	2	1	3	0	0	0	0	1	0	1	0	0	2
Polychaeta: Trichobranchidae	*Terebellides stroemii*	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Crustacea	Tanaidacea	22	5	21	2	0	14	20	27	6	1	9	22	2	0	1	17
Crustacea	Nebalia sp.																
Crustacea	Mysidacea	0	1	6	1	0	2	0	2	0	0	1	0	0	0	0	0
Cumacea	Cumacea	57	43	29	40	38	11	4	18	3	27	25	15	42	25	40	46

		Station_replicate															
General group	**Taxa**	**Diffuse -A**	**Diffuse -B**	**Diffuse -C**	**Diffuse -D**	**MZE-A**	**MZE-B**	**MZE-C**	**MZE-D**	**50m N-A**	**50m N-B**	**50m N-C**	**50m N-D**	**Control-A**	**Control-B**	**Control-C**	**Control-D**
Isopoda	Anthuridea	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0
Isopoda	*Uromunna schauinslandi*	2	3	3	4	1	0	0	0	0	0	3	1	3	0	0	0
Isopoda	Asellota	0	3	0	0	0	0	0	0	0	1	1	0	1	3	1	1
Isopoda	Gnathiidea	0	0	0	0	0	0	0	0	0	3	0	1	2	0	0	0
Isopoda	Valvifera																
Amphipoda	Amphipoda	20	14	12	9	9	8	14	6	2	9	9	6	7	31	10	19
Amphipoda	Lysianassidae	5	0	0	2	1	2	0	1	3	15	5	0	0	0	0	0
Amphipoda	Phoxocephalidae	11	8	13	9	5	13	0	14	15	12	0	6	10	5	1	13
Decapoda	Paguridae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Decapoda	*Palaemon affinis*																
Ostracoda	*Cymbicopia hispida*	3	6	9	5	5	3	1	2	1	5	5	4	1	2	1	1
Ostracoda	*Diasterope grisea*	6	17	10	13	4	5	2	6	4	5	7	5	0	2	1	3
Ostracoda	*Parasterope quadrata*	1	6	3	4	5	1	0	5	2	11	4	1	0	3	1	3
Ostracoda	*Trachyleberis lytteltonensis*	1	0	0	0	0	0	0	2	1	1	4	2	0	0	0	0
Ostracoda	Neonesidea																
Ostracoda	*Euphilomedes* spp.	36	25	18	14	19	16	10	14	22	23	22	15	14	20	26	14
Ostracoda	*Cypridinodes* spp.	0	0	4	1	7	1	5	2	0	11	0	0	3	2	8	0
Ostracoda	Ostracoda	5	4	2	3	1	2	5	2	2	0	5	2	3	2	5	2
Bryozoa	Bryozoa	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Echinoidea	*Echinocardium cordatum*	0	0	0	0	0	2	0	1	0	0	0	2	0	3	1	0
Asteroidea	*Patiriella* sp.	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Ophiuroidea	Ophiuroidea	4	5	2	2	4	0	2	5	2	3	3	6	4	4	5	1
Ascidiacea	*Molgula* sp.																