Omakiwi Cove Jetty - Coastal Ecological Values Assessment

February 2023

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1. INTRODUCTION

1.1 Background Information

Explore Limited proposes to construct a jetty at the southern end of the beach at Omakiwi Cove, eastern Bay of Islands (Figure 1).

This report provides the results of ecological assessments within the marine intertidal area, shallow subtidal zone and coastal area of the proposed jetty and construction works area.

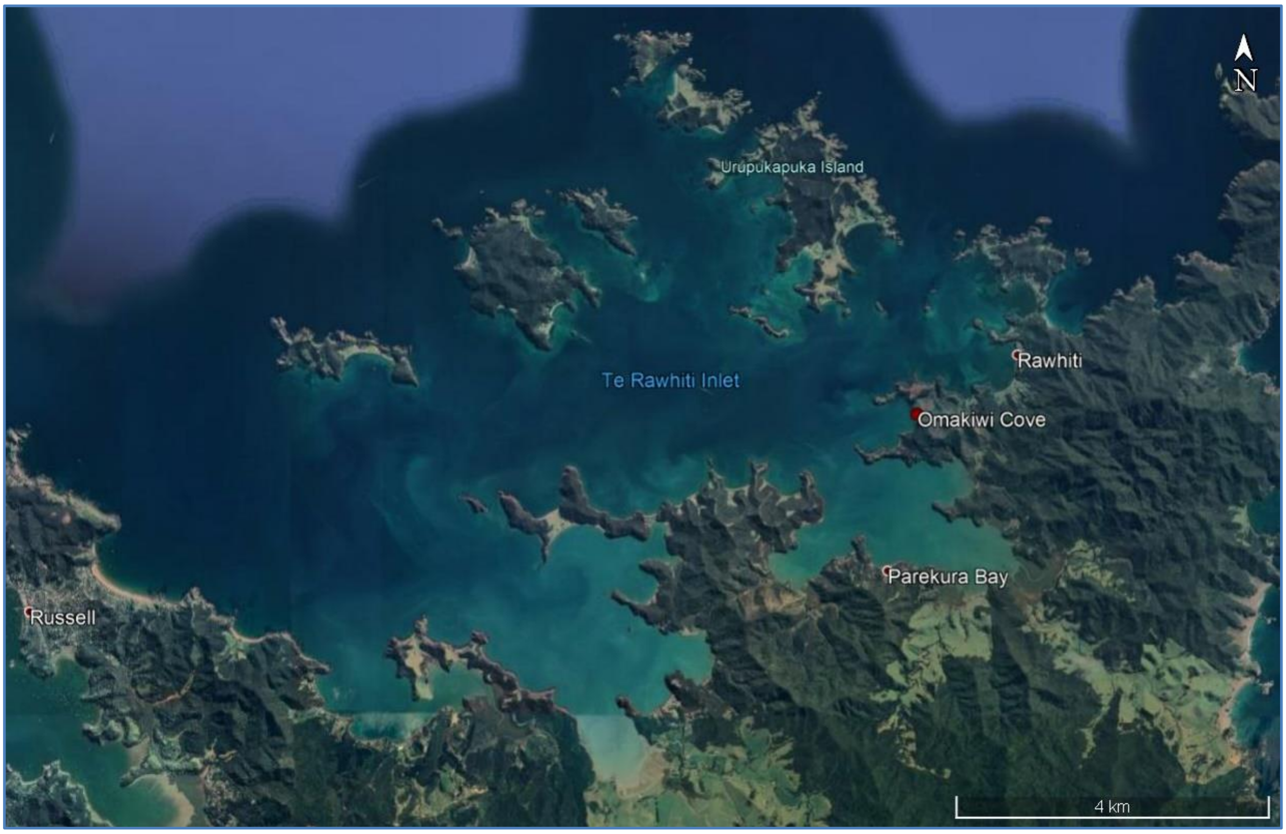

Figure 1. Omakiwi Cove location in the Bay of Islands (Google Earth 2021)

The proposed project is the construction of a 150m long piled jetty from the grassed shore, ending with a 12m by 4m floating pontoon (Figure 2, Appendix 1). The pontoon would be held in place with piles and accessed by a 12m by 2.1m gangway. Due to the presence of seagrass in the bay Explore Limited intends manage the use of the pontoon by using vessels able to operate in the natural tidal depths.

A site assessment of the coastal zone, intertidal area, and shallow subtidal zone within the proposed alignment of the jetty, was carried out at low tide on 10 June 2021. Additional observations were made of the shallow subtidal zone under and adjacent to the proposed alignment of the jetty area on 10 June 2021, 14 July 2021, and 20 February 2023.

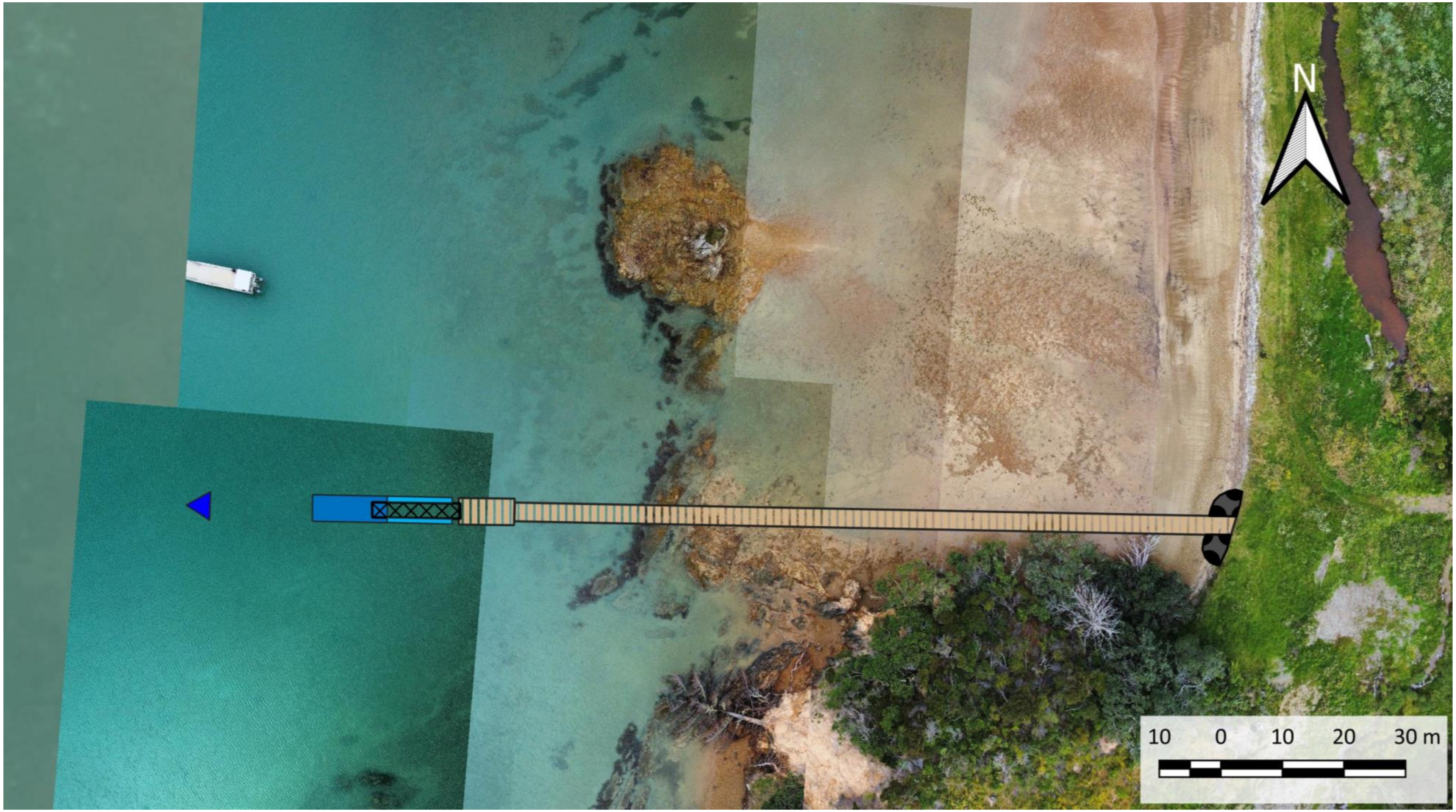

Figure 2. ***Proposed Omakiwi jetty design (in orange), pontoon extension (in blue). Based on revised plans provided by Total Marine Services dated 14/10/2021. Background imagery georeferenced drone photographs taken 6 December 2022.***

2. ECOLOGICAL VALUES OF THE INTERTIDAL ZONE

2.1 Methodology for the intertidal zone

The intertidal zone within the proposed jetty footprint was assessed at low tide for species present and habitat quality during the site visit on 10 June 2021.

The intertidal habitats were assessed, with specific attention on edible shellfish resources. Qualitative observations of key biota zones as well as substrate were recorded for each habitat zone. Fauna was either recorded as percentage cover or numbers per square metre using a $0.25m^2$ quadrat (for sessile invertebrates) or as an estimate of abundance (i.e., rare, occasional, common, abundant) and identified to species or next highest taxonomic classification. Edible shellfish species were measured with callipers to assess whether the resource was of edible size.

Photographs were collected and notes were made on additional habitat features (e.g., coastal riparian vegetation) of significance.

2.2 Ecological values

The intertidal zone was approximately 100m wide at the southern end of the cove with a sandstone cliff marking the southern limit of the beach. The upper beach was a mobile cobble beach, bordered by a wide band of kikuyu grass, with occasional to rare flax (*Phormium tenax*) and adventive weed species to the landward side. Pōhutukawa (*Metrosideros excelsa*) dominate the tree assemblage on the cliff with one large tree spreading canopy into the intertidal near the proposed pathway to the jetty.

The cobble beach was approximately 10m wide and sloped moderately steeply to a sandstone platform. To the north of the alignment the sandstone platform graded to sand, forming a sand and cobble beach. On the alignment isolated rocks or areas of harder substrate were present in elevated patches above the platform base. Most depressions in the platform were filled with fine sand (Figure 3 and Figure 4).

The sandstone platform extended just over 80m before forming a shallow ridge and dropping into the muddy sand subtidal zone (Figure 5 to Figure 7). Approximately 30m north of the proposed jetty alignment a tall rocky knoll was present at the intertidal subtidal boundary.

Offshore the substrate appeared to be dominated by muddy sand.

The upper intertidal zone was dominated by mobile cobbles and did not support any significant biota.

In the upper section of the mid-intertidal zone, sparse rocks jutting above the platform were dominated by a patchy distribution of rock oysters (*Saccostrea glomerata)* with black nerita (*Nerita melanotragus*). Cockles (*Austrovenus stutchburyi*) were common in patches in the cracks in the platform where sand and muddy sand had accumulated. The areas of cockles were sparse, but when present in the depressions in the platform they reached densities of over 130 per m^2. The cockles averaged 18mm width, well below an attractive edible size of 25mm width, with a maximum size of 25mm (one individual).

Approximately 40m offshore, the rocky platform was overlaid with a thin layer of sand (less than 10mm deep), with rare rocks supporting oysters (Figure 4 and Figure 5).

At 75 – 90 m offshore the rock platform formed a series of deep depressions and ridges. The ridge supported rock oysters, Cat's eye snail (*Lunella smaragda*), black nerita, spotted topshell (*Diloma aethiops*), chitons (*Sypharochiton pelliserpentis*, *Chiton glaucus*) and Neptune's necklace (*Hormosira banksii*). The depressions supported a similar species composition with fewer oysters, more spotted topshell and sporadic patches or small clumps of seagrass (*Zostera muelleri*).

At low tide level the intertidal rocky platform was dominated by a thick band of Neptune's necklace with cat's eye snails (168 per m², average size 15mm) and Corallina turf (*Corallina officinalis*). This zone graded down a short vertical step, supporting brown seaweed (*Carpophyllum flexuosum*) to the sandy shallow subtidal Figure 6 and Figure 7).

Figure 3. Upper and mid-intertidal zone at the southern end of Omakiwi Cove, view towards where the jetty is proposed.

Figure 4. Mid intertidal zone rocky platform, jetty alignment to the photo right

Figure 5. Lower and mid intertidal zone on jetty alignment.

Figure 6. Elevated reef at the edge of the lower intertidal zone, with a dense layer of Neptune's necklace

Figure 7. Low tide drop off into sandy subtidal. Brown algae transition from Neptune's necklace to Carpophyllum.

3. ECOLOGICAL VALUES OF THE SUBTIDAL ZONE

3.1 Methodology for the subtidal zone

A preliminary assessment of the subtidal zone within the proposed jetty footprint was assessed at low tide during the site visit on 10 June 2021. The subtidal habitats were investigated with a drop-camera tripod, however, the in water visibility was poor resulting in poor quality images. On 14 July 2021 additional seabed photographs were recorded at five locations (Refer Figure 8) (Z1 to Z3, Sed C and Sed D). The cameras recorded a framed 0.25m² from above and one lateral view from 0.3m above the seabed. Images were recorded on GoPro Hero4 Silver cameras set on a time lapse of 2 seconds at 12 MP resolution and wide field of view. At each location, the camera frame system was lowered by hand to the seafloor, leaving it for a minimum of 30 seconds to record a series of images.

The assessment, using photography from the GoPro cameras, was preliminary to provide information on the presence or absence of seagrass beds within the embayment, specifically along the jetty alignment the area around the pontoon (Figure 2). On 14 July 2021 sediment quality and benthic biota samples were collected from four sites (Sed A to Sed D) around the jetty (refer Figure 8).

An in water visual and video inspection of the jetty alignment and floating pontoon area was conducted at low tide on 20 February 2022.

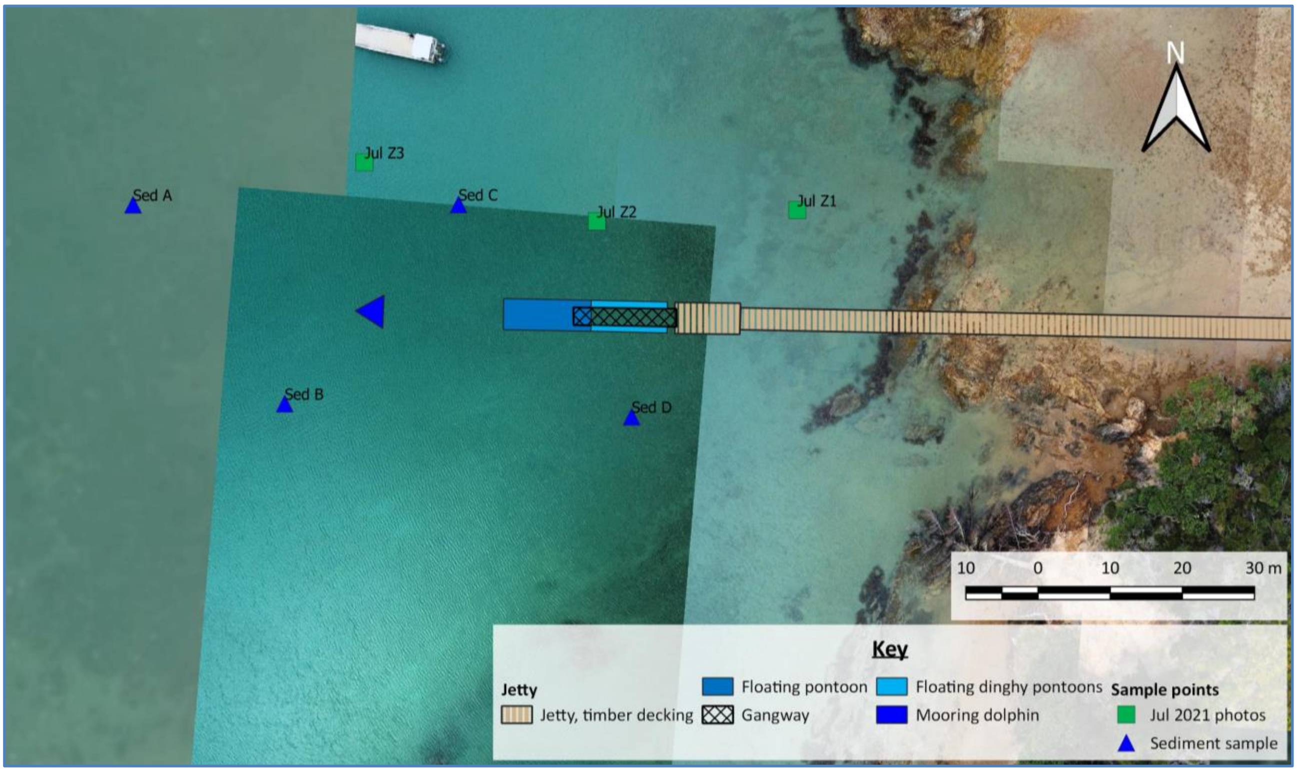

Figure 8. Proposed Omakiwi pontoon and jetty design. Sample sites of seabed images Z1 to Z3, Sed C and Sed D, sediment quality and benthic biota (Sed A to Sed D). Based on revised plans provided by Total Marine Services dated 14/10/2021.

3.2 Seagrass

New Zealand has only one species of seagrass, *Zostera muelleri*. Its distribution is listed as 'at risk – declining' under the New Zealand Threat Classification System (de Lange *et al.* 2018). The Northland Regional Council (NRC) online mapping tool has a layer (Biodiversity Wetlands) where areas of *Zostera* are modelled to be present[1]. This layer shows that seagrass beds are thought to have been present and may still be present in the subtidal zone of Omakiwi Cove (Figure 9). This modelled seagrass distribution map dated July 2015, was based on a number of aerial photographs spanning over 10 years. It is uncertain if the quality of the seagrass habitat has been ground-truthed as the NRC attribute tables were not available online.

Seagrass meadows (Figure 10 and Figure 11) are vital coastal ecosystems providing important ecosystem services. For instance, they form nursery habitats for numerous fish species, contribute to the nutrient recycling, and stabilise sediments (Turner and Schwarz 2006).

The proposed Regional Policy Statement for Northland states in Policy 4.4.1. that *"(1) in the coastal environment, avoid adverse effects … so they are no more than minor on (a) indigenous taxa that are listed as threatened or at risk in the New Zealand Threat Classification System lists"*; and *"(2) In the coastal environment, avoid significant adverse effects… on (c) indigenous ecosystems and habitats that are particularly vulnerable to modification, including…….eelgrass…."*

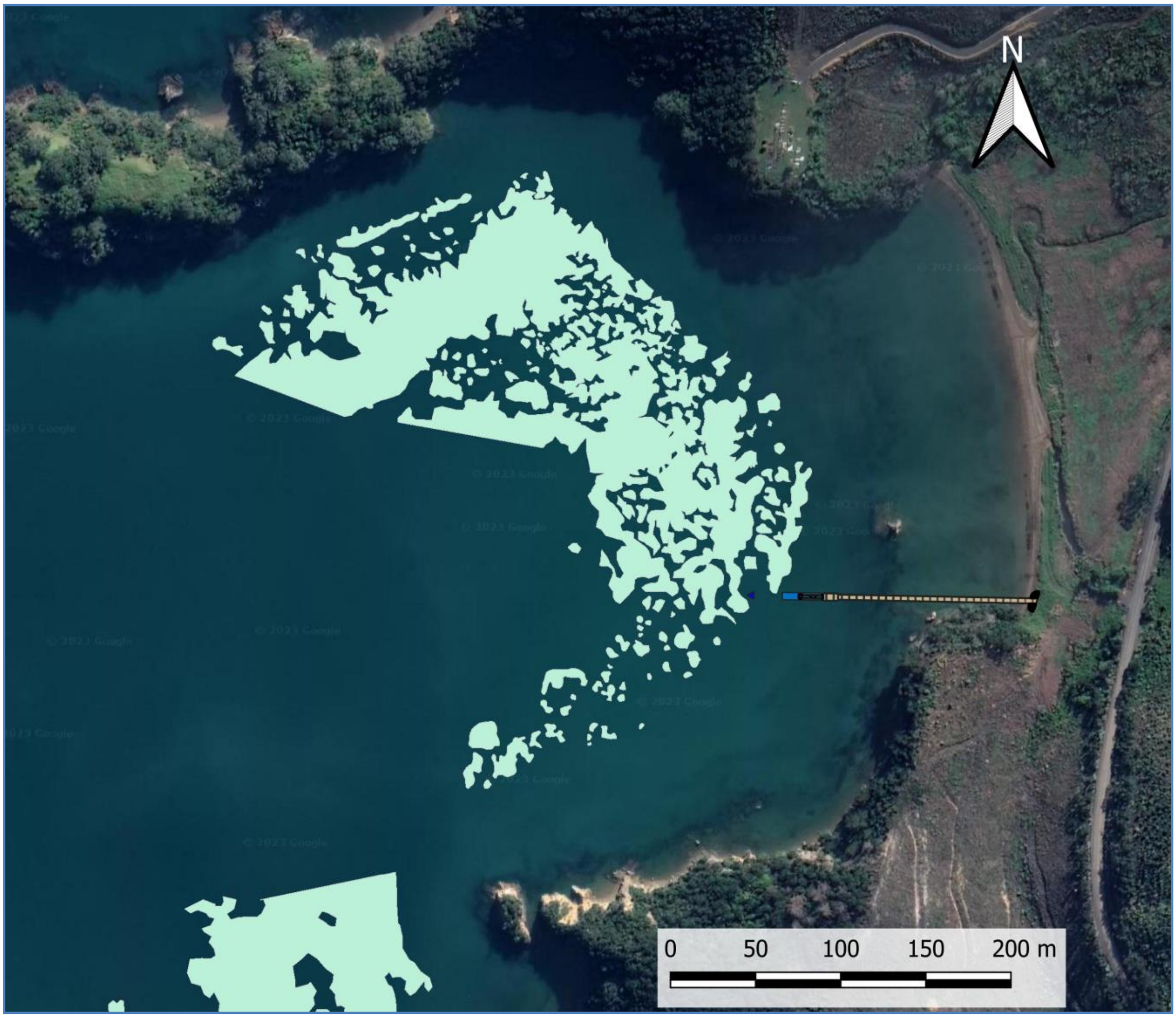

Figure 9. NRC modelled seagrass habitat from aerial photographs. Seagrass layer dated 2015 from the NRC map online tool.

[1] https://localmaps.nrc.govt.nz/localmapsviewer/?map=55bdd943767a493587323fc025b1335c

Figure 10. Example of healthy Zostera meadows from Moturua Island (Bioresearches 2022)

Figure 11. Diver sampling a subtidal seagrass meadow (NIWA Seagrass Guide)

3.2.1 Distribution and quality

The visibility in June was very poor underwater, limiting the quality of the photos, however all seabed photos showed either no *Zostera* or a sparse distribution of *Zostera* plants on the seabed. Selected photos at each drop camera location presented in Appendix 3 and summarised in Figure 12.

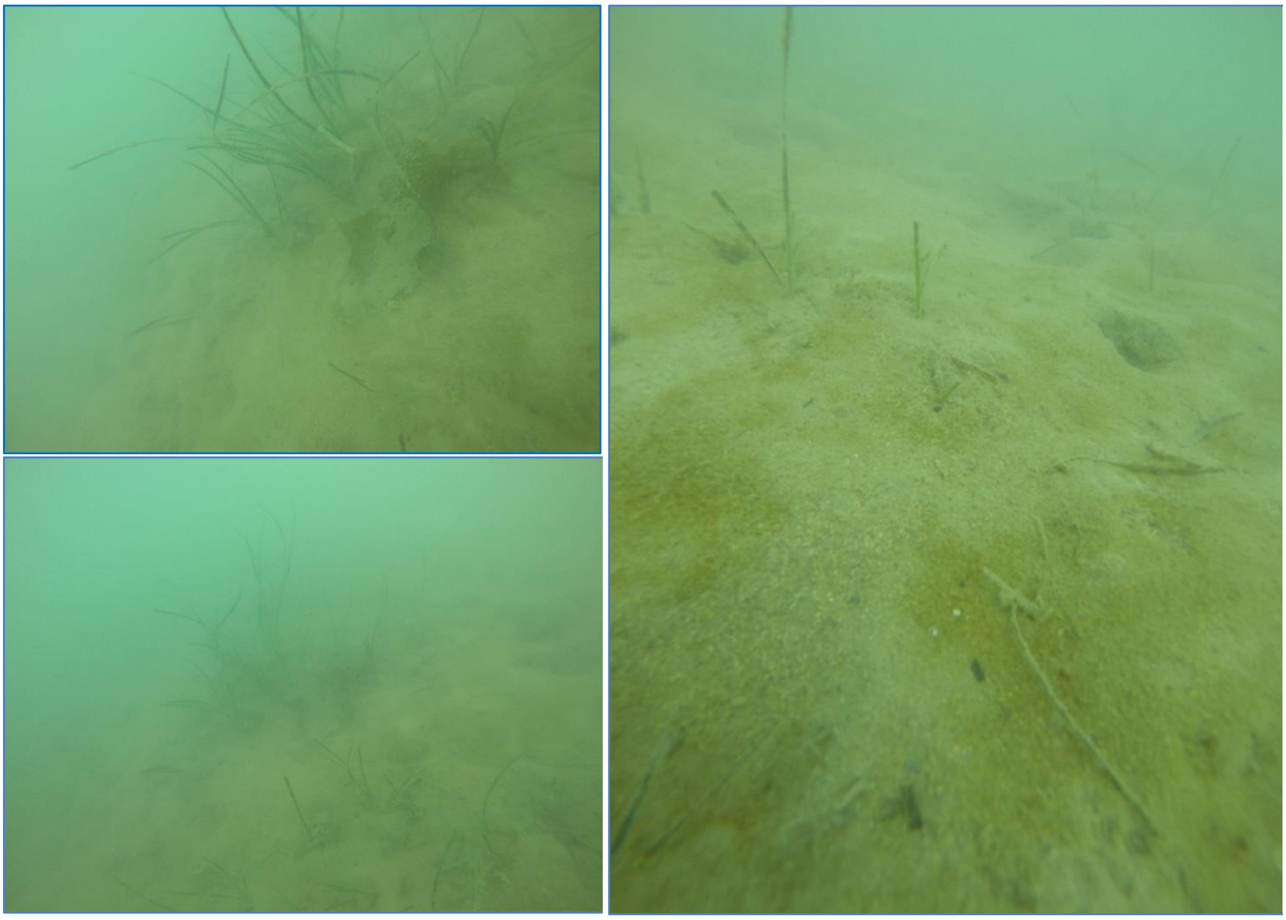

Figure 12 Examples of drop camera images captured from the project foot print showing sparse Zostera.

Historical aerial photography has shown the presence of a *Zostera* bed in the bay. However, the quality of the historical seagrass habitat has not been confirmed. From the observations made during this initial investigation, there was no indication of healthy *Zostera* meadows or beds near the proposed jetty or pontoon area. *Zostera* was very patchy in its distribution and plants were sparse. Plants that were observed were generally in poor health and brown, with few individual plants showing any green. The *Zostera* was not present in sufficient quantity or quality to provide any significant ecological function as a habitat. Subsequent sampling under better water visibility in July 2021 confirmed the low abundance and poor quality of the *Zostera* habitat present on the seabed in the offshore area around the jetty pontoon.

While the NRC modelled seagrass habitat distribution shown in Figure 9 shows that the jetty and pontoon do not overlap with the presence of seagrass. Seabed photograph sites Z3 and Sed C correspond to areas identified by NRC as having seagrass present, however no significant seagrass was observed in the winter of 2021. It was considered possible that the *Zostera* bed could be semi seasonal, dying off in the low light levels of winter and proliferating in the warmer longer sun light hours of summer. To this end an in water visual inspection was conducted at low tide on 20 February 2022. The survey area was limited to that of the proposed pontoon and jetty areas as well as areas closely adjacent. The weather on the day was fine and sunny however the 2022/23 summer has been far from normal with higher than normal rainfall. In water visibility during the survey was only about 1m which was less than expected. Transects along the edges of the proposed pontoon footprint showed a muddy sandy seabed covered with a low (<20mm) thick layer of filamentous algae or diatom with very sparse blades of *Zostera* (Figure 13). *Zostera* was very slightly more abundant on the southern side (bottom picture) of the proposed pontoon. It is considered that the presence of the floating pontoon would have no detectable effect on the abundance of *Zostera*. Transects 5-10 m parallel to the proposed pontoon showed similar habitat.

A video transect run along the alignment of the proposed jetty showed the seabed habitat grade from the muddy sandy filamentous algae habitat at the pontoon, to include more sparse low Z*ostera* at about 20 m off the rock fringe (Figure 14 top), to a bed of denser longer leaved *Zostera* at about 10 m off the rock fringe (Figure 14 bottom), within the zone of larger boulders. Between the denser bed of *Zostera* and the rock reef fringe boulders were present some of which showed the presence of sponges (Figure 15 top) and the invasive sea squirt (*Eudistoma elongatum*) (Figure 15 bottom).

Other existing similar jetty structures in the Bay of Islands have dense beds of *Zostera* under and nearby. Thus, the habitats present within and adjacent to the jetty and pontoon footprints are not expected to be significantly adversely affected by the occupation of the area by these structures.

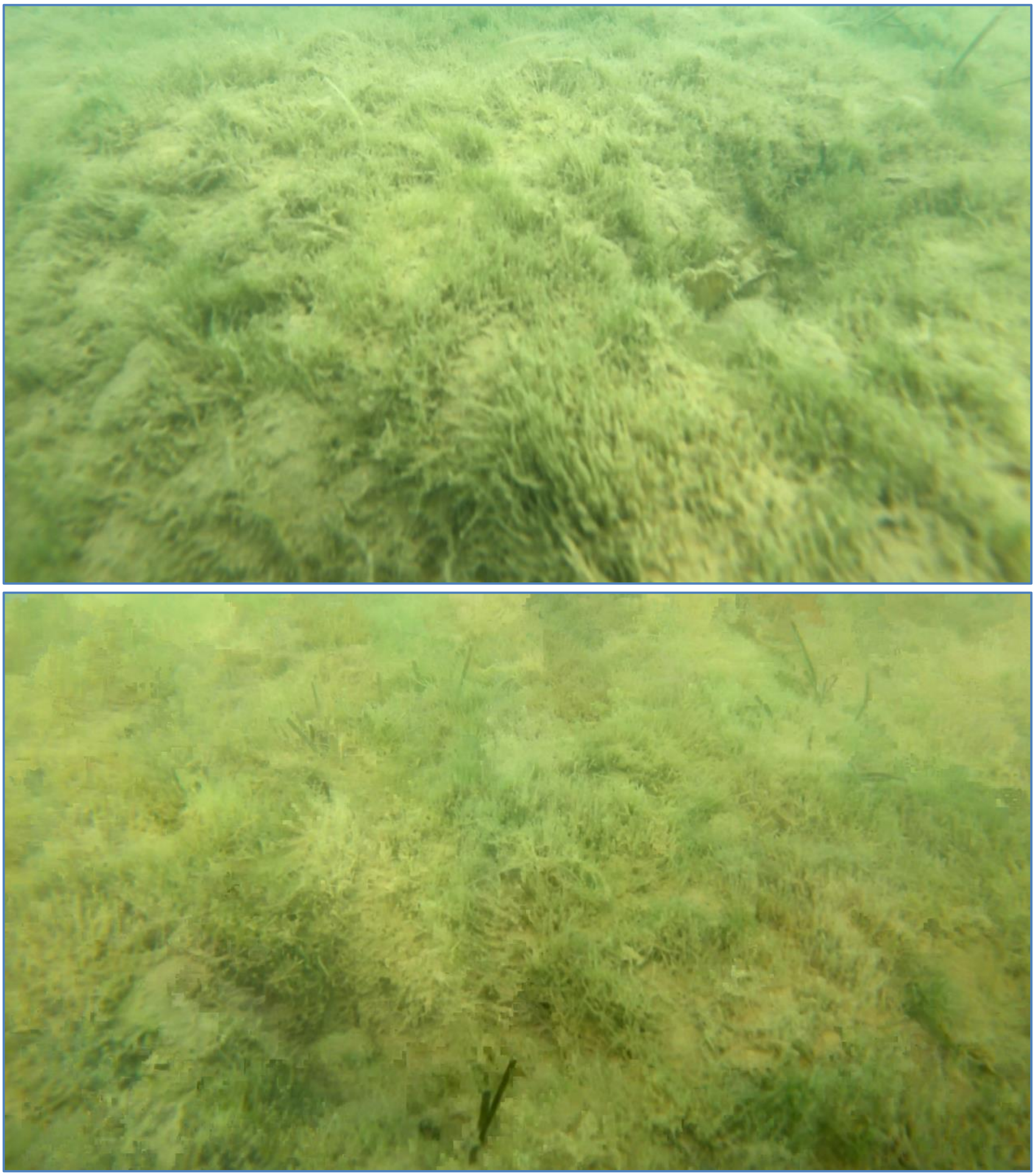

Figure 13 Typical seabed habitat in the area of the proposed floating pontoon, 20 Feb. 2023.

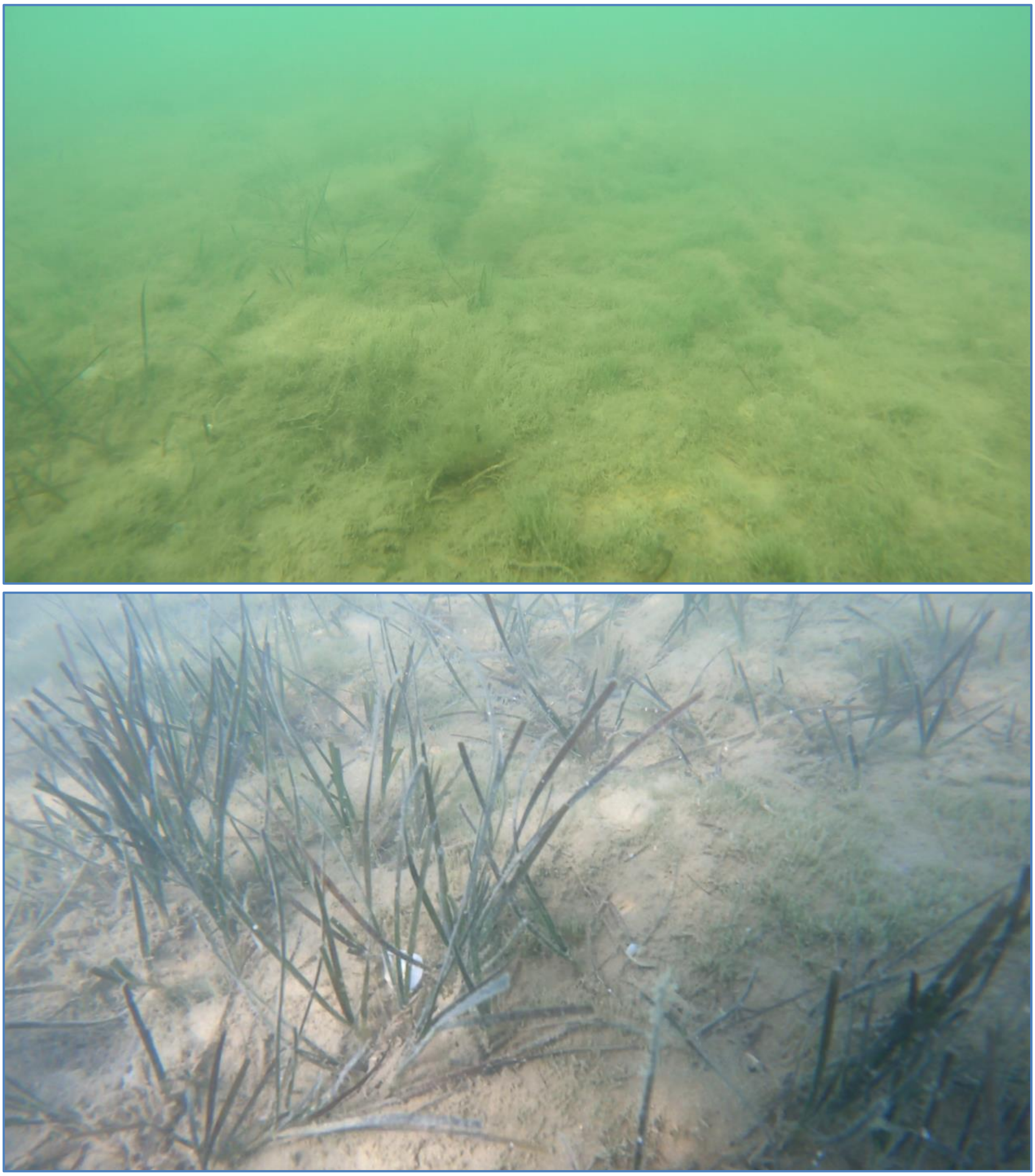

Figure 14 Habitats along jetty transect, Top; 20m off rocks sparse Zostera, Bottom; 10m off rocks dense Zostera. 20 Feb. 2023.

Figure 15 Habitats 5 m off rocks, Top; Sponges on boulders, Bottom; Invasive sea squirt. 20 Feb. 2023.

3.3 Subtidal Benthic Biota

Benthic biota sampling was undertaken using a 180 x 120mm box dredge to obtain a sample to a depth of approximately 100mm from the surface of the sediments. A single sample was taken from sites Sed A, B, C and D adjacent to the jetty and pontoon areas shown in Figure 8. The box dredge was lowered to the bottom on a rope and dragged for approximately 5m or until the dredge bit into the seabed. The dredge was then raised, and its contents poured into a clean bucket, labelled, and then sieved as soon as practical by washing each whole sample through 0.5mm mesh sieves with sea water. The material retained on the sieves was transferred to a fresh clean polyethylene zip lock bag, and preserved with a 10% glyoxal, 70% ethanol and sea water solution, sealed, placed in a second clean polyethylene zip lock bag, and packed into a labelled plastic container for transportation to the laboratory.

In the laboratory, the samples were rinsed with fresh water and placed in a white sorting tray where any organisms were picked out of the samples and placed in a labelled vial of 70% ethanol solution prior to taxonomic identification to the lowest possible level.

The results of the benthic biota sampling are presented in Table 3.1.

3.3.1 Benthic Biota

The benthic biological community found in the area adjacent to the proposed jetty and pontoon was diverse but not particularly abundant, with a total of 49 taxa recorded. The benthic biological communities found were numerically dominated by polychaete worms, particularly from the family Eunicidae. Taxa differed between sites with a greater variety and abundance recorded from site D. The offshore sites (A and B) had higher diversity index scores than the inshore sites. No non-indigenous species were found in the sediments.

Table 3.1 Qualitative Benthic Biota Data, 14 July 2021 (Dredged Samples)

Taxa	Site			
	A	B	C	D
Phylum Annelida				
Class Polychaeta				
Heteromastus filiformis	3	3	2	
Notomastus zeylanicus	4	1		13
Phyllochaetopterus socialis		1		
Cirratulidae	2	1	1	
Dorvilleidae	9	11	3	8
Eunice sp.	26	20	46	120
Glyceridae	2	1	1	1
Goniada sp.				2
Hesionidae	1		2	
Maldanidae	4	8	3	6
Nereidae (juvenile)		1		4
Nereis cricognatha				1
Oenonidae				1
Armandia maculata	5	4	1	19
Orbinia papillosa			1	
Phylo felix	1			
Myriowenia sp.				5
Owenia petersenae				8
Pectinaria australis		2		
Polynoidae				1
Euchone pallida	8	7	11	17
Sabellidae			2	
Scalibregmidae	1			
Serpula sp.			2	1
Boccardia sp.		1		
Polydora sp.				2
Prionospio multicristata	1	2		2
Syllidae	1			
Terebellidae	2	1	1	1
Phylum Arthropoda				
Class Crustacea				
Order Amphipoda				
Amphipoda Unid.	6			
Lysianassidae	1	1	2	4
Phoxocephalidae				2
Order Decapoda				
Alpheus sp.	1	1		
Halicarcinus cookii	1		1	
Order Isopoda				
Anthuridea	4			
Order Ostracoda				
Diasterope grisea			1	1
Phylum Cnidaria				
Class Anthozoa				
Edwardsia sp.		1		
Phylum Echinodermata				
Class Holothuroidea				
Trochodota dendyi				1
Class Ophiuroidea				
Ophiuroidea		4		
Phylum Mollusca				
Class Amphineura				
Rhyssoplax stangeri				1
Class Bivalvia				
Corbula zelandica	1			
Nucula hartvigiana			6	12
Class Gastropoda				
Amalda australis				1
Bulla quoyi				1
Cominella quoyana	4	4	1	
Sigapatella novaezelandiae		1		
Philine auriformis	1			
Phylum Nemertea				
Nemertea	2	1	1	
Phylum Bryozoa				
Bryozoa (encrusting)			1	
Total Number of Species/Taxa	**24**	**22**	**20**	**26**
Total Number of Individuals	**91**	**77**	**89**	**235**
Shannon- Wiener Diversity Index	**2.63**	**2.54**	**1.94**	**2.01**

3.4 Seabed Sediment Quality

Surface sediment samples were collected from sites A, B, C and D, and analysed for grain size and metals concentrations. Samples were collected from a boat with a box dredge. A sample from each site was placed in a clean bucket, homogenised and a sub-sample was retained and analysed for dry matter, total organic carbon, and metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc). An additional sample of approximately 100g of the homogenised site sample was retained and analysed for grain size. Between sample sites, the box dredge sampler was flushed and rinsed with seawater.

Raw sediment quality data from the four sites are presented and assessed against ANZECC DGV-Low Trigger values (Australian New Zealand Environment Conservation Council 2018) in Table 3.2. In Table 3.2, cells highlighted in orange have exceeded the ANZEC DGV low values, and in red have exceeded the ANZEC DGV high values. Grey text values indicate the results are less than the detection limit. The results as received from Hill Laboratories are attached in Appendix 4.

Raw grain size data for each of the four sites are attached in Appendix 4 and summarised in Table 3.3.

Table 3.2 Sediment Total Recoverable Metals Data (dry weight) (averaged)

Tests	Site				Average	ANZECC DGV	
	A	B	C	D		Low	High
Dry Matter (%)	59.0	63.0	58.0	62.0	*60.5*		
Total Organic Carbon (%)	0.75	0.89	0.98	0.53	*0.79*		
Total Recoverable Heavy metals (mg/kg dry wt)							
Arsenic	18.7	18.7	18.4	**25.0**	*20.2*	**20**	**70**
Cadmium	0.063	0.061	0.059	0.047	*0.058*	**1.5**	**10**
Chromium	11.2	11.4	11.6	10.5	*11.2*	**80**	**370**
Copper	2.7	2.5	2.7	3.2	*2.8*	**65**	**270**
Lead	5.7	5.2	5.2	5.2	*5.3*	**50**	**220**
Mercury	< 0.02	0.03	0.03	0.03	*0.03*	**0.15**	**1**
Nickel	2.3	2.3	2.4	2.5	*2.4*	**21**	**52**
Zinc	16.0	15.3	17.5	19.5	*17.1*	**200**	**410**

Table 3.3 Sediment Grain Size Data (Percentage by Weight)

Grain size		Percentage of total sample			
(mm)	Class	A	B	C	D
> 3.35	Gravel	0.0	0.0	0.0	0.0
3.35 - 2.00	Granules	0.0	0.0	0.0	0.0
2.00 - 1.18	Very Coarse Sand	2.3	0.7	0.9	1.9
1.18 - 0.600	Coarse Sand	14.0	9.0	16.1	16.9
0.600 - 0.300	Medium Sand	16.2	11.8	20.0	17.4
0.300 - 0.150	Fine Sand	10.7	8.2	10.5	11.9
0.150 - 0.063	Very Fine Sand	19.5	24.5	22.8	27.4
0.063 - 0.0313	Coarse Silt	14.1	16.5	11.4	9.2
0.0313 - 0.0156	Medium Silt	6.3	8.0	4.9	4.0
0.0156 - 0.0078	Fine Silt	6.0	8.4	5.4	4.7
0.0078 - 0.0039	Very Fine Silt	5.1	6.6	4.0	3.4
< 0.0039	Clay	5.8	6.4	4.1	3.3
< 0.063	**Silt and Clay**	**37.3**	**45.8**	**29.7**	**24.6**
Mean Size (mm)		**0.096**	**0.067**	**0.122**	**0.146**
Grain size description		zS	zS	zS	zS

3.4.1 Total Recoverable Metals

The concentrations of cadmium, chromium, copper, lead, mercury, nickel, and zinc, were less than or very similar to the background concentrations reported for Parekura and Kaingahoa bays in NRC (2016) and all below the ANZECC DGV low guideline values. The concentration of arsenic ranged from 18.4 mg/kg at site C to 25 mg/kg at site D. Arsenic exceeded the ANZECC DGV low guideline value of 20 mg/kg at one of the four sites. The elevated concentrations are likely the result of naturally elevated arsenic concentrations in the soils of the region (Christie and Barker, 2007).

3.4.2 Total Organic Carbon

The concentrations of total organic carbon were less than or very similar to the background concentrations reported for Parekura and Kaingahoa bays in NRC (2016).

3.4.3 Grain Size

Sediment at all sites contained low to moderate proportions (25 - 50%) of silt and clay. The sediment at all sites were described as silty Sand (zS).

4. ASSESSMENT OF MARINE ECOLOGICAL EFFECTS

The effects of the project on the ecology of the intertidal area can be divided into construction effects and operational effects.

The primary construction effects are the temporary loss of habitat through access to the construction area and permanent loss of habitat from piling for the jetty. Disturbance to subtidal habitats from the drilling or driving of piles, with the potential for the release of sediment, and creation of underwater noise when piling in the subtidal area are also expected during construction.

For the construction of the intertidal sections of the jetty, the works are proposed to be carried out from the land, with access through the intertidal zone, and assisted by floating lifting equipment where required. Some intertidal flora and fauna in the local area will be impacted. However, the generation of sediment during installation of piles in the intertidal zone will be very low on the hard platform areas provided any excavated substrate is not left in mounds. The species present in the intertidal area are common in the local environment and region. Any species impacted are likely to re-colonise the immediate surroundings of the jetty in the months after construction ends. Pilling and construction of the offshore sections will be conducted by floating barge. The holes for the new piles will be drilled and driven (depending on what is found under the surface with an 8-12t digger mounted on floating plant). During piling operations, a leader mounted drop hammer will be used on a TMS barge mounted crane. During drilling the visual clarity and plume will be monitored, and drilling will be stopped if this alters significantly from the background level. H6 Timber piles will be used. They will be fitted with plastic sleeves. Sand will be used to fill between the pile and the sleeve.

Dredging is not proposed for this project, therefore, there will be no loss of the poor quality *Zostera* habitat, thus the wider scale effects of construction will be less than minor.

Habitat disturbance will occur during installation of the subtidal piles. These activities will cause disturbance of the habitat through habitat removal, resuspension of sediment and vibration/noise. The removal of seabed habitat will result in a very small area (<1 m^2) of habitat loss. Re-suspended sediment has the potential to temporarily adversely affect organisms that use vision to detect prey or predators, and those organisms that filter feed. Sediment quality sampling shows the sediment is generally low in contaminant concentrations, with the exception of arsenic, which is naturally elevated. Thus, there will be little or no effects from the release of contaminants as a result of disturbance of sediments. The relatively low percentage of silt and clay sized particles means elevated suspended solids in the water will likely be low and not spread far from the works area. The benthic biota recorded in the sediments of the adjacent to the jetty and pontoon area are not particularly diverse, unusual, or abundant, thus their removal during pilling will cause negligible effects. The biota are expected to recolonise the small area of affected seabed quickly with biota back to similar diversity within a year. Depending on the level of extreme peak noise and vibrations created during pilling, this could cause mobile organisms (e.g., fish and potential marine mammals) to avoid the area and may cause sessile organisms to cease feeding. Both types of disturbance are expected to be temporary and short term. Impacts to marine mammals can be limited by use of conditions to cease activity when mammals are close and insight.

5. CONCLUSION

The ecological values of the footprint of the proposed jetty and floating pontoon are common to the region. The effects to the intertidal area of the proposed jetty will be less then minor and temporary in nature assuming appropriate construction methods are followed.

The area under and adjacent to the pontoon contains poor quality *Zostera* at densities less than that deemed to form a bed and provide any meaningful ecological function. The effects of pilling and construction are assessed as less than minor and temporary in nature. The disturbance of the seabed will result in the loss of a very small (<1m²) area of habitat which will undergo recolonisation with similar biota currently present, following completion of the project.

Other existing similar jetty structures in the Bay of Islands have dense beds of *Zostera* under and nearby. Thus, the habitats present within and adjacent to the jetty and pontoon footprints are not expected to be significantly adversely affected by the occupation of the area by these structures.

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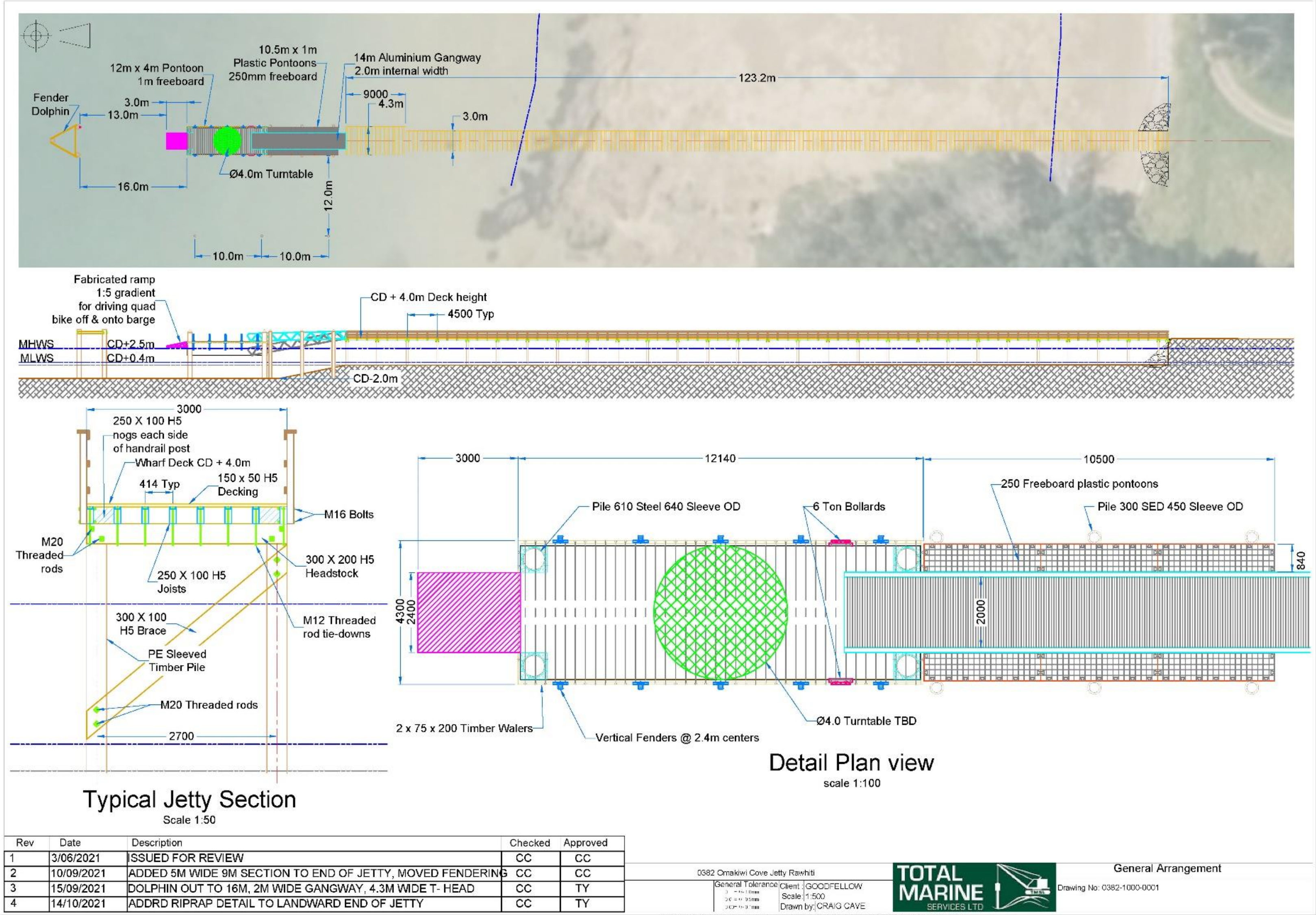
7. APPENDICES

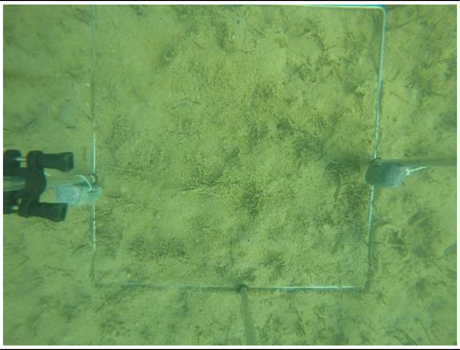
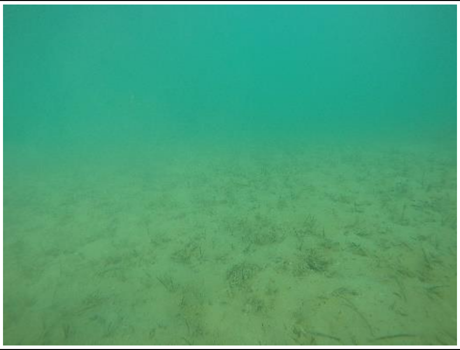
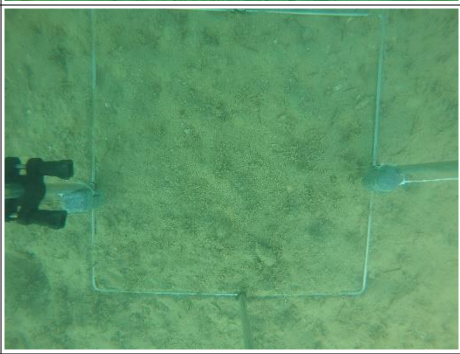
Appendix 1. General Arrangement Plan (14/10/21).

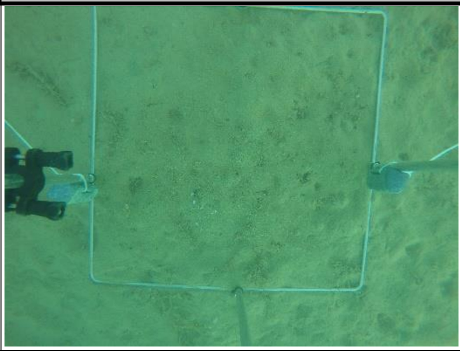


Appendix 2 Marine macro-biota observed during the site visit (10/06/2021)

Common Name	Scientific Name	Abundance
Mid intertidal		
Rock oysters	*Saccostrea glomerata*	Occasional
Black Nerita	*Nerita melanotragus*	Occasional
NZ cockles	*Austrovenus stutchburyi*	Abundant in narrow depressions in rock
Dark top shell	*Diloma aethiops*	Common
Lower intertidal		
Rock oysters	*Saccostrea glomerata*	Common
Black Nerita	*Nerita melanotragus*	Common
Dark top shell	*Diloma aethiops*	Occasional
Chiton	*Chiton glaucus*	Occasional
Leathery sea slug	*Onchidella nigricans*	Rare
Grey sponge	*unidentified*	Rare
Neptune's Necklace	*Hormosira banksii*	occasional
Lower intertidal – elevated reef at the low tide mark		
Neptune's Necklace	*Hormosira banksii*	Abundant
Coralline algae	*Corallina officinalis*	Abundant
Carpophyllum seaweed	*Carpophyllum flexuosum*	Abundant on the subtidal edge
Catseye	*Lunella smaragda*	Abundant
Chiton	*Chiton glaucus*	Occasional
Spotted whelk	*Cominella maculosa*	Rare
Zostera	*Zostera muelleri*	Occasional
Red rust bryozoan	*Watersipora subtorquata*	Occasional

Appendix 3. Subtidal photos North and South of proposed Jetty Pontoon.

Location name	Seafloor photo	Side photo	Zostera presence and density
North of Pontoon (Z3) 14 July 2021			Sparse
North of Pontoon (Sed C) 14 July 2021			Sparse
North of Pontoon (Z2) 14 July 2021			Sparse
South of Pontoon (Sed D) 14 July 2021			Sparse

Location name	Seafloor photo	Side photo	Zostera presence and density
North of Jetty (Z1) 14 July 2021			None visible

Appendix 4 Laboratory Results

Hill Laboratories
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R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

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T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis

Page 1 of 2

Client:	Bioresearches	**Lab No:**	2659793 SPv1
Contact:	S West	**Date Received:**	20-Jul-2021
	C/- Bioresearches	**Date Reported:**	30-Jul-2021
	PO Box 2828	**Quote No:**	
	Auckland 1140	**Order No:**	
		Client Reference:	64577
		Add. Client Ref:	Omakiwi Jetty - Dredging
		Submitted By:	S West

Sample Type: Sediment

Sample Name:		Sed-A 14-Jul-2021 10:00 am	Sed-B 14-Jul-2021 10:05 am	Sed-C 14-Jul-2021 10:25 am	Sed-D 14-Jul-2021 10:30 am	
Lab Number:		2659793.1	2659793.2	2659793.3	2659793.4	
Individual Tests						
Dry Matter	g/100g as rcvd	59	63	58	62	-
Particle size analysis*‡		See attached report	See attached report	See attached report	See attached report	-
Total Organic Carbon*	g/100g dry wt	0.75	0.89	0.98	0.53	-
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	18.7	18.7	18.4	25	-
Total Recoverable Cadmium	mg/kg dry wt	0.063	0.061	0.059	0.047	-
Total Recoverable Chromium	mg/kg dry wt	11.2	11.4	11.6	10.5	-
Total Recoverable Copper	mg/kg dry wt	2.7	2.5	2.7	3.2	-
Total Recoverable Lead	mg/kg dry wt	5.7	5.2	5.2	5.2	-
Total Recoverable Mercury	mg/kg dry wt	< 0.02	0.03	0.03	0.03	-
Total Recoverable Nickel	mg/kg dry wt	2.3	2.3	2.4	2.5	-
Total Recoverable Zinc	mg/kg dry wt	16.0	15.3	17.5	19.5	-

Analyst's Comments

‡ Analysis subcontracted to an external provider. Refer to the Summary of Methods section for more details.

Appendix No.1 - Waikato University Report

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
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-4
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%.	-	1-4
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, trace level.	0.010 - 0.8 mg/kg dry wt	1-4
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	1-4
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-4

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Sample Type: Sediment			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Particle size analysis*	Malvern Laser Sizer particle size analysis from 0.05 microns to 3.4 mm. Samples are measured in volume %. Subcontracted to Earth Sciences Department, Waikato University, Hamilton.	-	1-4
Total Organic Carbon*	Acid pretreatment to remove carbonates present followed by Catalytic Combustion (900°C, O2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	1-4

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

Testing was completed between 21-Jul-2021 and 30-Jul-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.

Ara Heron BSc (Tech)
Client Services Manager - Environmental

Bioresearches
A Babbage Company

Analysis - Under

Malvern Instruments

Malvern

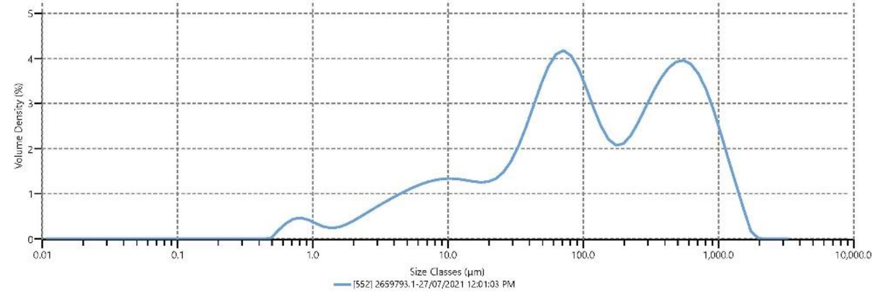
Measurement Details	
Sample Name	2659793.1
SOP File Name	Sediment.msop
Lab Number	2021177/1
Operator Name	hharveyw

Measurement Details	
Analysis Date Time	27/07/2021 12:01:03 PM
Measurement Date Time	27/07/2021 12:01:03 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.33 %
Laser Obscuration	13.80 %

Result	
Concentration	0.0313 %
Span	7.351
Uniformity	2.226
Specific Surface Area	390.8 m²/kg
D [3,2]	15.4 μm
D [4,3]	268 μm
Dv (10)	6.99 μm
Dv (50)	103 μm
Dv (90)	765 μm
Volume Below (10) μm	13.06 %
Volume Below (20) μm	18.92 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	10.91	88.0	46.22	350	70.64	1410	99.21
0.0600	0.00	15.6	16.87	105	50.40	420	74.96	1680	99.92
0.120	0.00	31.0	23.13	125	53.89	500	79.36	2000	100.00
0.240	0.00	37.0	25.61	149	56.71	590	83.64	2380	100.00
0.490	0.00	44.0	28.70	177	59.10	710	88.24	2830	100.00
0.980	1.55	53.0	32.81	210	61.43	840	92.03	3360	100.00
2.00	2.93	63.0	37.26	250	64.12	1000	95.28		
3.90	5.81	74.0	41.63	300	67.42	1190	97.66		

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Analysis - Under

Malvern Instruments Malvern

Measurement Details

Sample Name 2659793.2
SOP File Name Sediment.msop
Lab Number 2021177/2
Operator Name hharveyw

Measurement Details

Analysis Date Time 27/07/2021 12:09:11 PM
Measurement Date Time 27/07/2021 12:09:11 PM
Result Source Measurement

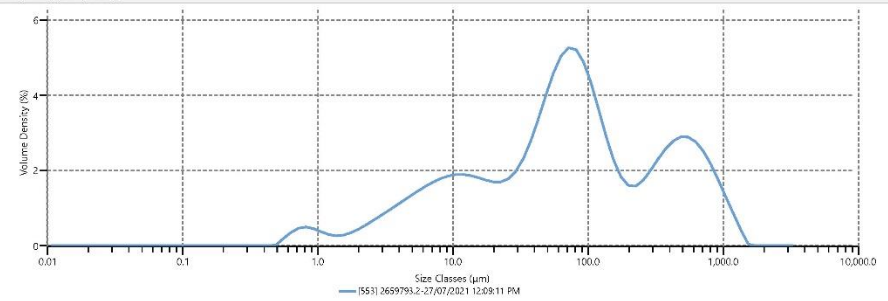
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.33 %
Laser Obscuration 16.80 %

Result

Concentration 0.0335 %
Span 8.059
Uniformity 2.193
Specific Surface Area 448.5 m²/kg
D [3,2] 13.4 μm
D [4,3] 184 μm
Dv (10) 5.92 μm
Dv (50) 71.3 μm
Dv (90) 580 μm
Volume Below (10) μm 15.95 %
Volume Below (20) μm 24.20 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	12.98	88.0	57.19	350	80.79	1410	99.96
0.0600	0.00	15.6	21.38	105	62.61	420	83.94	1680	100.00
0.120	0.00	31.0	29.33	125	67.04	500	87.19	2000	100.00
0.240	0.00	37.0	32.13	149	70.30	590	90.31	2380	100.00
0.490	0.00	44.0	35.64	177	72.61	710	93.55	2830	100.00
0.980	1.62	53.0	40.44	210	74.45	840	96.08	3360	100.00
2.00	3.12	63.0	45.84	250	76.28	1000	98.06		
3.90	6.43	74.0	51.30	300	78.52	1190	99.33		

Analysis - Under

Malvern Instruments Malvern

Measurement Details

Sample Name 2659793.3
SOP File Name Sediment.msop
Lab Number 2021177/3
Operator Name hharveyw

Measurement Details

Analysis Date Time 27/07/2021 12:17:27 PM
Measurement Date Time 27/07/2021 12:17:27 PM
Result Source Measurement

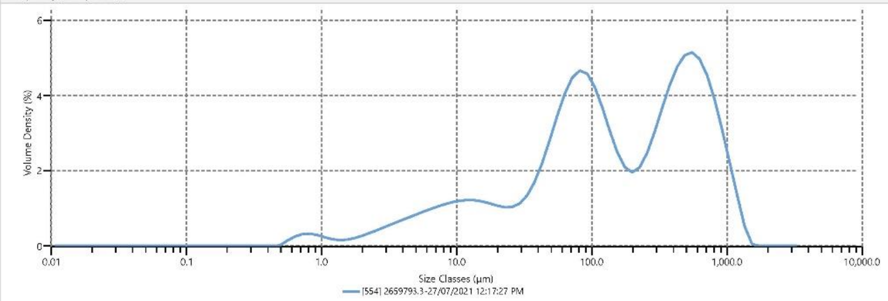
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.30 %
Laser Obscuration 20.94 %

Result

Concentration 0.0652 %
Span 5.572
Uniformity 1.747
Specific Surface Area 295.4 m²/kg
D [3,2] 20.3 μm
D [4,3] 280 μm
Dv (10) 10.1 μm
Dv (50) 131 μm
Dv (90) 737 μm
Volume Below (10) μm 9.95 %
Volume Below (20) μm 15.28 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	8.09	88.0	39.51	350	66.60	1410	99.95
0.0600	0.00	15.6	13.46	105	44.66	420	71.83	1680	100.00
0.120	0.00	31.0	18.31	125	49.08	500	77.47	2000	100.00
0.240	0.00	37.0	19.95	149	52.51	590	83.03	2380	100.00
0.490	0.00	44.0	22.17	177	55.10	710	88.87	2830	100.00
0.980	1.09	53.0	25.53	210	57.30	840	93.43	3360	100.00
2.00	2.00	63.0	29.70	250	59.75	1000	96.94		
3.90	4.06	74.0	34.25	300	63.04	1190	99.08		

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Analysis - Under

Malvern Instruments

Malvern

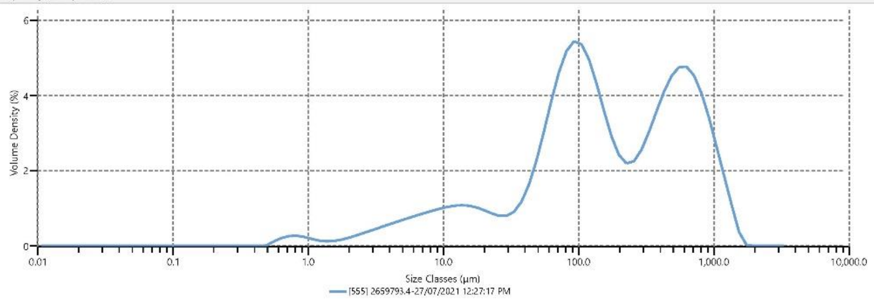
Measurement Details	
Sample Name	2659793.4
SOP File Name	Sediment.msop
Lab Number	2021177/4
Operator Name	hharveyw

Measurement Details	
Analysis Date Time	27/07/2021 12:27:17 PM
Measurement Date Time	27/07/2021 12:27:17 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.26 %
Laser Obscuration	22.08 %

Result	
Concentration	0.0813 %
Span	5.632
Uniformity	1.709
Specific Surface Area	251.5 m²/kg
D [3,2]	23.9 µm
D [4,3]	298 µm
Dv (10)	12.9 µm
Dv (50)	138 µm
Dv (90)	792 µm
Volume Below (10) µm	8.25 %
Volume Below (20) µm	12.98 %

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	6.68	88.0	34.99	350	66.74	1410	99.61
0.0600	0.00	15.6	11.34	105	41.26	420	71.16	1680	100.00
0.120	0.00	31.0	15.37	125	47.09	500	76.10	2000	100.00
0.240	0.00	37.0	16.48	149	51.94	590	81.21	2380	100.00
0.490	0.00	44.0	18.07	177	55.61	710	86.90	2830	100.00
0.980	0.91	53.0	20.78	210	58.45	840	91.57	3360	100.00
2.00	1.64	63.0	24.59	250	60.94	1000	95.44		
3.90	3.33	74.0	29.17	300	63.80	1190	98.09		

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