Appendix V Marine Ecology Assessment

Marine Ecological Impact Assessment

TIL Central and Southern Block Fast-Track Application

Taharoa Ironsands Limited

Prepared by:

SLR Consulting New Zealand

SLR Project No.: 850.V15262.00001

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Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
1	7 March 2022	Pete Wilson	Mark Poynter	Keren Bennett
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Basis of Report

This report has been prepared by SLR Consulting New Zealand (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Taharoa Ironsands Limited (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

This report has been prepared for Taharoa Ironsands Limited in respect of its application for all approvals under the Fast-track Approvals Act 2024 for the Central and Southern Blocks of the Taharoa Ironsand Mine. The Panel appointed to consider the application for the Central and Southern Blocks Mining Project may rely on this report for the purpose of making its decision under the Fast-track Approvals Act 2024.

This report has been prepared in accordance with the Environment Court's Code of Conduct for expert witnesses, contained in the Environment Court's Practice Note 2023. The authors of this report agree to comply with the Code of Conduct, and confirm that unless otherwise stated, the issues addressed in this report are within the area of expertise of the authors. No material facts have been omitted that might alter or detracted from the opinions expressed in this report.

SLR disclaims any responsibility to the Client and others in respect of any matters outside the agreed scope of the work.

Executive Summary

Taharoa Ironsands Ltd (TIL) operate an iron sand mining operation at Taharoa on the west coast of the North Island, south of Kawhia Harbour. TIL is seeking new resource consents to continue the existing iron sand mining operation, concentration and processing facilities and enable the export of titanomagnetite from the Port of Taharoa.

SLR Consulting conducted a desktop assessment and one-off field survey to assess the effects of discharges from the vessel dewatering process, operational water and stormwater discharges, and coastal structures on the marine environment off the coast of Taharoa.

To conduct the survey, one-off sampling was conducted of marine sediments and analysed for their chemical and physical characteristics (i.e., mud and metal content) and benthic macrofaunal community composition at two locations approximately 250 m from the mooring and two suitable reference sites approximately 2 km away from the mooring[1].

Iron was the only metal with statistically significantly higher concentrations in sediments near the mooring than at the northern reference site. Iron is a commonly occurring metal, and although concentrations are elevated near the mooring relative to the northern reference site, the concentrations are unlikely to cause adverse effects on the environment, notably in sands that are known for their naturally high iron concentrations.

All sediment metal concentrations with ANZG (2018) default guideline values (DGV) for toxicants in sediment were below the DGV. This indicates a low risk of unacceptable effects occurring to benthic organisms due to metal concentrations.

Hydrodynamic modelling by MetOcean shows that elevations of total suspended solids in the water column resulting from the dewatering discharge are low (<0.1 mg/L increase from background concentrations). These slightly elevated levels of total suspended solids could extend up to 20 km south towards Tirua Point and over 30 km north past Kawhia and Aotea Harbours up to 10% of the time.

The amount of sediment predicted to be deposited on the seafloor over the large area noted above is low at <0.002 mm near the mooring and <0.006 mm in the nearby Kawhia and Aotea Harbours over a three-month period. The highest levels of deposition (>0.05 mm/year) were predicted to occur over less than 1% of Kawhia and Aotea Harbours, which is highly unlikely to be measurable over and above natural variability.

A broad range of common macroinvertebrates was identified; notable groups include amphipods, bivalves, shrimp, nematodes, and polychaete worms. None of the identified species are listed as Threatened or At Risk. The survey identified a small difference in the benthic macrofaunal community composition between the mooring and two reference sites; however, there were species identified at all sites that have known sensitivities to elevated mud and metal concentrations. The species richness and diversity near the mooring are similar to the southern reference site, and the difference in species composition reflects a minor change from baseline conditions. This confirms that the small changes that have occurred to sediment mud and metal concentrations near the mooring due to the existing dewatering discharge and the discharge of stormwater and process water have not had a significant adverse effect on the benthic macrofaunal community.

[1] These locations were considered appropriate because very little sediment from the plume is likely to remain at these reference locations due to the low modelled concentration in the water column (as modelled by MetOcean) and the high current speed likely to disperse and resuspend sediment in these locations.

The coastal structures (pipelines and mooring anchors) replace soft sediment habitat with hard structures. The hard structures provide a small positive effect due to the limited amount of hard substrate in the vicinity. As such, the loss of soft habitat and introduction of hard structures results in an effect no greater than 'Low'.

We conclude that the effects of the proposed activity on the marine environment will be 'Low' from an ecological perspective, in accordance with the EIANZ Ecological Impact Assessment Guidelines. We consider it appropriate for low effects under these guidelines to be interpreted as a less than minor effect on the environment. Accordingly, no ecological monitoring is considered necessary.

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1.0 Introduction

Taharoa Ironsands Ltd (TIL) operate an iron sand mining operation near Taharoa on the west coast of the North Island, south of Kawhia Harbour. TIL is seeking new resource consents to continue the existing iron sand mining operation, concentration and processing facilities and enable the export of titanomagnetite from the Port of Taharoa, all within or from the Central and Southern blocks.

Iron sand is transported onto vessels via a pipeline connecting the land to the Port of Taharoa mooring buoy located approximately 3.5 km offshore at approximately 35 m water depth (Figure 1). The iron sand is transported as a sand–water slurry and loaded into a vessel moored at the mooring buoy. The vessel is de-watered during the loading process, discharging a mix of water and fine sediment into the coastal marine area (CMA), which creates a visible plume during the loading operation.

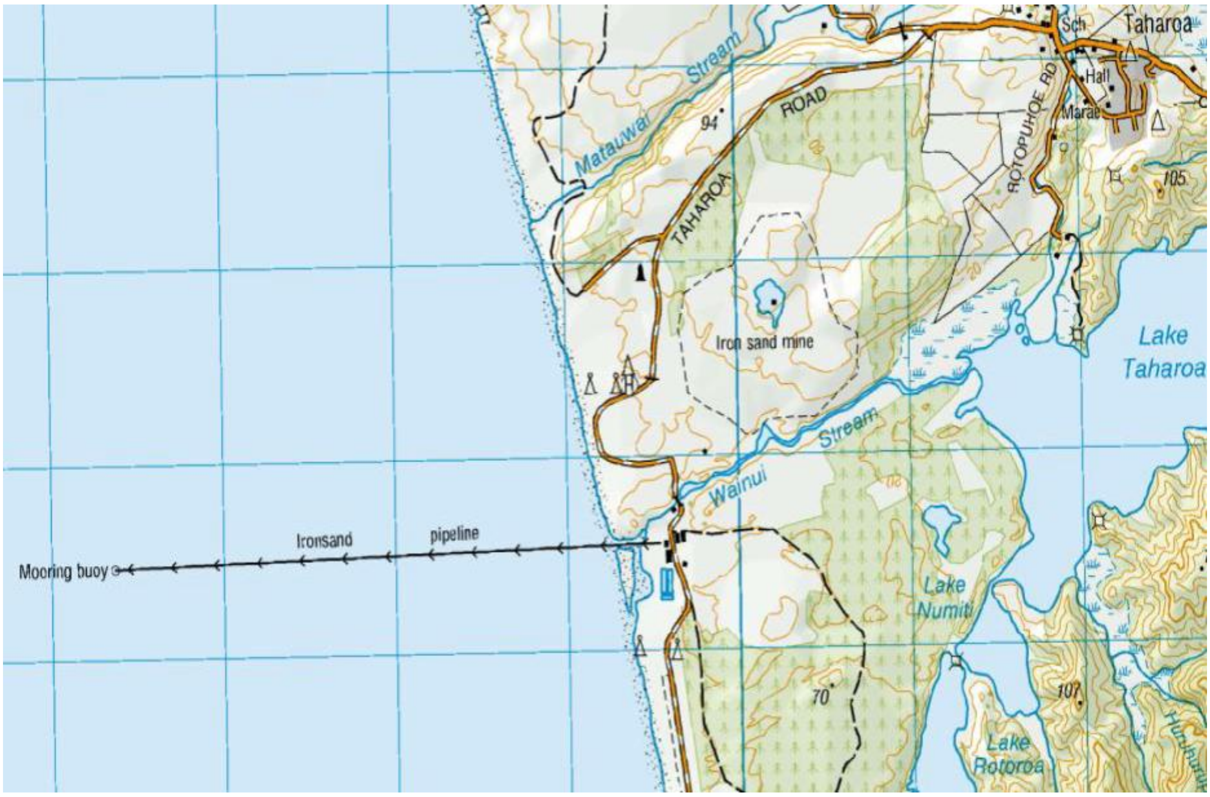


Figure 1: Location of the TIL mine site and Port of Taharoa mooring buoy.

This report is a Marine Ecological Impact Assessment synthesising an initial marine ecological impact assessment (T+T, 2020[2]) and additional field sampling and reporting conducted by SLR Consulting in 2021. No further sampling has been conducted since 2021.

[2] T+T (2020). Taharoa Mine Resource Consent Application: Marine Ecological Assessment. Report prepared by Tonkin & Taylor Limited for Taharoa Ironsands Limited.

2.0 Relevant Proposed Activities

A range of resource consents are being sought to continue the mining operations undertaken within and from the Central and Southern Blocks for the next 35 years. This section provides an overview of the proposed activities that have the potential to adversely affect the marine environment. Those proposed activities are:

- Discharging of water into the CMA from vessels during ship loading activities;
- Discharging of process water and stormwater from the mine site into the CMA; and
- The installation, ongoing use and repair/maintenance of coastal marine structures.

2.1 Dewatering discharge

Consent is being sought to discharge up to 75,000 m^3 of dewatering fluid per day into the CMA, up to a maximum of 7,500,000 m^3 per year. This is the same volume of de-watering discharge that TIL is currently authorised to discharge under its existing resource consents.

As a vessel is loaded with the water–iron sand slurry, excess water from the vessel hull is discharged into the CMA. This discharge contains a mix of freshwater and fine sediment. The concentration of total suspended solids (TSS) in the ship loading water was measured to be approximately 1 kg/m^3 (MetOcean, 2025[3]). Ship loading typically takes between two and four days and releases up to 150,000 m^3 of de-watering fluid over this period (i.e., 150,000 kg of fine sediment) (T+T, 2025[4]).

This report assesses the potential effects of the fine sediment discharged into the water column and its deposition on the seabed. The potential effects of contaminants (heavy metals) associated with the sediment are also assessed.

2.2 Process water and stormwater discharge

Consent is also being sought to discharge up to 32,000 m^3 per day of process water and stormwater to the CMA for the purpose of stormwater management. This is the same volume of process water that TIL is currently authorised to discharge under its existing resource consents.

TIL currently store ‘process water’ on site in ponds that have the potential to overflow during high rainfall events. Water levels within the ponds are managed by discharging excess process water from these ponds into the CMA via the export pipeline, which is also used to transport iron sand to vessels. This activity is proposed to continue.

A review of previous discharges showed that the discharge of process water and stormwater to the CMA has been infrequent, with a monthly total of up to 7,615 m^3 (T+T+, 2000).

This report assesses the potential effects of this discharge on the CMA in a similar manner to the dewatering discharge described in the previous section. Sampling hasn’t been conducted of previous discharges and so, for the purpose of this assessment, is it assumed that the quality of the water is similar to that of the dewatering discharge from ship loading activities; that is, turbid water with a TSS concentration of approximately 1 kg/m^3 and

[3] MetOcean (2025). Discharge Dispersion Modelling: Updated report for Iron Sand Mining Operations. Report prepared for Taharoa Ironsands Limited.

[4] T+T (2025). Effects on Coastal Processess. Report prepared by Tonkin & Taylor Limited for Taharoa Ironsands Limited.

potentially containing heavy metals naturally found in iron sand. This has been made because:

- the typical 'contaminants' are the same — being primarily water, as well as non-ferrous sand (including heavy metals occurring in the sand) and fine sediment;
- like dewatering discharge, process water discharge contains no additives or hazardous substances;
- the discharge of process water to the CMA involves the discharge of a smaller volume of process water over a shorter period of time than ship-loading and is infrequent (so much lower volumes than the dewatering discharge); and
- the concentrations of sediment in the discharge are likely similar to those discharged from nearby streams and rivers during a heavy rainfall event (i.e., they are unlikely to be notably different to other naturally occurring freshwater discharges at the time).

2.3 Coastal marine structures

Consent is being sought for the following infrastructure (that is currently in place) to support the current mining operations:

- The export pipeline connecting the land with the Port of Taharoa mooring buoy, located approximately 3.5 km offshore (pipeline number 2). The pipeline is made up of twin 318 mm diameter pipes submerged steel pipelines which terminate at a point 30 m below the SBM (see Figure 2). There is also an old pipeline (pipeline number 1) which is no longer in use, but which provides cathodic protection for the main pipeline. The pipelines are secured to the seabed by piles on pile frames approximately every 50 m.
- The Port of Taharoa mooring buoy (single buoy mooring or SBM) has a diameter of 11 m, a height of 7 m, and a draft of 3 m. The buoy is anchored to three Bruce anchors on the seabed, each weighing nine tonnes. These are connected to the mooring buoy by six catenary anchor leg mooring chains, each of which is 350 m long. The SMB is designed to allow a moored vessel to rotate freely around its circumference in various wind and tide conditions.

This report assesses the effects of these structures on the marine environment as if the infrastructure had been removed by TIL at the end of the term of its existing resource consents and is now to be reinstalled. That is, the assessment considers the effects of constructing the pipeline and mooring buoy anchors and the permanent space they occupy on the seabed.

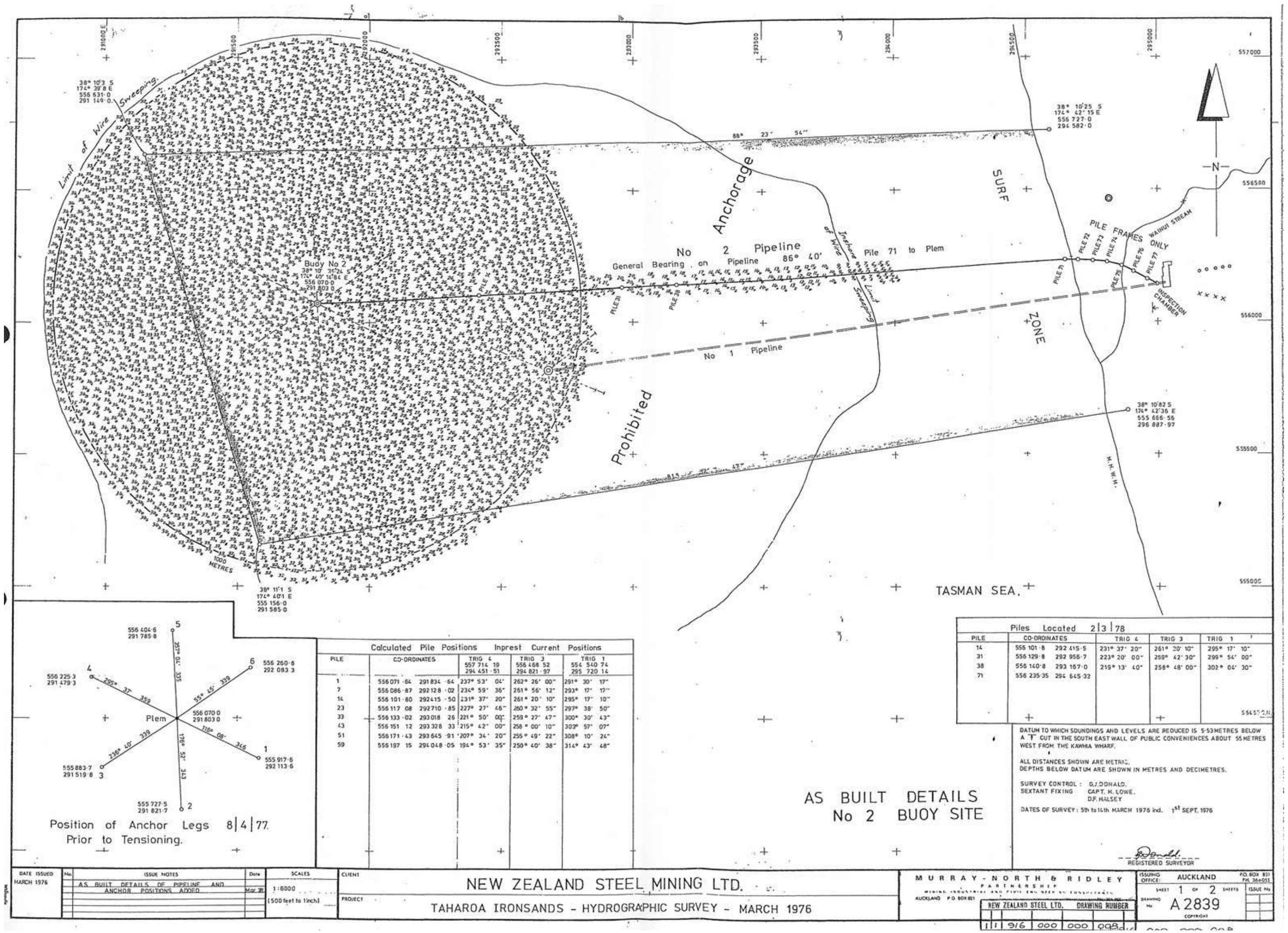


Figure 2: Port of Taharoa pipelines.

3.0 Methods

This assessment synthesises the findings of a desktop assessment (T+T, 2000) and additional field sampling undertaken in 2021.

To conduct the one-off field sampling, marine sediments were sampled and analysed for their chemical and physical characteristics and benthic macrofaunal community composition at locations near the mooring and from two suitable reference sites away from the mooring. The approach is described in this section.

The dewatering discharges into the marine environment have been occurring for a long time; therefore, the receiving environment is considered to reflect the long-term state of these discharges. As such, one-off sampling is considered appropriate as a snapshot of the current state and to assess the differences near and away from the Port of Taharoa mooring buoy.

3.1 Locations and sampling

Sediment core samples were collected by SCUBA on 9–10 November 2021 from the locations and water depths shown in Figure 3. On both days, the weather was fine with some cloud cover and wind. The sea was calm with little swell.

The two ‘Mooring’ sampling sites are approximately 250 m north and south of the mooring and were placed to capture the area of the seabed that is most likely to be affected by fine sediments from the dewatering discharge and operational water and stormwater discharges.

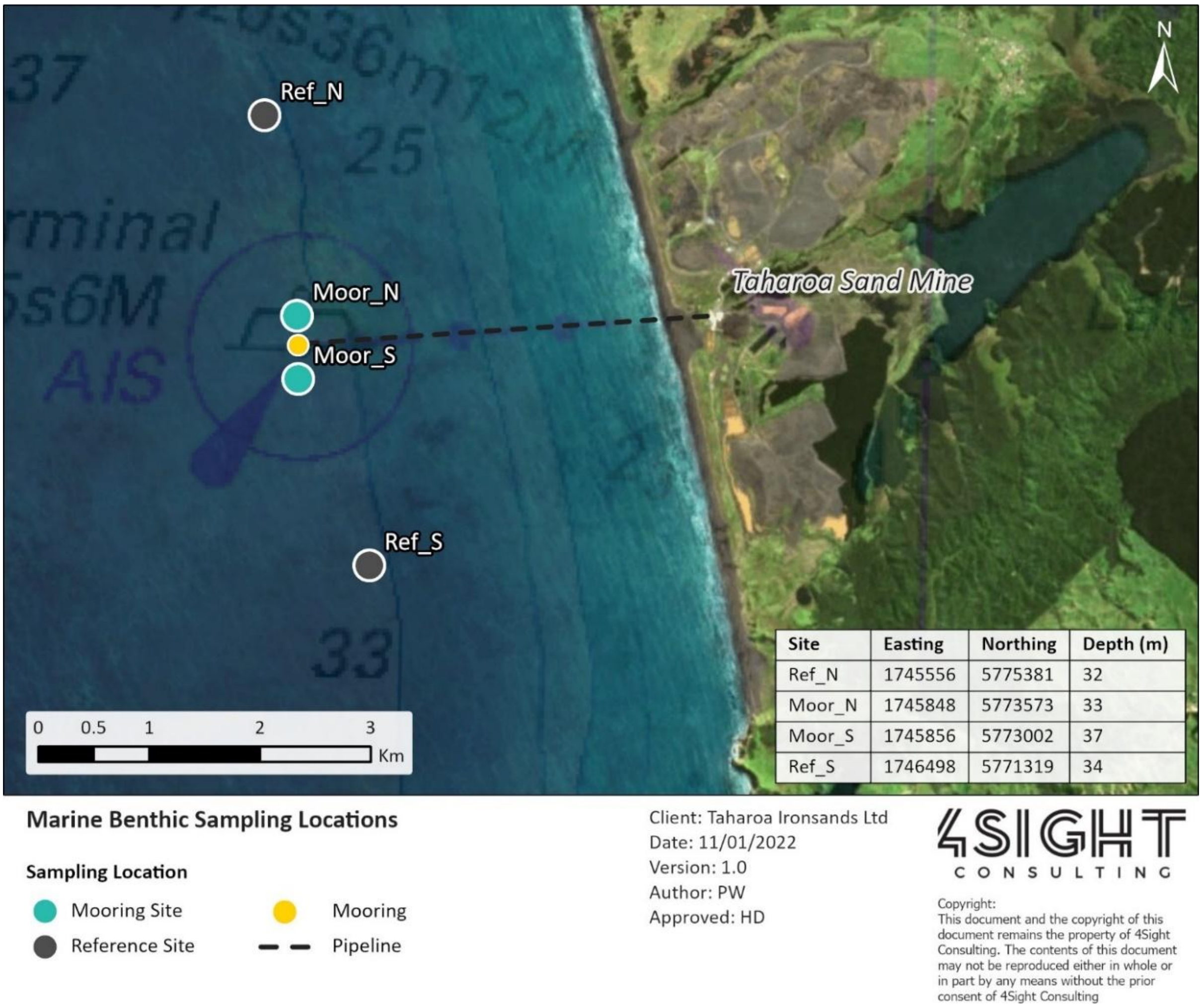
The two ‘Reference’ sites are approximately 2 km north and south of the mooring and placed at a similar water depth to the ‘Mooring’ sites. All sampling sites were on approximately the 33m depth contour. The reference sites are considered a sufficient distance from the dewatering activity to represent background seabed conditions and environmental influences.

Field sampling was conducted prior to the coastal dispersion modelling report prepared by MetOcean Solutions[5] (the ‘MetOcean report’). The findings of the MetOcean report suggest that sediment deposition from the dewatering discharge over a three-month modelled period is very low near the mooring (<0.002 mm) and in the nearby Kawhia and Aotea Harbours (<0.006 mm).

The maps presented in the MetOcean report show that the ‘Mooring’ sampling sites are located within the highest likely depositional area near the mooring and the ‘Reference’ sites are outside this area.

Accordingly, we consider that the ‘Reference’ sites selected for this study are an appropriate comparison for the ‘Mooring’ sites.

[5] Cussioli M., Berthot A. (2025) Discharge Dispersion Modelling: Updated report for Iron Sand Mining Operations. MetOcean Solutions report prepared for Taharoa Ironsands Limited.



Site	Easting	Northing	Depth (m)
Ref_N	1745556	5775381	32
Moor_N	1745848	5773573	33
Moor_S	1745856	5773002	37
Ref_S	1746498	5771319	34

Figure 3: Benthic sampling locations and water depths

The tubes used for sampling had a diameter of 10 cm and a length of 30 cm. Sediment core samples are typically collected by inserting a hollow tube perpendicular to the sediment surface. Trials by SCUBA divers at the sampling locations found the sediment to be too compacted to collect sediments using this approach. Instead, the core was pushed at an angle to the sediment to acquire sufficient sediment for the necessary analyses. The resulting samples contained sediment to a depth of approximately 10 cm.

Eight sediment cores were proposed to be collected from each location — five for analysis of benthic macroinvertebrates and three for analysis of sediment physicochemical properties. However, because of technical difficulties and the limited bottom time of the divers (<10 minutes per diver per day and near-zero visibility), only six cores were able to be collected from each site. Some tubes were only partially full, and these were only used for physicochemical samples. Tubes with the greatest volumes of sediment were used for biota; typically, the tube was about three-quarters full (i.e., ~1.5 L).

Four, instead of five, biota samples were collected from Moor_S and Ref_S due to insufficient sediment. We consider this replication to be sufficient to broadly assess the biological communities at the sampling sites due to the previous dive and hydrographic surveys finding the general area to comprise featureless sandflat with some minor shoaling (T+T, 2000). It would be highly unlikely that an additional biota sample at Moor_S and Ref_S would result in different conclusions being reached in this report.

For sites Moor_S and Ref_S, samples for sediment physicochemical analysis were created by sub-sampling two sediment cores (For example, a sub-sample was taken from cores 1 and 2 to create physicochemical sample 1 and the remaining sediment in cores 1 and 2 was used to create biota samples 1 and 2). We consider triplicate samples per site to provide sufficient information to characterise the 'Mooring' and 'Reference' sites.

Table 1: Summary of the number of biota and physicochemical samples sent to the laboratory for analysis

Site	No. biota samples	No. physicochemical samples
Ref_N	5	3
Moor_N	5	3
Moor_S	4	3
Ref_S	4	3

3.2 Laboratory analysis

Sediment samples for physicochemical analysis were transferred to laboratory-supplied containers, chilled, and transported to Hill Laboratories in Hamilton within 48 hours of collection. Samples were analysed for grain size[6], aluminium, arsenic, copper, iron, lead, manganese, nickel, and zinc. These are the same metals that are reported in Table 5.2 of T&T (2020) in reference to the ship loading discharge water quality.

Sediment samples for macroinvertebrate analysis were transferred into resealable plastic bags and kept chilled. Samples were subsequently sieved through a 500 µm mesh, transferred to a plastic jar, and preserved using 80% ethanol on 10 November 2021. Prior to extracting the macroinvertebrates from the debris, they were stained with Rose Bengal dye to differentiate the biological material from the rest of the sample. The separated macroinvertebrates were sent to Cawthron Institute for taxonomic identification to the lowest practicable level.

3.3 Statistical analysis

The distribution of data was visually inspected and a Shapiro-Wilk test of normality was used to determine the appropriate statistical approach (e.g., parametric or non-parametric methods).

Generally, the metal and grain size data for most groups were normally distributed with some groups having data that were non-normally distributed. Various transformations (e.g., log, square root) did not result in any changes to normality, so raw data were used. Statistically significant differences between means were assessed using a multiple lines of enquiry approach using analysis of variance (ANOVA) and the non-parametric Kruskal-Wallis rank sum test, and considered significant if the p-value was <0.05. ANOVA and Kruskal-Wallis results were in agreement with statistically significant differences among groups. Where statistically significant differences were detected among groups, a post-hoc Tukey test was conducted to identify pairwise differences.

[6] Wet sieving method using seven size classes: <63µm (mud), 63–125µm (very fine sand), 125-250µm (fine sand), 250-500µm (medium sand), 500µm-1mm (coarse sand), 1-2mm (very coarse sand), >2mm (gravel).

Differences among the sites near the mooring and reference sites were further explored using principal component analysis (PCA) using metal concentrations and the percentage mud composition. All mud and metal results were log10-transformed prior to conducting the PCA analysis.

3.3.1 Benthic macroinvertebrates

Meiofauna, including nematodes, ostracods, and cumaceans, were removed from the dataset prior to analysis as recommended by Waikato Regional Council in a preliminary review of version 3 of this report.

Benthic community analysis was conducted by inspection of the species list and calculation of abundance, species richness and Shannon-Weiner diversity for each sample. Multivariate techniques, including Nonmetric Multidimensional Scaling (NMDS) using Bray-Curtis dissimilarity and PERMANOVA, were also used to assess the difference in benthic community composition among sites. Data were transformed using a Wisconsin double standardisation prior to using multivariate analyses (MDS and PERMANOVA).

4.0 Results

Results of the sediment physicochemical analyses and benthic macroinvertebrate identification are presented in this section. The laboratory results containing raw data for sediment physicochemical parameters are presented in Appendix B, and the full list of species and abundance is presented in Appendix C.

4.1 Sediment physicochemical characterisation

4.1.1 Metals

Sediment metal concentrations are summarised in Figure 4 and show the high variability of some sediment metals in this area, even at the reference locations. This indicates a high level of sediment heterogeneity but could also be a consequence of the difficulties encountered with sampling (e.g., samples collected at different angles and volumes).

To put results in context, they were compared to the ANZG (2018)[7] default guideline values (DGVs) for toxicants in sediment. The DGVs indicate the concentrations below which there is a low risk of unacceptable effects occurring. DGVs were available for all metals except aluminium, iron, and manganese.

For the metals with DGVs, all concentrations collected for the purposes of this analysis were well below their respective guideline value, which indicates a low level of risk to aquatic organisms with regard to metal contaminants.

Iron was the only metal to have statistically significantly higher concentrations near the ‘Mooring’ than the northern ‘Reference’ site. Iron is a commonly occurring metal, and although concentrations are elevated near the ‘Mooring’ site relative to the northern ‘Reference’ site, the concentrations are unlikely to cause adverse effects on the environment, notably in sands that are known for their naturally high iron concentrations.

[7] ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines

The mean concentrations of manganese, nickel, and zinc were slightly elevated at the mooring sites relative to 'Reference' sites; however, these differences were not statistically significant and still well below their respective DGV, where applicable, which indicates a low level of risk to aquatic organisms.

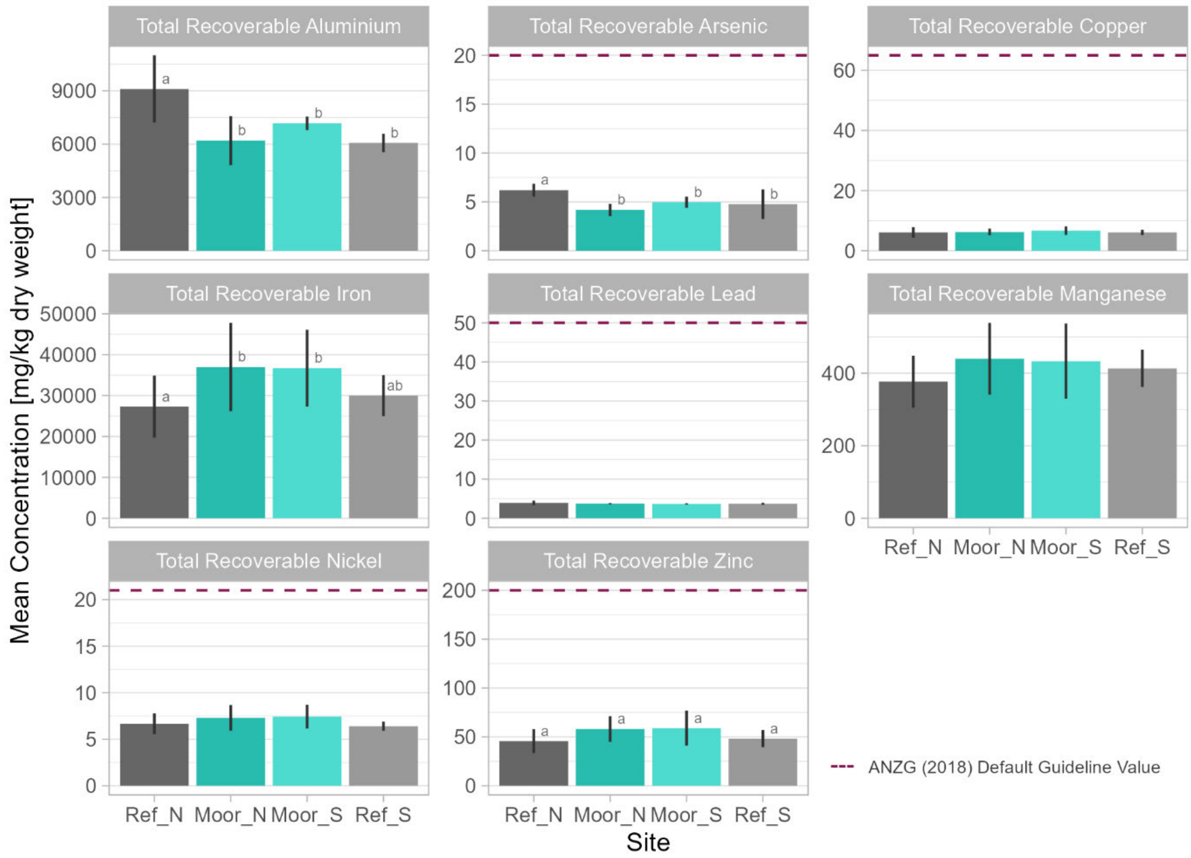


Figure 4: Summary of sediment metals measured near the mooring and at reference sites. Error bars show the 95% confidence interval of the mean (n = 3). The letter above each bar shows the results of a Tukey post-hoc test, where an ANOVA showed significant differences – different letters represent statistically significant differences. ANZG Default Guideline Values are shown by the purple dashed line. Note that there is no guideline value for aluminium, iron, or manganese.

4.1.2 Grain size

Sediment grain size analysis showed that sediments in the south were slightly coarser than those in the north (Figure 3). This could be due to a wide range of factors, including the northward drift of sediments on the west coast and the potential contribution of fine sediments discharged via rivers and streams into the CMA, such as by the Mitiwai Stream, which discharges to the coast between the mooring zone and the northern reference site. There were negligible amounts of grain sizes larger than fine sand.

The two reference sites contained similar amounts of mud (mean ~19%). The mud content of sediments near the mooring was elevated relative to the reference sites (mean ~28%). Mud was the only size class to have a significant difference among the means (ANOVA, see Appendix A, Table A5), and the only statistically significant difference within this size class was Moor_S having a higher mean mud content than Ref_S (Tukey post-hoc test, see Appendix A, Table A6).

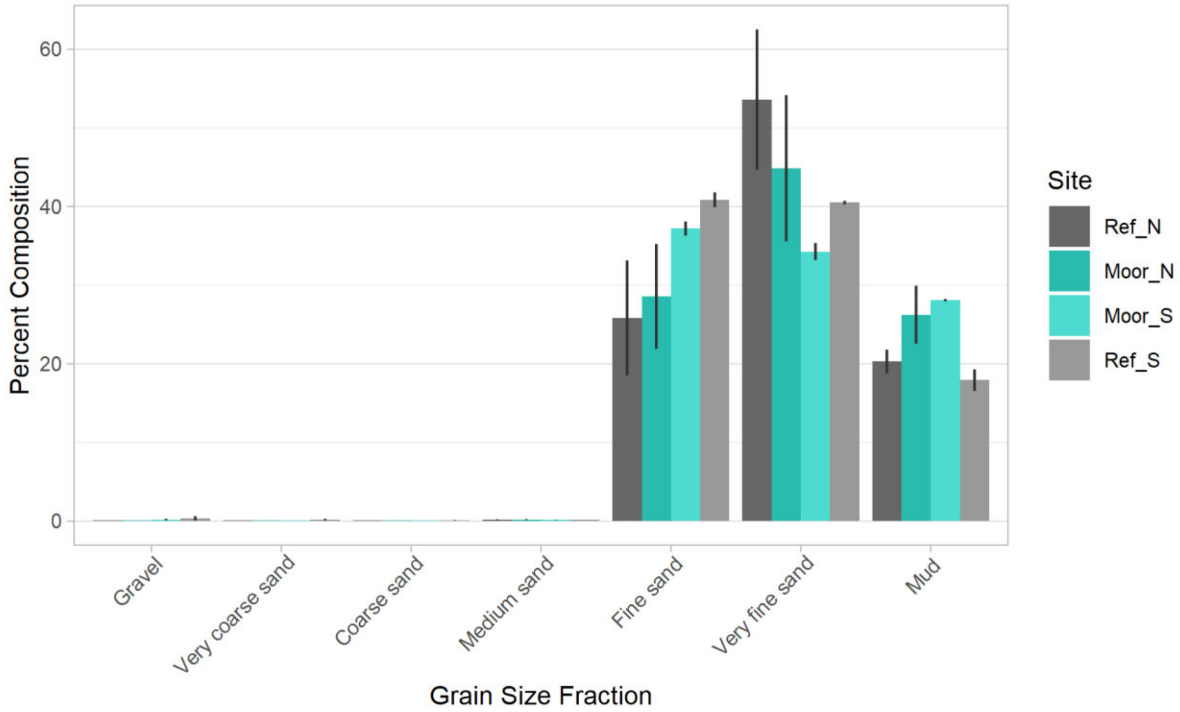


Figure 5: Grain size distribution at the four sampling sites. Error bars show the standard error of the mean (n = 3).

4.1.3 Multivariate analysis

Principal component analysis (PCA) was conducted to look at differences among sites considering all metal and mud concentrations (Figure 6). The assessment loosely groups sites, where 'Reference' sites are to the left of the plot and 'Mooring' sites are on the right. Based on this assessment, the differences between 'Mooring' and 'Reference' sites appear to be driven mostly by elevated levels of mud, iron, and zinc at the mooring. Elevated levels of arsenic and aluminium are indicative of the 'Reference' sites (specifically, the northern reference site). To a lesser extent, elevated levels of copper, nickel, and manganese are also indicative of sites near the mooring. All sites are spread relatively broadly across the plot, which once again indicates the heterogeneity of the environment.

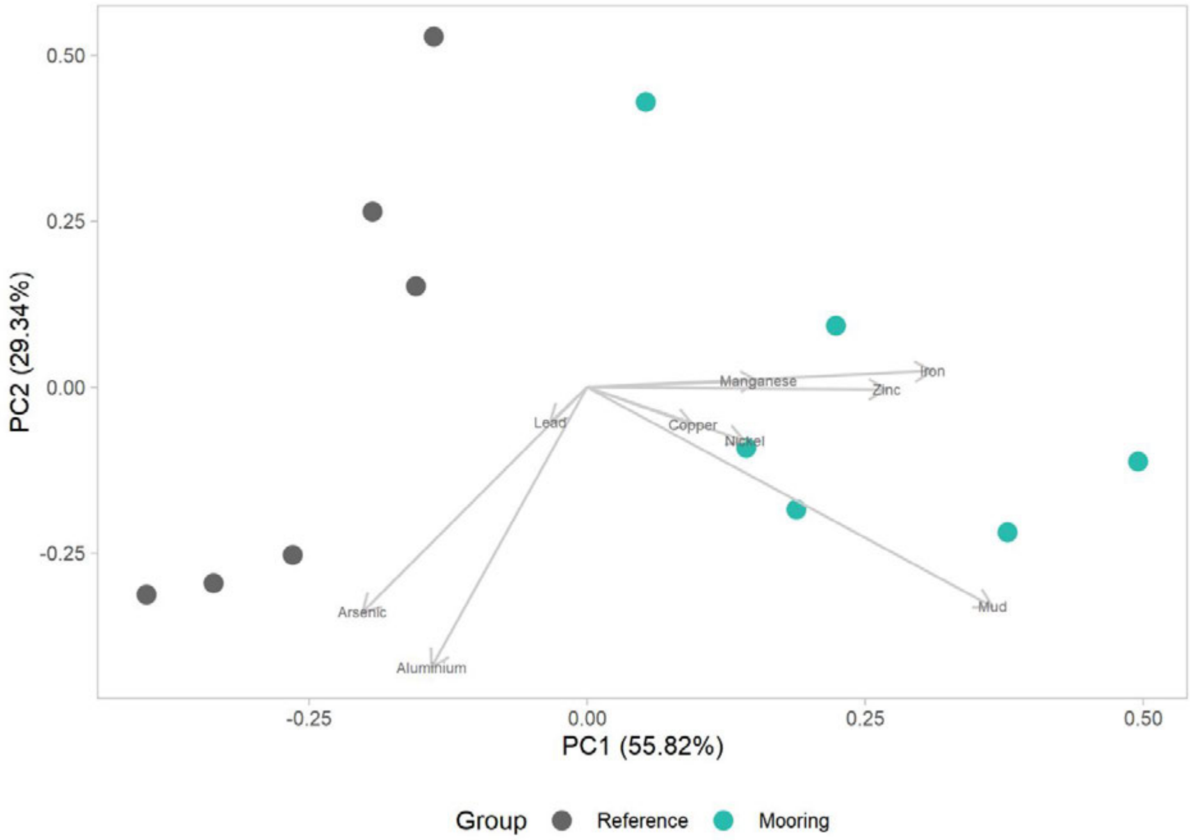


Figure 6: Principal component analysis using (log-transformed) mud percentage and metal concentrations measured near the mooring and at reference sites.

4.2 Benthic macroinvertebrates

A broad range of common macroinvertebrates was identified; notable groups include amphipods, bivalves, shrimp, nematodes, and polychaete worms. Consistent with previous reports (T+T, 2020), none of the species identified are listed as Threatened or At Risk (Funnell et al., 2021)[8].

The two mooring sites generally had a lower number of individuals and lower species richness than the northern reference site (Figure 7); however, the means of each parameter were not statistically significantly different among sites (Appendix A, Table A8). Due to decreases in both parameters, the Shannon-Weiner diversity index is very similar at each of the four sites. Essentially, the two mooring sites have very similar descriptive statistics to the southern reference site.

[8] Funnell, G., Gordon, D., Leduc, D., Makan, T., Marshall, B.A., Mills, S., Michel, P., Read, G., Schnabel, K., Tracey, D., Wing, S. Conservation status of indigenous marine invertebrates in Aotearoa New Zealand, 2021. New Zealand Threat Classification Series 40. Department of Conservation, Wellington. 42p.

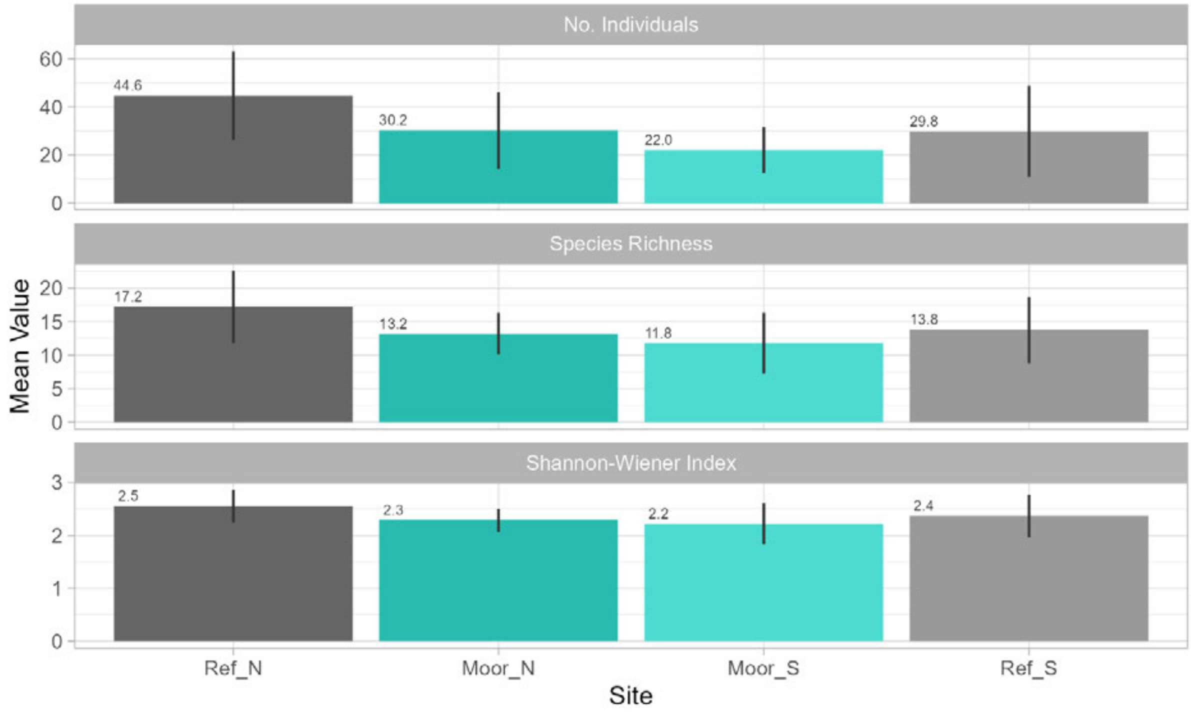


Figure 7: Summary statistics for biota collected at mooring and reference sites. Error bars show the 95% confidence interval of the mean (Ref_N and Moor_N, n = 5; Moor_S and Ref_S, n = 4). Exact values are shown to the left of each bar.

4.2.1 Multivariate analysis

Nonmetric Multidimensional Scaling (nMDS) was used to further interrogate the benthic macroinvertebrate data and assess similarities (or differences) in community composition (Figure 8). nMDS assembles the data to reflect the order of least dissimilarity among groups (in this case, sites). Ordination summarises community data from which similar species and samples plot closer together, and dissimilar species and samples plot further apart. Data points that overlap between site clusters indicate that those individual core samples from one site are similar in species composition and representation to results from the other sites. This ordination technique is used to describe relationships between species compositions and any intrinsic patterns that the data may have. It displays results in a visual manner that makes complex data easier to interpret.

The circles around the data cluster for each group represent an approximate 95th percentile distribution. The larger the circle, the more heterogeneous (dissimilar) the community in that group. Overlapping points and circles indicate a similarity in the community composition.

There were statistically significant differences among the community compositions when sites were assessed individually (Ref_N, Moor_N, Moor_S, and Ref_S) and grouped as 'Mooring' and 'Reference' sites (Appendix A, Tables A9-10).

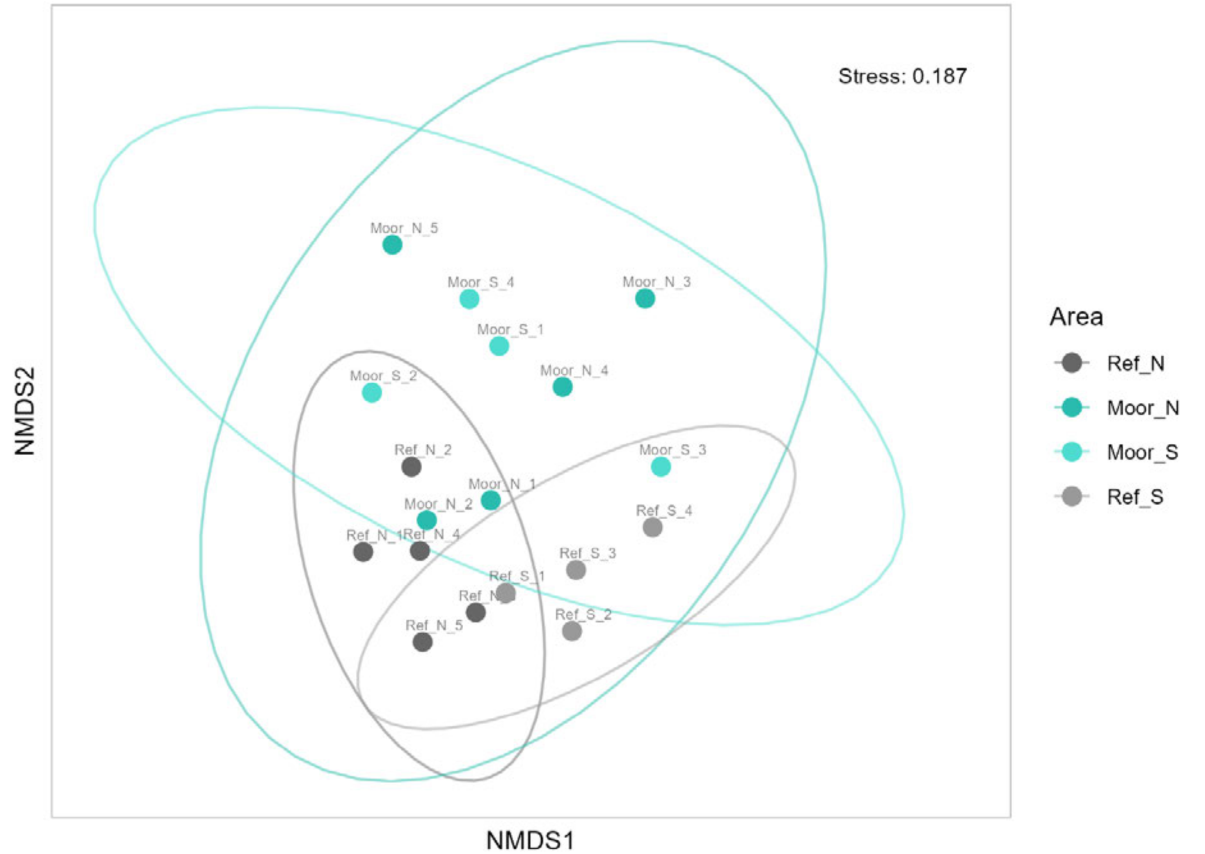


Figure 8: Nonmetric Multidimensional Scaling (NMDS) plot of biota results for every sample

4.2.2 Species absence/presence differences

Based on general inspection of the data, the greatest differences between the 'Reference' and 'Mooring sites' with regard to species absence/presence are as follows:

- 24 amphipods from the Haustoriidae family found at 'Reference' sites, but none at mooring sites.
- 12 shrimp (*Ogyrides* sp.) identified at mooring sites but none at 'Reference' sites.
- 33 bivalves from the Mactridae family found at 'Reference' sites and 3 at mooring sites.

Where possible, information regarding a species' sensitivity to sediment mud content and/or metal concentrations from NIWA (2021)[9] has been included in the interpretation of identified benthic fauna, discussed below.

There was no published information available at the time of preparing this report to determine the sensitivity towards sedimentation or metal contaminants of the species listed above. However, it is plausible that the species that are present at the reference sites but not

[9] NIWA, 2021. Estuarine macroinvertebrate taxonomic resolution assessment and taxon identification tree. NIWA technical report prepared for Envirolink.

the mooring sites have some sensitivity to sediment mud content and/or metal concentrations.

Of the species with information on sensitivity towards sedimentation and metal contaminants:

- The polychaete worm *Magelona* sp. is present in low to moderate abundances at most sites. It is noted to prefer sandy environments and is sensitive to elevated levels of copper, lead, and zinc.
- The amphipod *Torridoharpinia hurleyi* is present in low abundance at almost all sites. It prefers sandy habitats (over muddy habitats) and is sensitive to metal contaminants.
- The polychaete worm *Heteromastus filiformis* is moderately abundant at all locations. It prefers muddy sediments over sandy sediments but is intolerant of sediment with high mud content.
- The polychaete worm *Armandia maculata* is present at all sites, but less abundant at the mooring sites. It too prefers sediments with some mud but not high percentages.

Overall, there are species present at all sites that are typical of slightly muddy sand substrates, but which have known sensitivities to highly elevated mud and metal concentrations. Some species are absent from the 'Mooring' sites that are at the 'Reference' sites, but there are no descriptions of their habitat preferences or tolerances. As noted earlier, none of the species identified are listed as Threatened or At Risk.

5.0 Effects Assessment

The open west coast environment is highly dynamic and exposed to strong currents.[10] The effects of the proposed activity are considered in this context. We consider an appropriate environmental scale in which to consider the actual and potential effects of the proposed activity is from Albatross Point in the north, leading to the entrance to Kawhia Harbour, to Motunau Rocks in the south — there is approximately 13 km between these two features.

5.1 Sediment metals

The deposition of sediment containing heavy metals has the potential to result in elevated levels of heavy metals in receiving environment sediments.

Iron was the only metal to have statistically significantly higher concentrations in sediment near the 'Mooring' than at the 'Reference' sites; this is not unexpected because of the iron sand that will be suspended in the discharge from the dewatering process. Further, elevated levels of iron are unlikely to cause adverse effects on the environment, notably in sands known for their naturally high concentration of iron. Concentrations of nickel, zinc, and manganese also appeared slightly elevated near the mooring. The reason for their elevation is not clear because their concentrations in the ship loading discharge quality data presented in the T&T (2020) report Table 5.2 were not notably elevated, however, even with slightly elevated metal concentrations near the mooring relative to the reference sites, all metals were well below the DGV, which indicates a low level of risk of adverse effects occurring to benthic organisms. The effects of sediment metals will decrease with distance from the

[10] T+T (2025) Effects on Coastal Processes. Report prepared for Taharoa Ironsands Limited by Tonkin & Taylor Ltd.

discharge point. As such, the effects of the discharged sediment metals in the nearby Kawhia and Aotea Harbours will be even less (i.e., negligible).

5.2 Dewatering discharge

MetOcean developed a dispersal model to estimate how the dewatering discharge mixes with and is dispersed by oceanic water. The MetOcean report presents the outputs of numerical modelling of the plume dispersion and settlement. This model was run for the following two scenarios:

- A representative three-month period during winter conditions. During this time, it included 12.5 de-watering events, each event discharging 15,000 m^3 of ship loading water over 48 hours (total of 1,875,000 m^3 of ship loading water).
- Same as above for a three-month period during summer conditions.

Each of these scenarios includes discharging a quarter of the total annual volume for which consents are being sought.

The key potential effects from TIL’s proposed ship loading discharge are the contribution of suspended sediment to the coastal environment and associated contaminants (heavy metals).

The modelling results show that the concentrations of suspended sediment in the water column will be very low - the MetOcean report suggests that 10% of the time the sediment plume is likely to extend up to 20 km south towards Tirua Point and over 30 km north past Kawhia and Aotea Harbours, albeit at low concentrations (<0.1 mg/L increase in water column TSS from background concentrations). The model is able to predict very low suspended sediment concentrations. To provide some context to these values, the laboratory level of detection for total suspended solids is 1 mg/L when supplying the laboratory with 2 L of water. This means that, although total suspended solid concentrations in the water column are predicted to be elevated by a small amount from the dewatering discharges, they would not be measurable except with a more sensitive in situ instrument such as an optical turbidity sensor. Even being able to measure such small changes, being able to identify that these small changes are due to the dewatering discharge over and above natural variability would be very difficult, if possible at all. These concentrations are within typical natural variability and are not close to typical ecological thresholds or triggers where adverse effects would be anticipated, even when considering margins of error that may be expected by using modelling.

Similarly, the levels of sediment deposition predicted by the MetOcean report are low - the amount of sediment predicted to be deposited on the seafloor over the large area noted above is low at <0.002 mm near the mooring and <0.006 mm in the nearby Kawhia and Aotea Harbours over a three-month period.

To understand the potential annual deposition in Kawhia and Aotea Harbours associated with dewatering discharges, the Coastal Processes Assessment (T+T, 2025) combined the summer and winter outputs and doubled the results to represent a 12-month period. The results of this showed that up to 0.01 mm of sediment (approximately equivalent to the thickness of 1 grain of sediment) could occur over 40% of the Kawhia Harbour and 13% of the Aotea Harbour. Similar to the previously discussed modelled water column effects, the model is able to predict small changes in sediment deposition that are highly unlikely to be able to be measured over and above the natural variability of sedimentation occurring within estuaries. Sediment deposition of up to 0.05 mm (approximately 5 grains high) could occur on less than 1% of the harbour areas (T+T, 2025).

Regarding deposition in the estuaries, the ANZG (2018) guidelines[11] provide a DGV of 2 mm of sediment accumulation per year above the natural annual sedimentation rate for the specific estuary or part of the estuary. The deposition predicted by the model is much less than this guideline value, so the dewatering discharge is considered to have no adverse effects on the nearby estuarine benthic habitats, nor is it likely to have adverse effects on water quality for activities such as marine farming. The concentration of metals in sediments near the mooring is low (well below DGVs) and, as such, the small amount of deposition occurring in the harbours is unlikely to have effects on sediment contaminant concentrations, especially at the harbour scale.

On average, the mud content of sediments near the mooring was 27%. This is elevated relative to the reference sites, which had an average mud content of 18%. Such elevated mud content is likely an effect of the discharge from the dewatering process and is consistent with the deposition predictions presented in the MetOcean report. Such increases in the mud content of sediments near the mooring have the potential to affect the composition of benthic communities, and the extent of the effect is dependent on the communities that are present and their tolerance to fine sediments. Considering that the reference sites have mud contents of ~18%, it can be inferred that the communities in the general area are likely to be relatively mud tolerant. Therefore, small-scale shifts in the proportion of mud in what can be generally described as 'slightly to moderately muddy sands' are unlikely to cause or constitute an adverse ecological effect at a community level. T+T (2025) notes that the deposition of fine sediment from the discharge has a negligible effect on coastal processes and landforms in both the open coast and nearby harbours and that the magnitude of deposition from the discharge is undiscernible when compared to the natural baseline and alongshore transport. As such, the level of effect of the deposition of sediment from ship loading water is considered to be 'Low'.

Based on the low predicted levels of suspended sediment and sediment deposition, and low levels of effects associated with that deposition, further monitoring of the plume or benthic environment around the mooring buoy is not considered necessary.

Additional sampling would likely provide more detailed characterisation of the benthic communities; however, the state of the benthic environment is not anticipated to change markedly as a result of further or increased discharges due to the highly dynamic nature of the west coast environment and the length of time the current discharges have been occurring. As such, additional sampling is considered to be more of a research or exploratory nature than required as a result of the potential effects of the activity.

5.3 Process water and stormwater discharge

As noted above, no sampling has been undertaken of process water and stormwater discharges, and so the actual quality of the discharge is unknown. However, due to the general activities occurring on the site, the typical contaminants in the discharge are likely to include fine sediments and heavy metals occurring in the sand. The quality of process water and stormwater discharge is potentially similar to that of the dewatering discharge. As such, the discharges do not contain additives or hazardous substances. The volume of process water and stormwater is much less than that of the dewatering discharge, will occur over shorter periods, and is infrequent. Further, these discharges typically occur during heavy rainfall events and are likely to have concentrations of sediment that are similar to those discharged from nearby streams and rivers (that is, they are unlikely to be notably different

[11] https://www.waterquality.gov.au/anz-guidelines/your-location/new-zealand

to other naturally occurring freshwater discharges at the time). These assumptions have been used in the following assessment.

Consents are being sought for up to 32,600 m^3 of stormwater (from around the pump house and concentrate stockpiles) and process water (including freshwater and fine sediment) per day to be discharged to the CMA through the ship loading pipeline on occasions when it is not possible to discharge to land (the primary method of disposal), for example during flood events.

Due to being discharged to the CMA via the ship loading pipeline, there is a large degree of mixing and dilution with oceanic water, which would minimise the potential adverse effects of the discharge. The adverse effects resulting from an intermittent discharge occurring during heavy rainfall events is likely to be very low and, accordingly, there are unlikely to be adverse cumulative effects on water quality or benthic habitats/fauna from the discharge of up to 75,000 m^3 per day of ship loading water and of process water and stormwater. The volume of water discharged will be much less than the catchment-derived discharge of water that is generated during rain events.

As such, the effects of these discharges will be no greater than ‘Low’.

5.4 Effects on fisheries

A desktop assessment was conducted to assess the effects of the proposed activities on fish and shellfish using the available information. Of particular note are the cultural fishery areas, including the Marokopa Mätaitai Reserve approximately 22 km south of the Port of Taharoa and Kawhia Aotea Taiāpure approximately 15 km north of the Port of Taharoa.

5.4.1 Fish

T&T (2020) lists fish species that are likely present or that have been observed during maintenance or operation of the Taharoa Port and are likely to remain in the environment, including:

- Kahawai (*Arripis trussa*);
- Red gurnard (*Chelidonichthys cuculus*);
- John dory (*Zeus faber*);
- Spiny dogfish (*Squalus acanthias*);
- Sea perch (*Sebastes alutus*);
- Snapper (*Pagrus auratus*);
- Trevally (*Caranx ignobilis*);
- Leatherjacket (*Oligoplites saurus*);
- Yellowtail kingfish (*Seriola lalandi*);
- Barracoutta (*Sphyraena* sp.);
- Tuna (*Thunnini* sp.)
- Arrow squid (*Loligo plei*);
- Marlin (*Istiophoridae*);
- Blue shark (*Prionace glauca*);
- Mako shark (*Isurus* spp.);

- Hammerhead shark (*Sphyrna* spp.);
- Yellow-eye mullet (*Aldrichetta forsteri*);
- New Zealand sole (*Rhombosolea novae zeelandiae*); and
- Yellowbelly flounder (*Rhombosolea leporina*).

There is no information that suggests that the area near the Port of Taharoa is specifically utilised by these species, and they would also be able to feed in nearby areas.

The discharge dispersion modelling by MetOcean estimates the concentrations of suspended sediment in the water column to be very low (<1 mg/L at the most, but typically <0.1 mg/L), even within one hour of the discharge commencing. Such concentrations are low, within the range of natural variability, and highly unlikely to cause adverse effects (acute or chronic) in fish.

No further information was available regarding species found in Kawhia and Aotea harbours; however, as these locations are more than 15 km from the point of the discharge, a large amount of dilution of the ship loading discharge takes place. The concentration of suspended sediment (and, therefore, associated metals) predicted by the MetOcean modelling is very low (<0.08 mg/L for less than or equal to 10% of the simulation time) and not at levels that would be expected to have adverse effects (acute or chronic) on fish. Furthermore, such low sediment accumulation or metal concentrations would be very difficult, if at all possible, to measure over and above natural variability.

5.4.2 Shellfish

The assessment conducted in T&T (2020) was limited to green-lipped mussels (*Perna canaliculus*) found within the Port of Taharoa and the surrounding area. This location would be exposed to the highest potential suspended sediment concentrations in the water column and greatest sediment deposition on the seabed from the ship loading discharge and process water and stormwater discharges. The effects of suspended sediment and sediment deposition were considered to be low (T&T, 2020). The same approach can be used to consider other seafood resource species, which could include intertidal shellfish along the open coast beach or within the nearby Kawhia and Aotea Harbours. The levels of suspended and deposited sediment in Kawhia and Aotea Harbours are estimated by the MetOcean model to be less than those near the mooring buoy. Accordingly, the effects of the discharge on shellfish in these locations will be less than for green-lipped mussels near the mooring buoy. As such, the overall level of effect for shellfish in these locations will be ‘Very Low’ at most.

5.5 Effects on benthic fauna

The survey identified a broad range of benthic macroinvertebrates, including those that have known sensitivities to elevated mud and metal concentrations at all sites. Many of these same species were also identified near the mooring. The presence of the polychaete worms *H. filiformis* and *A. maculata* at all sites suggests that the communities present in the area are tolerant of moderate levels of mud and that the metal concentrations are not having adverse effects. As noted in Section 4.2.2, some species are absent near the mooring that are present at both the northern and southern reference sites. These may be species that are more sensitive to muddy habitats and the additional mud near the mooring sites may be unfavourable for these species. Overall, there appears to be a small difference in the benthic community composition near the ‘Mooring’ sites relative to the two ’Reference’ sites.

The benthic communities identified in this survey are likely to be tolerant of the periodic discharges that have been occurring since the 1970s and to nearby freshwater discharges that will contain elevated levels of fine sediment following rain events. Table 6.1 of the T&T (2020) report assigns the subtidal benthic communities an ecological value of 'Moderate', which is a value typically associated with high species richness, diversity, and abundance. We consider the results to indicate that the benthic communities at the sampled locations have no greater than high species richness, diversity, and abundance and that assigning a 'Moderate' ecological value is appropriately conservative.

There is a small difference in the benthic communities near the mooring and at the two reference sites. Species richness and diversity are similar at the mooring to the southern reference site, which may indicate a combination of effects from mud and a longitudinal gradient. As such, the effects of the discharges on benthic fauna near the mooring are considered to be a minor shift from baseline conditions. This results in a 'Low' magnitude of effect and a 'Low' overall level of effect on benthic fauna.

5.6 Effects from coastal marine structures

The existing export pipelines run approximately 3.5 km from the Taharoa Mine site to the mooring buoy and are partially submerged in the seabed. Dive and hydrographic surveys have found the general area to comprise featureless sandflats, with some minor shoaling. The benthic macroinvertebrate communities in the area generally have a high abundance, richness, and diversity, are expected to be tolerant of the periodic disturbances, and comprise no threatened or At Risk species.

The pipeline, mooring buoy, and the chains/anchors used to keep the mooring buoy in place provide a hard substrate for marine organisms to colonise that is otherwise rare or absent in the area. Dive surveys have shown that these are colonised by various encrusting species, including green-lipped mussels (*Perna canaliculus*) and that none of the species are listed on the unwanted organisms register or identified as secondary target species. In this regard, these structures provide a small, positive effect.

Based on the unconsented existing environment, this assessment considers the installation of the pipelines and mooring anchors. Their installation would result in temporary resuspension of sediments and the permanent loss of a small area of soft sediment habitat. The hard structures replacing the soft habitat provide some small positive effects. Ongoing maintenance of these structures has negligible effects on the benthic habitats, with some temporary resuspension of sediment adjacent to the structures when working near the seabed. The installation, maintenance, and ongoing occupation of the pipelines and mooring anchors is considered to be 'Low'.

5.7 Conclusions

Considering the large, exposed west coast environment, we consider that a relatively small proportion of the marine environment is potentially affected by the discharge from the dewatering process and process water and stormwater discharges.

A sediment plume is visible on the surface of the water during dewatering events; however, modelling shows that the suspended sediment concentrations throughout the water column are low as a result of the wide area of dispersal.

Near the mooring site, there is an increase in the average mud content by 9% and, at the time of sampling, a small difference in the benthic macroinvertebrate community composition, including the absence of a small number of species that are present at the reference sites. These differences can be at least partially accounted for by natural spatial and temporal variations. As such, the magnitude of effects is 'Low', in that the differences measured at the mooring sites indicate a "minor shift away from existing baseline conditions" as defined in the EcIA Guidelines. The results of the field sampling support the overall 'Low' level of effect from the dewatering process discharge and the stormwater/process water discharge on the benthic environment concluded by the desktop assessment. No further monitoring is considered necessary due to the highly dynamic and dispersive receiving environment and low concentrations of sediment metals (other than iron) detected.

The coastal structures permanently replace a small area of soft sediment habitat with hard structures. Hard structures provide habitat that is otherwise rare near the mooring and provide a small positive effect. Accordingly, the overall level of effect from coastal structures is no greater than ‘Low’.

We conclude that the overall effects of the proposed activity on the marine environment will be ‘Low’ from an ecological perspective. We consider it appropriate for low effects under these guidelines to be interpreted as a less than minor effect on the environment.

Appendix A Statistical Outputs

Marine Ecological Impact Assessment

TIL Central and Southern Block Fast-Track Application

Taharoa Ironsands Limited

SLR Project No.: 850.V15262.00001

6 August 2025

Sediment Metals

Table A1: Summary of Shapiro-Wilks test of normality on sediment metals. Groups with a p-value <0.05 are not normally distributed (highlighted).

Parameter	Site	n	Shapiro Test (p-value)
Total Recoverable Aluminium	Moor_N	3	0.702
Total Recoverable Aluminium	Moor_S	3	0.637
Total Recoverable Aluminium	Ref_N	3	0.780
Total Recoverable Aluminium	Ref_S	3	0.463
Total Recoverable Arsenic	Moor_N	3	0.780
Total Recoverable Arsenic	Moor_S	3	<0.001
Total Recoverable Arsenic	Ref_N	3	0.363
Total Recoverable Arsenic	Ref_S	3	0.637
Total Recoverable Copper	Moor_N	3	0.878
Total Recoverable Copper	Moor_S	3	0.510
Total Recoverable Copper	Ref_N	3	0.274
Total Recoverable Copper	Ref_S	3	0.537
Total Recoverable Iron	Moor_N	3	0.220
Total Recoverable Iron	Moor_S	3	0.253
Total Recoverable Iron	Ref_N	3	0.637
Total Recoverable Iron	Ref_S	3	1.000
Total Recoverable Lead	Moor_N	3	<0.001
Total Recoverable Lead	Moor_S	3	<0.001
Total Recoverable Lead	Ref_N	3	<0.001
Total Recoverable Lead	Ref_S	3	1.000
Total Recoverable Manganese	Moor_N	3	1.000
Total Recoverable Manganese	Moor_S	3	0.463
Total Recoverable Manganese	Ref_N	3	<0.001
Total Recoverable Manganese	Ref_S	3	0.463
Total Recoverable Nickel	Moor_N	3	0.702
Total Recoverable Nickel	Moor_S	3	0.567
Total Recoverable Nickel	Ref_N	3	0.878
Total Recoverable Nickel	Ref_S	3	1.000
Total Recoverable Zinc	Moor_N	3	0.363
Total Recoverable Zinc	Moor_S	3	0.537
Total Recoverable Zinc	Ref_N	3	0.194
Total Recoverable Zinc	Ref_S	3	0.843

Table A2: Summary of ANOVA and Kruskal-Wallis rank sum test results for sediment metals. Comparisons were made using four groups (Ref_N, Moor_N, Moor_S, Ref_S) with n = 3 for each group. Significant differences (p <0.05) are highlighted.

Parameter	ANOVA					Kruskal-Wallis	
	df	sumsq	meansq	statistic	p.value	statistic	p.value
Total Recoverable Aluminium	3	17633333.33	5877777.78	24.84	**0.0002**	9.36	**0.0249**
Total Recoverable Arsenic	3	6.56	2.19	15.63	**0.0010**	8.26	**0.0409**
Total Recoverable Copper	3	0.65	0.22	0.75	0.5499	1.79	0.6176
Total Recoverable Iron	3	210916666.67	70305555.56	6.03	**0.0189**	8.76	**0.0326**
Total Recoverable Lead	3	0.13	0.04	2.46	0.1373	6.00	0.1118
Total Recoverable Manganese	3	7291.67	2430.56	2.11	0.1768	4.38	0.2231
Total Recoverable Nickel	3	2.22	0.74	3.62	0.0647	7.17	0.0668
Total Recoverable Zinc	3	408.92	136.31	4.67	**0.0361**	8.40	**0.0384**

Table A3: Summary of post-hoc Tukey test results for sediment metal groups identified to have statistically significant differences (see Table A2). Significant differences (p <0.05) are highlighted.

Parameter	contrast	estimate	conf.low	conf.high	adj.p.value
Total Recoverable Aluminium	Moor_N-Ref_S	133.33	-1138.68	1405.35	0.9860
Total Recoverable Aluminium	Moor_S-Ref_S	1100.00	-172.01	2372.01	0.0921
Total Recoverable Aluminium	Ref_N-Ref_S	3033.33	1761.32	4305.35	**0.0003**
Total Recoverable Aluminium	Moor_S-Moor_N	966.67	-305.35	2238.68	0.1474
Total Recoverable Aluminium	Ref_N-Moor_N	2900.00	1627.99	4172.01	**0.0004**
Total Recoverable Aluminium	Ref_N-Moor_S	1933.33	661.32	3205.35	**0.0054**
Total Recoverable Arsenic	Ref_S-Moor_N	0.60	-0.38	1.58	0.2766
Total Recoverable Arsenic	Moor_S-Moor_N	0.80	-0.18	1.78	0.1139
Total Recoverable Arsenic	Ref_N-Moor_N	2.03	1.05	3.01	**0.0007**
Total Recoverable Arsenic	Moor_S-Ref_S	0.20	-0.78	1.18	0.9110
Total Recoverable Arsenic	Ref_N-Ref_S	1.43	0.45	2.41	**0.0068**
Total Recoverable Arsenic	Ref_N-Moor_S	1.23	0.25	2.21	**0.0158**
Total Recoverable Iron	Ref_S-Ref_N	2666.67	-6264.27	11597.60	0.7769
Total Recoverable Iron	Moor_S-Ref_N	9333.33	402.40	18264.27	**0.0408**
Total Recoverable Iron	Moor_N-Ref_N	9666.67	735.73	18597.60	**0.0346**
Total Recoverable Iron	Moor_S-Ref_S	6666.67	-2264.27	15597.60	0.1564
Total Recoverable Iron	Moor_N-Ref_S	7000.00	-1930.93	15930.93	0.1326
Total Recoverable Iron	Moor_N-Moor_S	333.33	-8597.60	9264.27	0.9993
Total Recoverable Zinc	Ref_S-Ref_N	2.67	-11.45	16.79	0.9277
Total Recoverable Zinc	Moor_N-Ref_N	12.33	-1.79	26.45	0.0886

Parameter	contrast	estimate	conf.low	conf.high	adj.p.value
Total Recoverable Zinc	Moor_S-Ref_N	13.33	-0.79	27.45	0.0643
Total Recoverable Zinc	Moor_N-Ref_S	9.67	-4.45	23.79	0.2049
Total Recoverable Zinc	Moor_S-Ref_S	10.67	-3.45	24.79	0.1504
Total Recoverable Zinc	Moor_S-Moor_N	1.00	-13.12	15.12	0.9956

Grain Size

Table A4: Summary of Shapiro-Wilks test of normality on sediment grain size. Groups with a p-value <0.05 are not normally distributed (highlighted).

Size Class	Group	n	Shapiro Test (p-value)
Fine sand	Ref_N	3	0.174
Fine sand	Moor_N	3	0.967
Fine sand	Moor_S	3	0.000
Fine sand	Ref_S	3	0.414
Very fine sand	Ref_N	3	0.111
Very fine sand	Moor_N	3	0.322
Very fine sand	Moor_S	3	0.152
Very fine sand	Ref_S	3	1.000
Mud	Ref_N	3	0.220
Mud	Moor_N	3	0.931
Mud	Moor_S	3	0.363
Mud	Ref_S	3	0.081

Table A5: Summary of ANOVA and Kruskal-Wallis rank sum test results for sediment grain size. Comparisons were made using four groups (Ref_N, Moor_N, Moor_S, Ref_S) with n = 3 for each group. Significant differences (p <0.05) are highlighted.

Size Class	ANOVA					Kruskal-Wallis	
	df	sumsq	meansq	statistic	p.value	statistic	p.value
Fine sand	3	451.46	150.49	2.01	0.1907	3.99	0.2627
Very fine sand	3	593.96	197.99	1.58	0.2688	5.36	0.1473
Mud	3	208.04	69.35	5.18	**0.0280**	7.67	0.0534

Table A6: Summary of post-hoc Tukey test results for sediment grain size groups identified to have statistically significant differences (see Table A5). Significant differences (p <0.05) are highlighted.

Group	contrast	estimate	conf.low	conf.high	adj.p.value
Mud	Ref_N-Ref_S	2.37	-7.20	11.93	0.8561
Mud	Moor_N-Ref_S	8.30	-1.27	17.87	0.0909
Mud	Moor_S-Ref_S	10.17	0.60	19.73	**0.0377**
Mud	Moor_N-Ref_N	5.93	-3.63	15.50	0.2688
Mud	Moor_S-Ref_N	7.80	-1.77	17.37	0.1151
Mud	Moor_S-Moor_N	1.87	-7.70	11.43	0.9212

Biota

Table A7: Summary of Shapiro-Wilks test of normality on biota metrics. Groups with a p-value <0.05 are not normally distributed.

Group	Parameter	n	Shapiro Test (p-value)
Ref_N	count	5	0.2268
Ref_N	richness	5	0.9617
Ref_N	shannon	5	0.9748
Moor_N	count	5	0.8073
Moor_N	richness	5	0.3842
Moor_N	shannon	5	0.5008
Moor_S	count	4	0.7917
Moor_S	richness	4	0.6248
Moor_S	shannon	4	0.3503
Ref_S	count	4	0.0805
Ref_S	richness	4	0.5381
Ref_S	shannon	4	0.8837

Table A8: Summary of ANOVA results for biota metrics. Comparisons were made using four groups (Ref_N, Moor_N, Moor_S, Ref_S).

Parameter	df	sumsq	meansq	statistic	p.value
count	3	1228.86	409.62	2.78	0.0801
richness	3	74.68	24.89	2.25	0.1279
shannon	3	0.29	0.10	1.79	0.1946

Table A9: Summary of PERMANOVA results grouping sites by 'Mooring' and 'Reference'.

	Df	SumOfSqs	R2	F	Pr(>F)
Group (Mooring/Reference)	1	0.436235	0.13227	2.438915	0.011
Residual	16	2.861833	0.86773		
Total	17	3.298069	1		

Table A10: Summary of PERMANOVA results grouping each sites (Ref_N, Moor_N, Moor_S, Ref_S).

	Df	SumOfSqs	R2	F	Pr(>F)
Group	3	0.983951	0.298342	1.984244	0.004
Residual	14	2.314117	0.701658		
Total	17	3.298069	1		

Appendix B Laboratory Results – Sediment Physicochemical Parameters

Marine Ecological Impact Assessment

TIL Central and Southern Block Fast-Track Application

Taharoa Ironsands Limited

SLR Project No.: 850.V15262.00001

6 August 2025

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Certificate of Analysis

SPv1

Client:	4Sight Consulting Limited	**Lab No:**	2763102
Contact:	Pete Wilson	**Date Received:**	10-Nov-2021
	C/- 4Sight Consulting Limited	**Date Reported:**	23-Dec-2021
	PO Box 1420	**Quote No:**	114827
	Waikato Mail Centre	**Order No:**	8506
	Hamilton 3240	**Client Reference:**	8506
		Submitted By:	Pete Wilson

Sample Type: Sediment

Sample Name:		Ref_N_1 10-Nov-2021 10:45 am	Ref_N_2 10-Nov-2021 10:45 am	Ref_N_3 10-Nov-2021 10:45 am	Moor_N_1 10-Nov-2021 11:12 am	Moor_N_2 10-Nov-2021 11:12 am
Lab Number:		2763102.1	2763102.2	2763102.3	2763102.4	2763102.5
Individual Tests						
Total Recoverable Aluminium	mg/kg dry wt	9,000	9,900	8,400	6,100	5,700
Total Recoverable Arsenic	mg/kg dry wt	6.3	5.9	6.4	4.4	3.9
Total Recoverable Copper	mg/kg dry wt	6.4	6.6	5.3	6.2	5.8
Total Recoverable Iron	mg/kg dry wt	30,000	28,000	24,000	35,000	34,000
Total Recoverable Lead	mg/kg dry wt	3.8	4.2	3.8	3.7	3.7
Total Recoverable Manganese	mg/kg dry wt	410	360	360	440	400
Total Recoverable Nickel	mg/kg dry wt	6.7	7.1	6.2	7.2	6.8
Total Recoverable Zinc	mg/kg dry wt	49	48	40	56	54
7 Grain Sizes Profile as received*						
Dry Matter of Sieved Sample*	g/100g as rcvd	76	76	78	79	78
Fraction >/= 2 mm*	g/100g dry wt	< 0.1	< 0.1	0.1	0.1	< 0.1
Fraction < 2 mm, >/= 1 mm*	g/100g dry wt	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fraction < 1 mm, >/= 500 µm*	g/100g dry wt	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Fraction < 500 µm, >/= 250 µm*	g/100g dry wt	< 0.1	0.1	0.3	0.3	< 0.1
Fraction < 250 µm, >/= 125 µm*	g/100g dry wt	17.4	19.7	40.4	40.0	16.9
Fraction < 125 µm, >/= 63 µm*	g/100g dry wt	63.4	61.6	35.8	33.0	63.2
Fraction < 63 µm*	g/100g dry wt	19.1	18.5	23.3	26.5	19.7

Sample Name:		Moor_N_3 10-Nov-2021 11:12 am	Moor_S_1 10-Nov-2021 12:00 pm	Moor_S_2 10-Nov-2021 12:00 pm	Moor_S_3 10-Nov-2021 12:00 pm	Ref_S_1 09-Nov-2021 11:30 am
Lab Number:		2763102.6	2763102.7	2763102.8	2763102.9	2763102.10
Individual Tests						
Total Recoverable Aluminium	mg/kg dry wt	6,800	7,300	7,200	7,000	5,900
Total Recoverable Arsenic	mg/kg dry wt	4.2	5.1	5.1	4.7	4.1
Total Recoverable Copper	mg/kg dry wt	6.7	7.3	6.5	6.2	6.4
Total Recoverable Iron	mg/kg dry wt	42,000	41,000	35,000	34,000	32,000
Total Recoverable Lead	mg/kg dry wt	3.8	3.7	3.6	3.7	3.6
Total Recoverable Manganese	mg/kg dry wt	480	480	420	400	390
Total Recoverable Nickel	mg/kg dry wt	7.9	8.0	7.3	7.0	6.6
Total Recoverable Zinc	mg/kg dry wt	64	67	57	53	52
7 Grain Sizes Profile as received*						
Dry Matter of Sieved Sample*	g/100g as rcvd	76	78	78	77	78
Fraction >/= 2 mm*	g/100g dry wt	< 0.1	< 0.1	0.4	0.1	0.9
Fraction < 2 mm, >/= 1 mm*	g/100g dry wt	< 0.1	< 0.1	< 0.1	< 0.1	0.4
Fraction < 1 mm, >/= 500 µm*	g/100g dry wt	< 0.1	< 0.1	< 0.1	< 0.1	0.2
Fraction < 500 µm, >/= 250 µm*	g/100g dry wt	0.2	0.1	0.2	0.2	0.2
Fraction < 250 µm, >/= 125 µm*	g/100g dry wt	28.8	36.3	39.0	36.3	42.7

Sample Type: Sediment						
Sample Name:		Moor_N_3 10-Nov-2021 11:12 am	Moor_S_1 10-Nov-2021 12:00 pm	Moor_S_2 10-Nov-2021 12:00 pm	Moor_S_3 10-Nov-2021 12:00 pm	Ref_S_1 09-Nov-2021 11:30 am
Lab Number:		2763102.6	2763102.7	2763102.8	2763102.9	2763102.10
7 Grain Sizes Profile as received*						
Fraction < 125 µm, >/= 63 µm*	g/100g dry wt	38.4	35.2	32.1	35.5	40.5
Fraction < 63 µm*	g/100g dry wt	32.5	28.3	28.2	27.8	15.2

Sample Name:		Ref_S_2 09-Nov-2021 1:50 pm	Ref_S_3 09-Nov-2021 1:50 pm			
Lab Number:		2763102.11	2763102.12			
Individual Tests						
Total Recoverable Aluminium	mg/kg dry wt	6,300	6,000	-	-	-
Total Recoverable Arsenic	mg/kg dry wt	5.3	4.9	-	-	-
Total Recoverable Copper	mg/kg dry wt	6.2	5.7	-	-	-
Total Recoverable Iron	mg/kg dry wt	30,000	28,000	-	-	-
Total Recoverable Lead	mg/kg dry wt	3.8	3.7	-	-	-
Total Recoverable Manganese	mg/kg dry wt	420	430	-	-	-
Total Recoverable Nickel	mg/kg dry wt	6.4	6.2	-	-	-
Total Recoverable Zinc	mg/kg dry wt	48	45	-	-	-
7 Grain Sizes Profile as received*						
Dry Matter of Sieved Sample*	g/100g as rcvd	80	80	-	-	-
Fraction >/= 2 mm*	g/100g dry wt	< 0.1	< 0.1	-	-	-
Fraction < 2 mm, >/= 1 mm*	g/100g dry wt	< 0.1	< 0.1	-	-	-
Fraction < 1 mm, >/= 500 µm*	g/100g dry wt	< 0.1	< 0.1	-	-	-
Fraction < 500 µm, >/= 250 µm*	g/100g dry wt	0.2	0.2	-	-	-
Fraction < 250 µm, >/= 125 µm*	g/100g dry wt	40.3	39.6	-	-	-
Fraction < 125 µm, >/= 63 µm*	g/100g dry wt	40.1	40.9	-	-	-
Fraction < 63 µm*	g/100g dry wt	19.4	19.2	-	-	-

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 simple 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. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request.
Unless otherwise indicated, analyses were performed at Hill Laboratories, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-12
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation May contain a residual moisture content of 2-5%.	-	1-12
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-12
Total Recoverable Aluminium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	10 mg/kg dry wt	1-12
Total Recoverable Arsenic	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	0.2 mg/kg dry wt	1-12
Total Recoverable Copper	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	0.2 mg/kg dry wt	1-12
Total Recoverable Iron	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	1-12
Total Recoverable Lead	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	0.08 mg/kg dry wt	1-12
Total Recoverable Manganese	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	1.0 mg/kg dry wt	1-12
Total Recoverable Nickel	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	0.2 mg/kg dry wt	1-12

Sample Type: Sediment			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Recoverable Zinc	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	0.8 mg/kg dry wt	1-12
7 Grain Sizes Profile as received			
Dry Matter for Grainsize samples (sieved as received)*	Drying for 16 hours at 103°C, gravimetry (Free water removed before analysis).	0.10 g/100g as rcvd	1-12
Fraction >/= 2 mm*	Wet sieving with dispersant, as received, 2.00 mm sieve, gravimetry.	0.1 g/100g dry wt	1-12
Fraction < 2 mm, >/= 1 mm*	Wet sieving using dispersant, as received, 2.00 mm and 1.00 mm sieves, gravimetry (calculation by difference).	0.1 g/100g dry wt	1-12
Fraction < 1 mm, >/= 500 µm*	Wet sieving using dispersant, as received, 1.00 mm and 500 µm sieves, gravimetry (calculation by difference).	0.1 g/100g dry wt	1-12
Fraction < 500 µm, >/= 250 µm*	Wet sieving using dispersant, as received, 500 µm and 250 µm sieves, gravimetry (calculation by difference).	0.1 g/100g dry wt	1-12
Fraction < 250 µm, >/= 125 µm*	Wet sieving using dispersant, as received, 250 µm and 125 µm sieves, gravimetry (calculation by difference).	0.1 g/100g dry wt	1-12
Fraction < 125 µm, >/= 63 µm*	Wet sieving using dispersant, as received, 125 µm and 63 µm sieves, gravimetry (calculation by difference).	0.1 g/100g dry wt	1-12
Fraction < 63 µm*	Wet sieving with dispersant, as received, 63 µm sieve, gravimetry (calculation by difference).	0.1 g/100g dry wt	1-12

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

Testing was completed between 18-Nov-2021 and 23-Dec-2021. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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

[redacted]

Ara Heron BSc (Tech)
Client Services Manager - Environmental

Appendix C Benthic Macroinvertebrate Results

Marine Ecological Impact Assessment

TIL Central and Southern Block Fast-Track Application

Taharoa Ironsands Limited

SLR Project No.: 850.V15262.00001

6 August 2025

General Group	Family	Genus	Taxa	Common Name	Feeding	Moor-N-1	Moor-N-2	Moor-N-3	Moor-N-4	Moor-N-5	Moor-S-1	Moor-S-2	Moor-S-3	Moor-S-4	Ref-N-1	Ref-N-2	Ref-N-3	Ref-N-4	Ref-N-5	Ref-S-1	Ref-S-2	Ref-S-3	Ref-S-4
Anthozoa	Edwardsiidae	Edwardsia	Edwardsia sp.	Burrowing anemone																	1		
Nemertea			Nemertea	Proboscis worms		1	4	1	2				1	1		2	3	1	3		2		1
Nematoda			Nematoda	Roundworm		9	1	2	2	1		1	1	3	16	5	29	10	30		2	1	
Scaphopoda	Dentaliidae	Antalis	Antalis suteri	Tusk shell		3					1			1	1	1	3	2	3			1	
Gastropoda			Gastropoda (micro snails)	Snails										1									
Gastropoda	Olividae	Amalda (Gracilispira)	Amalda (Gracilispira) novaezelandiae	Olive shell																	1		1
Gastropoda	Buccinidae	Austrofusus	Austrofusus glans					1															
Gastropoda	Acteonidae	Maxacteon	Maxacteon matericulatus							2	1	1			1								
Gastropoda	Conidae	Neoguraleus	Neoguraleus amoenus												1								
Bivalvia			Bivalvia Unid. (juv)			1						1											
Bivalvia	Lasaeidae	Arthritica	Arthritica sp.	Small bivalve	Infaunal deposit feeder													1					
Bivalvia	Tellinidae	Bartschicoma	Bartschicoma edgari					1															
Bivalvia	Lucinidae	Divalucina	Divalucina cumingi	Lace cockle							1	1		1	1								
Bivalvia	Veneridae	Dosinia	Dosinia lambata		Infaunal suspension feeder														1				
Bivalvia	Mactridae	Maorimactra	Maorimactra ordinaria			3	2								1		14	4	5		4	1	4
Bivalvia	Nuculidae	Nucula	Nucula nitidula	Nut shell	Infaunal deposit feeder					1				2	1	1			1				
Bivalvia	Tellinidae	Serratina	Serratina charlottae		Infaunal suspension feeder	1																	
Oligochaeta			Oligochaeta	Oligochaete worms	Infaunal deposit feeder		1								1								
Polychaeta: Ampharetidae	Ampharetidae		Ampharetidae	Polychaete worm (Family)	Surface deposit feeder	2	1				1	1	2		3				2	1	1	3	
Polychaeta: Chrysopetalidae	Chrysopetalidae		Chrysopetalidae	Polychaete worm (Family)															1				
Polychaeta: Pectinariidae	Pectinariidae	Lagis	Lagis sp.	Polychaete worm (Family)													1					2	
Polychaeta: Orbiniidae	Orbiniidae	Leodamas	Leodamas sp.	Polychaete worm (Family)				1															
Polychaeta: Orbiniidae	Orbiniidae	Phylo	Phylo felix	Polychaete worm (Family)	Infaunal deposit feeder								1										
Polychaeta: Paraonidae	Paraonidae		Paraonidae	Polychaete worm (Family)	Infaunal deposit feeder	1	1	1	1	3	1					1	1	1					
Polychaeta: Spionidae	Spionidae		Spionidae	Polychaete worm (Family)	Surface deposit feeder														1	1			
Polychaeta: Spionidae	Spionidae	Prionospio	Prionospio spp.	Polychaete worm (Family)	Surface deposit feeder					2	3	1									1	1	
Polychaeta: Spionidae	Spionidae	Spiophanes	Spiophanes modestus	Polychaete worm (Family)								1					1		2				
Polychaeta: Magelonidae	Magelonidae	Magelona	Magelona sp.	Polychaete worm (Family)	Surface deposit feeder	5	1		1	3	4	4		4	3	4	3	5	1	2	1		1
Polychaeta: Capitellidae	Capitellidae	Barantolla	Barantolla lepte	Polychaete worm (Family)		1															4	3	1
Polychaeta: Capitellidae	Capitellidae	Capitella	Capitella spp.	Polychaete worm (Family)	Infaunal deposit feeder	1																	
Polychaeta: Capitellidae	Capitellidae	Heteromastus	Heteromastus filiformis	Polychaete worm (Family)	Infaunal deposit feeder		5	3		13	2	1		6	6	3	4	4	8	3	2	5	

General Group	Family	Genus	Taxa	Common Name	Feeding	Moor-N-1	Moor-N-2	Moor-N-3	Moor-N-4	Moor-N-5	Moor-S-1	Moor-S-2	Moor-S-3	Moor-S-4	Ref-N-1	Ref-N-2	Ref-N-3	Ref-N-4	Ref-N-5	Ref-S-1	Ref-S-2	Ref-S-3	Ref-S-4
Polychaeta: Capitellidae	Capitellidae	Notomastus	Notomastus sp.	Polychaete worm (Family)	Infaunal deposit feeder							1			1								
Polychaeta: Opheliidae	Opheliidae	Armandia	Armandia maculata	Polychaete worm (Family)	Infaunal deposit feeder	4	1			1		2			7		5	3	6	2	4	1	
Polychaeta: Phyllodocidae	Phyllodocidae		Phyllodocidae	Paddle worms	Carnivore & scavenger					1													
Polychaeta: Sigalionidae	Sigalionidae		Sigalionidae		Infaunal carnivore								1	1									1
Polychaeta: Hesionidae	Hesionidae		Hesionidae		Carnivore and deposit feeder			1									1	1					
Polychaeta: Syllidae	Syllidae		Syllidae		Omnivorous			1													1		
Polychaeta: Glyceridae	Glyceridae		Glyceridae		Infaunal carnivore & deposit feeder														1				
Polychaeta: Goniadidae	Goniadidae		Goniadidae		Infaunal carnivore	12	8	3	3	3	3	7	5	3	3	4	2	8	2	2	6	11	7
Polychaeta: Nephtyidae	Nephtyidae	Aglaophamus	Aglaophamus sp.		Infaunal carnivore	1		1	1		2		1							1		2	1
Polychaeta: Onuphidae	Onuphidae	Onuphis	Onuphis aucklandensis		Infaunal surface deposit feeder/omnivore			1	1		1		1	1			1		1		2	1	1
Polychaeta: Lumbrineridae	Lumbrinerida e		Lumbrineridae		Infaunal carnivore & deposit feeder			1															
Polychaeta: Oweniidae	Oweniidae	Myriochele	Myriochele sp.			1													1	2	4	3	
Polychaeta: Oweniidae	Oweniidae	Owenia	Owenia petersenae	Polychaete worm	Infaunal deposit feeder				1						3			2	1				
Polychaeta: Flabelligeridae	Flabelligerida e		Flabelligeridae		Infaunal deposit feeder	1													1				
Crustacea	Tanaidae		Tanaidacea	Tanaid shrimp			1								2		3	2	2	1	1		
Cumacea			Cumacea	Cumaceans	Infaunal filter or deposit feeder	1											2	1	1				
Isopoda	Munnidae		Munnidae						1									1					
Amphipoda	Haustoriidae		Haustoriidae	Amphipod (family)											3	1	3	3	5	1	3	3	2
Amphipoda	Liljeborgiidae		Liljeborgiidae	Amphipods											1								
Amphipoda	Phoxocephali dae		Phoxocephalidae	Amphipod (family)		9	4	4	2			1	2	1	6	1	8	1	3	1	1	3	
Amphipoda	Phoxocephali dae	Torridoharpinia	Torridoharpinia hurleyi			1	4		1			2				1		5	6	1			
Amphipoda			Amphipoda - marine	Amphipods	Epifaunal scavenger																		1
Decapoda	Ogyrididae	Ogyrides	Ogyrides sp.	Shrimp (long eyes)				1	1	3	1	3		3									
Ostracoda	Cylindroleberi didae	Leuroleberis	Leuroleberis zealandica	Ostracod (Large)	Omnivorous scavenger	1		2				1				1						1	
Ostracoda			Ostracoda	Ostracod	Omnivorous scavenger														1				
Bryozoa			Bryozoa (bushy)	Bryozoans													1						
Ophiuroidea			Ophiuroidea	Brittle stars			1					1			1	1		1	1				
Holothuroidea	Heterothyonid ae	Heterothyone	Heterothyone ocnoides	Sea Cucumber						1											1		
			Count: No of Individuals			59	35	25	17	34	21	30	15	28	62	26	85	56	90	18	42	42	21
			Count: No of Taxa			20	14	16	12	12	12	17	9	13	20	13	18	19	26	12	19	16	11

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