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Ecological Assessment: Doug's Opua Boatyard

For Doug Schmuck

Assessment of ecological effects for proposed dredging and structural works

July 2018

REPORT INFORMATION AND QUALITY CONTROL

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1 INTRODUCTION

Doug's Opua Boatyard (DOB) has been in operation under existing consent conditions for many years and has applied for resource consent to make improvements to the boatyard infrastructure. DOB is seeking renewal of existing discharge consents and new consents for activities including demolition and reconstruction of an existing jetty, formation of two mudcrete grids, refurbishment of the existing slipway, the use of two jetty facility berths as a marina, and disturbance of the foreshore during demolition and construction activities. New capital and maintenance dredging is proposed to form five all-tide berths and an approach channel to the jetty and slipway. Installation of a subsurface erosion barrier is proposed to avoid any potential for erosion of the beach as a result of the dredging.

4Sight Consulting Ltd. (4Sight) has been engaged to conduct an ecological survey as the basis for an assessment of ecological and water quality effects in relation to those proposed activities.

The boatyard is located in a small embayment ~200 to 300 m west of the Opua Wharf and Car Ferry Terminal (Figure 1). The coastal marine area at this location is designated as Marine 4 (Mooring) Management Area under the Northland Regional Council's (NRC) Coastal Plan. Under Rules 31.6.3 k and l, and 31.6.7 b of the Plan, the structural and dredging works are designated as Discretionary activities.

The proposed dredging footprint covers an area of approximately 4460 m^2 of intertidal and subtidal sediment extending from the beach at the slipway approximately 130 m in a northeasterly direction toward the Veronica Channel (Figure 2). Dredging will be conducted by Total Marine Services using a barge-mounted long reach digger and hopper barge. It is estimated that 4265 m^3 of dredge spoil material will be removed, and all dredged material will be barged to an approved dumpsite for disposal on land. Some disturbance to a small area of the beach and foreshore is expected shoreward of the proposed dredge footprint during construction of the new jetty and refurbishment of the slipway.

2 STUDY OBJECTIVES

2.1 General description of the environment

A general description of the boatyard location and immediate vicinity in order to provide context for the surveys.

2.2 Sediments

Sediment quality was surveyed to establish the levels of a suite of heavy metal contaminants (including metals such as copper and zinc that are commonly associated with boatyards and slipways) within sediments in three broad zones. These were:

a) the immediate vicinity of the slipway facility being the zone most likely to have accumulated contaminants from boatyard activities;

b) within the area to be disturbed by the proposed structural and dredging works;

c) at reference positions outside of the area intended to be dredged, and at some distance from the slipway.

Together with sediment contaminant levels, determination of sediment grain size distribution was also made to assist in assessing the potential effects on water quality during dredging operation.

2.3 Subtidal and intertidal biota

A survey of intertidal and subtidal biota within the proposed dredge area and vicinity was conducted to describe the habitats and communities potentially affected by the proposed structural and dredging operations. The survey focussed on the infaunal community (animals living within sediments), epifauna (large bodied animals on the sediment surface) and the rocky intertidal habitat at the northern and southern ends of the embayment where the boatyard is situated.

2.4 Edible shellfish bed

A previous survey conducted in March 2018 characterised the edible shellfish population on the beach adjacent to Doug's Opua Boatyard (Brown, 2018). The results of that survey are summarised in this report, and further work was conducted in the present survey to determine concentrations of heavy metal contaminants in the shellfish. The purpose of surveying the shellfish bed was to gauge its status in terms of broad population structure, and to determine if the shellfish flesh was contaminated with heavy metals originating from the boatyard activity.

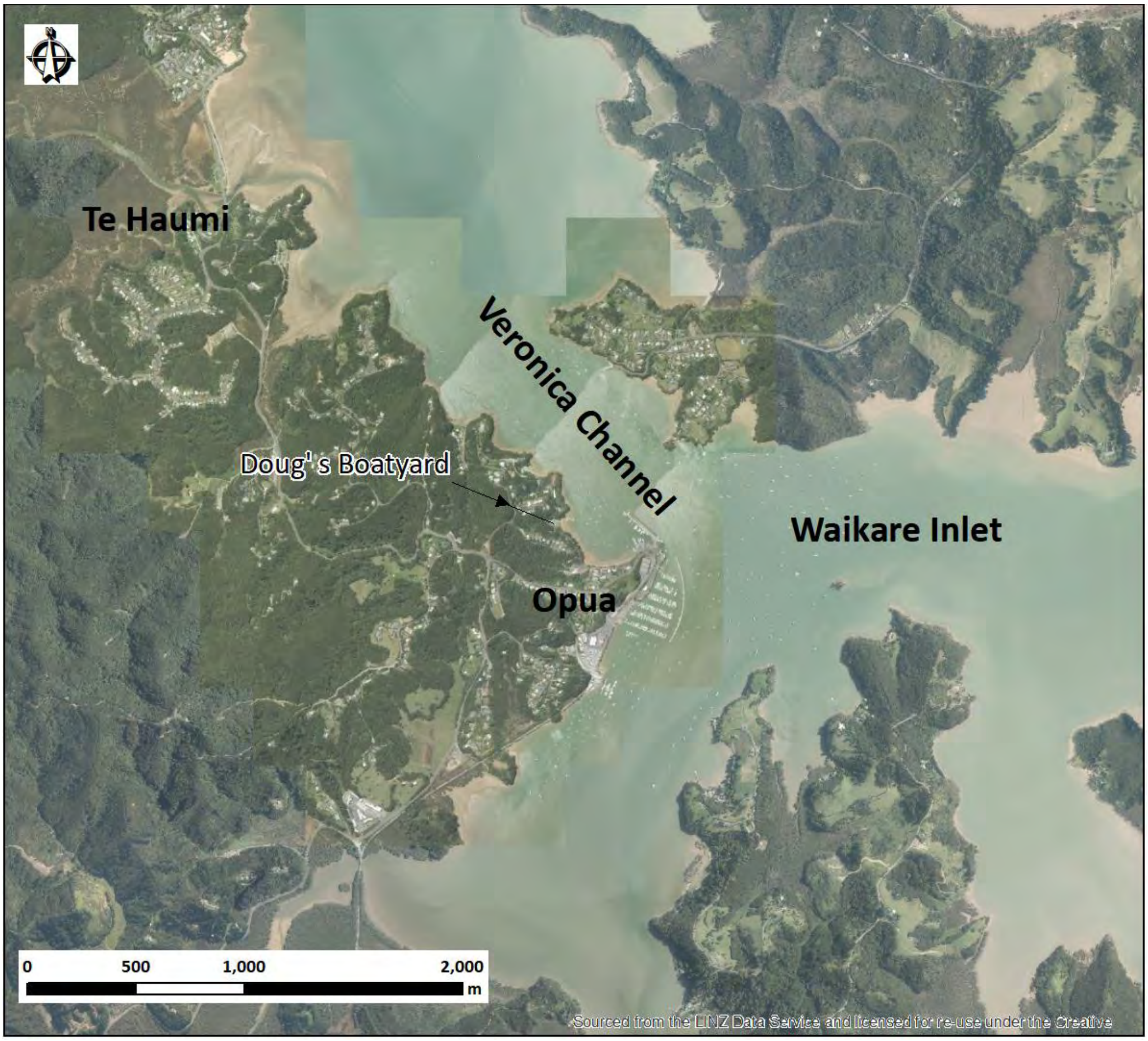

Figure 1: Map showing location of Doug's Opua Boatyard

2.5 Hydrodynamics

To gauge the likely movement of turbid water carrying fine sediment particles produced by the dredging activity a desktop search of available information was undertaken, and opportunistic field observations of surface currents were conducted at the site during the field survey.

3 METHODS

An ecological survey of the site was conducted on 31/5/18 by two qualified 4Sight staff working from 4Sight's alloy work vessel. Sample positions were all established and recorded using a handheld Garmin GPS. Supplementary information from a previous survey of the shellfish population (Brown, 2018) was also used in the preparation of this report.

3.1 Sediments

To assess the level of heavy metal contaminants in sediments, surficial sediment samples were collected at:

- Four subtidal sites: S1, S2 and S3 within the proposed area to be dredged, and at a reference site SC (Figure 2)
- Four intertidal sites: ISL (slipway), I3 (south of slipway), M (site of the proposed mudcrete grid), and I5 (northern headland outside the proposed dredge area) (Figure 2).

Each sample comprised a composite of three subsamples to ensure samples were representative of the contaminant level at each site. Subtidal samples were collected using a modified anchor box dredge. Samples were frozen and then couriered to Hills Laboratories for analysis of heavy metal content (Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel and Zinc). Intertidal sediment samples were collected using a plastic trowel. Each of the sediment samples was transferred to a 500 ml plastic container for transport to the laboratory for analysis.

Each box dredge sample was visually assessed, and a representative photograph was taken to enable description of the sediment type within the proposed dredge area. Representative sediment samples collected at sites S1, S3 and SC from within the proposed dredge footprint were delivered to GeoCivil Engineering laboratory for analysis of sediment grain size distribution.

3.2 Biota

Samples to describe infaunal communities (animals living within the sediments) within and near the area proposed to be dredged were collected at 4 subtidal sites (S1, S2, S3 and SC, Figure 2) using a box dredge (sample volume 5230 cm^3) and at 4 intertidal sites (ISL, M, I3 and I5) using a spade (sample area 14 cm x 14 cm, volume 1,960 cm^3). Samples were preserved in 70% Ethanol before being sent to Gary Stephenson of Coastal Marine Ecology Consultants for faunal identification to the lowest practical taxonomic denomination.

Two dredge tows were conducted using a modified scallop dredge (Epifauna dredge) (mouth width 60 cm, mesh size 6 mm) to collect epifaunal samples (samples of larger-bodied animals living on the sediment surface) in the same area. Epifauna was identified at the site at the time of sampling.

To survey rocky intertidal habitat a 15 m transect line was laid from a fixed location (Figure 2) and quadrats (0.5 x 0.5 m) were positioned at 0, 5, 10 and 15 m along the transect. The percentage cover of algal species and the identity and numbers of macrofaunal organisms was recorded within each quadrat.

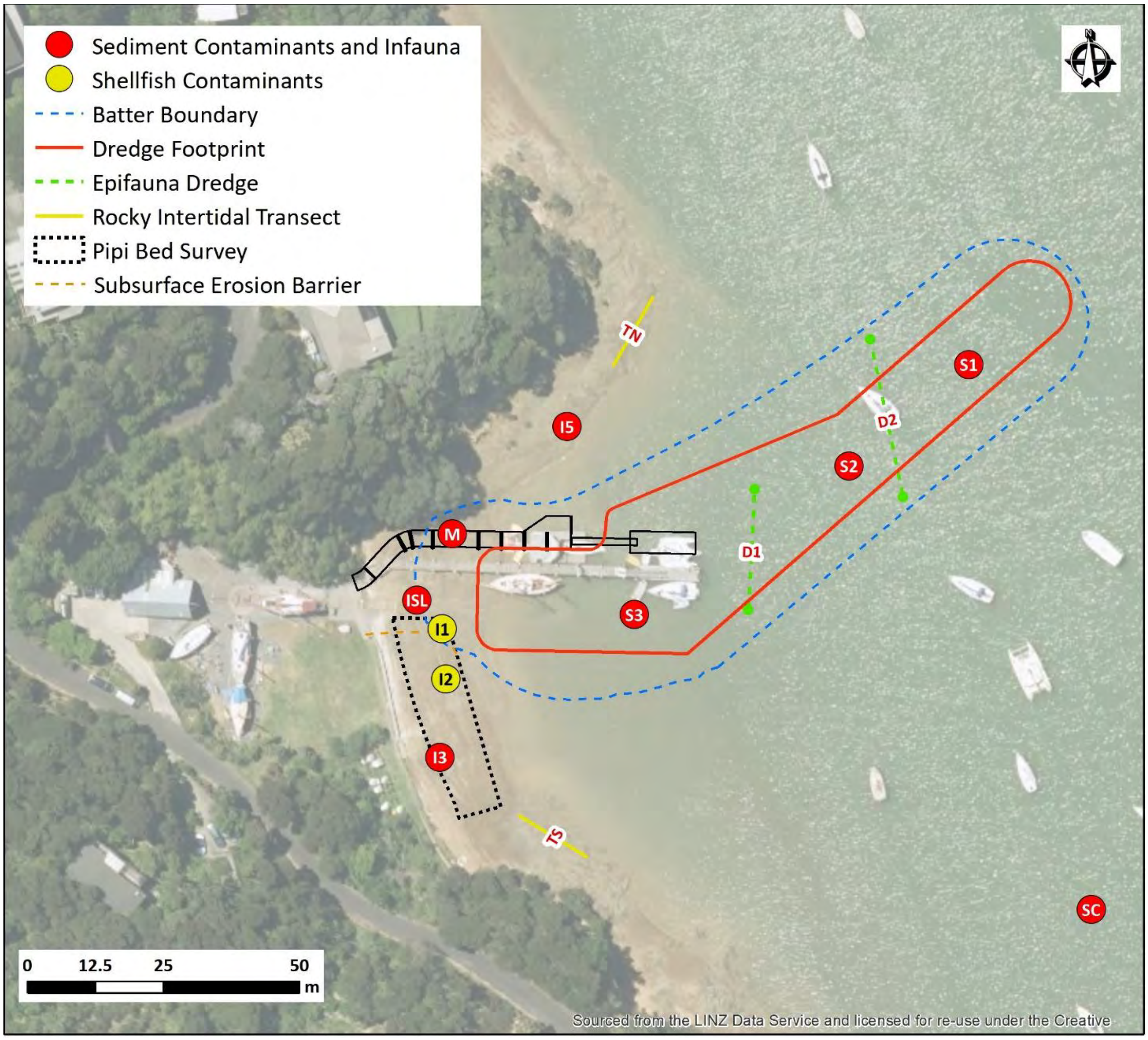

Figure 2: Map showing position of proposed structures, proposed area to be dredged and survey sample positions

3.3 Edible shellfish

3.3.1 Characterisation of shellfish bed

A survey was conducted on 14 March 2018 to broadly determine the status of edible shellfish on the beach adjacent to the boatyard. Ten shellfish samples were collected from the intertidal zone on the beach where the boatyard is located (Brown 2018). The general zone where shellfish were known to be present was initially identified by the boatyard owner Mr Doug Schmuck and confirmed by the 4Sight investigator prior to conducting the sampling. The area to be sampled (stratum) was defined by GPS corner points (pipi bed in Figure 2) and 10 sample stations were successively and haphazardly placed within the defined area (by randomly tossing an object over-shoulder to determine next sample position).

Each sample unit consisted of a 28 x 28 cm quadrat (area of 0.078 m^2) dug to a depth of ~15 cm. The contents were passed through a 2 mm aperture sieve. All individuals of the target species retained on the sieve were identified, counted, and measured across their widest axis to the nearest millimetre.

3.3.2 Contaminants in shellfish flesh

Approximately 30 individual edible shellfish of *Paphies australis* (pipis) were collected from each of 3 sites:

- Site **IS** - at the boatyard slipway
- Site **I2** representative of the middle of the edible shellfish population where pipis were dense and there was a high proportion of large individuals.
- Site **TH** – a reference or control site in the intertidal zone of the beach at Te Haumi (Figure 1), a location approximately 2.2 km northwest of Doug's Boatyard that is known to support a large pipi bed.

3.4 Hydrodynamics

A desktop search was undertaken to access available information regarding currents in the vicinity of the boatyard and the wider environment including the Veronica Channel.

That information was supplemented with opportunistic field observations using oranges as a form of drogue to determine water movement in the surface layer at one point in time during the field survey. Oranges are suitable for assessing surface water movement velocity due to their low surface signature and high visibility. The start and end positions of three 'drogue oranges' numbered with indelible marker deployed in the vicinity of the proposed dredge area for ~30 minutes during the first quarter of the ebb tide were recorded to determine the velocity (speed and direction) of the surface layer of the water. At the time of deployment, a light breeze (~4 to 5 knots) was blowing from the south east.

4 RESULTS

4.1 General site description

The boatyard is in a sheltered embayment known as Walls Bay close to the main commercial area of the Port of Opua, approximately 250 m from the Opua main wharf and 300 m from the Opua car ferry landing.

The slipway and jetty are located at the northern end of the beach adjacent to Richardson St, within the wider bay at Opua (Figures 1, 2, 3 and 4). The beach is approximately 60 m in length and at either end of the embayment there is a rocky point extending into the subtidal zone. The beach is moderately steep and coarse grained. There is a small retaining wall at the top of the beach, the base of which is approximately at the high tide mark. Landward of the beach is a grassed area

4.1.1 Foreshore vegetation

Landward of the beach and immediately adjacent to the boatyard there is a grassed area forming part of the Walls Bay Esplanade Reserve, administered by the Far North District Council. At the northern end of the beach a large pohutukawa (*Metrosideros excelsa*) (can be seen in Figure 3) is located adjacent to the proposed mudcrete grid. A range of other vegetation including manuka (*Leptospermum scoparium*), various adventive species such as tobacco weed (*Solanum mauritianum*) and wattle (*Acacia lophantha*) and scattered individuals of mangrove (*Avicennia marina*) are present on the slope immediately above the intertidal zone.

A similar collection of trees and shrubs including manuka, wattle, and tobacco weed occupy the headland at the south end of the beach and southernmost end of the reserve (Figure 4).

Figure 3: View from south end of beach looking north: Beach, slipway and existing jetty

4.2 Sediments

4.2.1 Sediment physical characteristics

The substratum in the upper 1-2 m of the shore is comprised mostly of sand and gravel with a high proportion of whole dead shell (mostly pipis *Paphies australis* and also some pacific oyster *Crassostrea gigas* shell). The substratum in the mid intertidal zone comprises sand, gravel and shell gravel. The gravel component of the sediment increases in the mid and lower intertidal and the low intertidal is comprised of coarser gravel and sand overlaying muddy sand. In the very low intertidal zone a layer of fine silty mud overlays the coarser gravel and sand and muddy sand (Figure 4).

Results of grain size analysis of subtidal sediment samples collected at sites S1, S3, and SC are presented in Appendix A and summarised in Table 1.

Table 1: Results of sediment grain size analysis

Site	% Gravel (>2 mm)	% Sand (2 mm - 0.063 mm)	% Mud (<0.063 mm)
S1	4	57	39
S3	6	71	23
SC	2	52	46

Figure 4: View from north end of beach looking south at low tide: slipway and beach at low tide

Figure 4: View from north end of beach looking south at low tide: slipway and beach at low tide

4.2.2 Heavy Metals (Contaminants)

The analysis of heavy metals in sediment samples is reported in Appendix B. Table 2 summarizes the heavy metal concentration results in relation to ANZECC (2000) Interim Sediment Quality Guidelines and the Canadian Sediment Quality Guidelines Threshold Effect Level (TEL). Each set of guidelines provide concentration threshold values, above which adverse biological effects are likely to occur. ANZECC ISQG Low trigger values indicate level at which there is a 10% risk of an effect on living organisms based on toxicological testing and ANZECC ISQG High trigger values indicate levels at which there is a 50% chance of an effect on organisms used in toxicological testing. The Northland Regional Council (NRC) compares results from their State of the Environment (SoE) sediment monitoring programme to both the ANZECC and CCME guidelines, however recommends that the more conservative CCME TEL values be used as the standard set of guideline values (Bamford, 2016).

Concentrations of cadmium, chromium and nickel at all sites were below CCME TEL and ANZECC ISQG threshold values. Levels of arsenic and mercury exceeded CCME TEL and ANZECC ISQG Low threshold values at all sites, but the concentrations were consistent across the sites and the relatively high levels of those metals are likely to be related to catchment geology rather than a result of anthropogenic factors. Similar elevated levels of arsenic and mercury likely to be of natural origin have been found in coastal sediments at other sites in the Bay of Islands (e.g. Brown 2018b).

The metals most commonly found in sediments associated with boatyard and slipway activities are copper and zinc. Of the subtidal sites sampled, only Site S3 closest to the slipway exhibited an elevated level of copper. The copper concentration there exceeded the CCME guideline value but was less than the ANZECC ISQG Low threshold value. Concentrations of both copper and zinc exceeded the ANZECC ISQG High threshold in sediment sampled at the slipway site (ISL). At site M copper levels in sediments also exceeded the ANZECC ISQG high threshold, and zinc concentration there was greater than the ISQG Low value. Copper and zinc concentrations were both above the ANZECC ISQG Low trigger value at site I3. At site I5 copper concentration was greater than the CCME TEL guideline value but less than the ANZECC ISQG Low value. Lead concentration exceeded the ANZECC ISQG low guideline value at sites ISL, M and I3.

In summary: Heavy metal contaminants copper and zinc that are commonly associated with boatyards and slipways were highly elevated at the slipway intertidal site (ISL). There was evidence of heavy metal contamination of beach sediments, in a decreasing gradient with increasing distance away from the slipway. Lead concentrations were also high at the intertidal sites closest to the slipway. Subtidal sediments sampled near the base of the slipway (Site S3) showed slightly elevated copper but more distant points within the proposed dredge area did not exhibit elevated heavy metal concentrations.

Table 2: Results of analysis of heavy metals in sediments

Heavy metals (mg/kg dry wt)	Sample Sites								CCME TEL	ANZECC ISQG LOW	ANZECC ISQG HIGH
	S1	S2	S3	SC	ISL	M	I3	I5			
Arsenic	21	23	32	21	37	25	30	27	7.24	20.00	70
Cadmium	0.028	0.027	0.03	0.025	0.064	0.034	0.025	0.049	0.70	1.50	10
Chromium	14.1	15.3	17	15.1	12.3	9.5	13.1	11.5	52.30	80.00	370
Copper	10.7	12.1	35	11.7	370	320	230	29	18.70	65.00	270
Lead	10	10.3	15.7	10.4	67	53	68	23	30.20	50.00	220
Mercury	0.27	0.35	0.41	0.33	0.21	0.12	0.21	0.21	0.13	0.15	1
Nickel	7.2	8.3	8.6	7.5	14.3	10.6	10.1	13.3	15.80	21.00	52
Zinc	82	90	120	85	430	260	210	113	124.00	200.00	410

4.3 Hydrodynamics and sediment transport

Three 'drogue oranges' were deployed between 10:30 and 10:35 am and recovered between 11:09 and 11:15 am. During that period the tide was ebbing and there was a light breeze (~4 to 5 knots) from the southeast. Thus the wind direction was reinforcing the predominant tidal set to the northwest. Two of the oranges drifted 55 m and 80 m respectively in a northwest direction, before beaching on the headland at the northern end of the embayment. The third drogue (orange) travelled 150 m in a northwesterly direction at an average speed of 6.95 cm/s. The drogue velocities were consistent with the relatively low current speed in that vicinity as predicted by hydrodynamic modelling produced as part of an assessment of currents and sediment transport in 2013 (Appendix C) (Met Ocean Solutions Ltd., 2013), and with the influence in near-surface waters of the light southeast wind at the time of deployment.

Modelling of tidal currents by MetOcean Solutions (2013) indicates that peak tidal flows in the vicinity of DOB are generally <5 cm/s (Appendix C (a)), and modelling of sediment transport capacity (Appendix C (b)) predicts minimal potential for sediment transport. The relatively low current speeds and limited sediment transport capacity shown in the modelling study together with the observed current movement indicate that there is only limited potential for dredge spoil material and fine sediment disturbed by the proposed dredging activity to disperse beyond the close vicinity of the operations.

4.4 Biota

4.4.1 Subtidal Infauna

A total of 43 separate infaunal taxa were identified within samples collected from the subtidal zone (Appendix D). The mean number of taxa per sample (taxonomic richness) was 25.0 ± 4.5 (95%CI) and the mean number of individuals per sample (abundance) was 226 ± 116 (95%CI). Values for the taxonomic richness and abundance in each sample are shown in Table 3. This is similar to the diversity reported within the subtidal area of the Opua Marina expansion nearby which used the same sampling approach and recorded a total of 36 taxa (Poynter & Associates, 2014).

Table 3: Taxonomic richness and abundance in samples from each subtidal site

	S1	S2	S3	SC
No. of taxa	28	24	29	19
No. of individuals	210	201	388	104

The dominant species in the subtidal infaunal community were the introduced bivalve mollusc known as the rice shell (*Theora lubrica*), and representatives from several families of polychaete worms (Ophelidae, Maldanidae, Capitellidae and Spionidae). All the taxa encountered were considered typical and widespread in soft sediment shallow subtidal habitat in Bay of Islands and around much of the New Zealand coast.

4.4.2 Intertidal Infauna

Eighteen separate taxa were identified in the samples from the intertidal zone (Appendix D). The mean number of taxa per sample (taxonomic richness) was 7.5 ± 2.3 (95%CI) and the number of individuals per sample (abundance) ranged widely from 9 at site M to 140 at site I5. The high abundance at that site was due to large numbers of the Spionid polychaete *Aonides trifida* (Appendix D). Values for the taxonomic richness and abundance in each sample are shown in Table 4.

Table 4: Taxonomic richness and abundance in samples from each intertidal site

	ISL	M	I3	I5
No. of taxa	11	6	7	6
No. of individuals	20	9	11	140

The most commonly sampled species in the intertidal infaunal community were the pipi (*Paphies australis*), and polychaete worms from the families Syllidae, Capitellidae and Spionidae. The spionid worm *Aonides trifida* was particularly abundant at site I5. All the taxa identified from the intertidal samples were common species in New Zealand intertidal habitats.

4.4.3 Biota in the rocky intertidal zone

Biota identified within transects on the rocky intertidal shoreline at either end of Walls Bay is shown in Table 5 and examples of the quadrats are shown in Figure 5. All the biota seen were species commonly found in the intertidal zone in Northland. The seaweed Neptunes necklace (*Hormosira banksii*) grew extensively on the rocky habitat and Pacific oysters (*Crassostrea gigas*) were abundant. The snail *Nerita melanotragus* was also commonly found within quadrats at both transect sites (Table 5).

Table 5: Biota seen at rocky intertidal transects TN and TS in quadrats at distances 0 m, 5 m, 10 m, and 15 m along each transect. Algal presence expressed as percent cover, fauna as number of individuals

Common name	Species name	North Transect (TN) 35.31104 S, 174.11697 E				South Transect (TS) 35.31182 S, 174.11670 E			
		0m	5 m	10 m	15 m	0 m	5 m	10 m	15 m
Mudflat anemone	*Anthopleura aureoradiata*		1						
Pacific oyster	*Crassostrea gigas*	7		25	4	20	50	>100	50
Topshell	*Diloma zelandica*					1			
Red seaweed	*Gracilaria chilensis*								2%
Neptunes necklace	*Hormosira banksii*	95%	1%	80%	10%	80%	1%	10%	20%
Chiton	*Ischnochiton maorianus*			3					
Sea snail	*Nerita melanotragus*	2		1	2		3	4	3
Cushion star	*Patiriella regularis*	1							

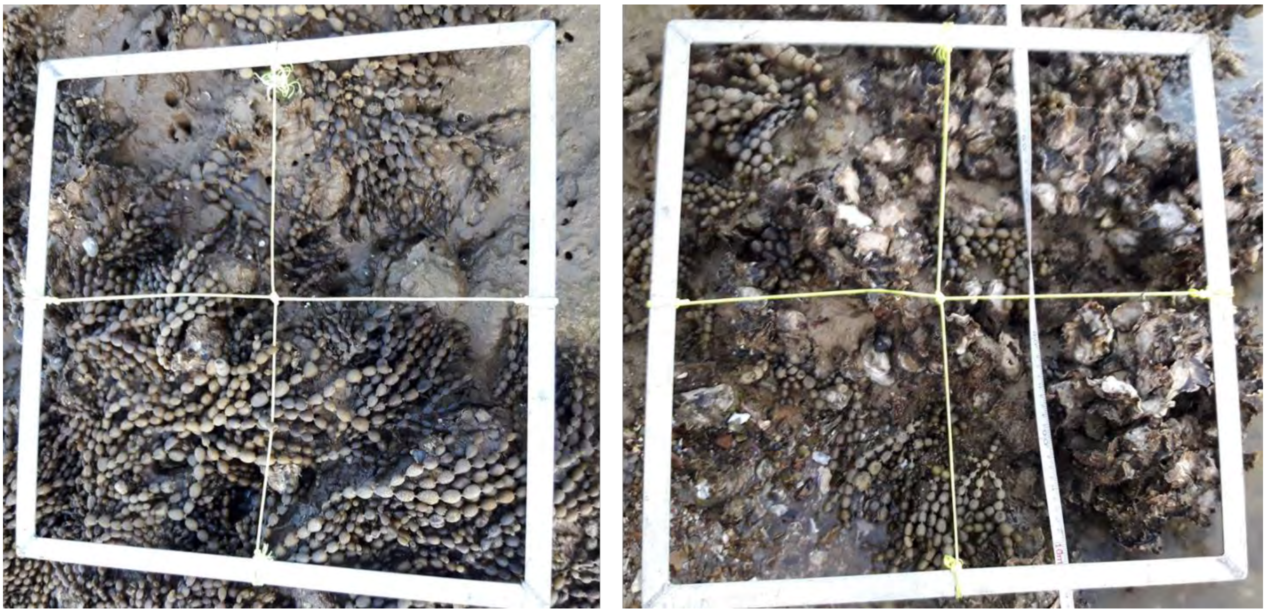

Figure 5: Representative quadrats from the northern (T1, left) and southern (T2, right) intertidal transects

4.4.4 Subtidal Epifauna

Biota was sparse in samples collected in epifauna dredge tows D1 and D2. In D1 there was a single cushion star (*Patiriella regularis*), four cockles (*Austrovenus stutchburyi*), and one whelk (*Cominella maculosa*). In D2, only 2 cockles (*A. stutchburyi*) were collected.

4.5 Edible Shellfish

The description of the edible shellfish bed is largely reproduced from an earlier survey conducted in March 2018 that was intended to characterise the edible shellfish population (Brown 2018).

Two species of edible shellfish were identified in the survey: pipis (*Paphies australis*); and cockles (*Austrovenus stutchburyi*). There were a few pacific oysters (*Crassostrea gigas*) growing on rocks at either end of the beach and on the boatyard jetty structures, but no measurements were made of the oyster population in this survey.

4.5.1 Pipis (*Paphies australis*)

The survey found pipis in all quadrats sampled on the mid and lower intertidal. The mean density of pipis was 288 per m^2. The population on the beach adjacent to the boatyard is considered to be a 'bed' of pipis according to the accepted definition (where shellfish density is greater than 10 per m^2, e.g. Pawley and Smith 2014). Length frequency data and summary statistics are shown in Figure 6 and Table 6.

There is no legal minimum size for the harvest of pipis but a generally accepted rule of thumb is that they are considered as harvestable at shell length greater than 50 mm (Pawley and Smith 2014). The mean density of harvestable pipis surveyed at the beach was 51 per m^2. The Ministry for Primary Industries has historically used a general guideline to define a harvestable shellfish population as 25 per m^2 for pipis 50 mm and over (Pawley and Smith 2014), so the population surveyed was a harvestable pipi bed, so defined. Assuming a nominal area of between 250 to 300 m^2 of suitable beach habitat it can be estimated that the bed holds approximately 12,500 to 15,300 edible sized pipi.

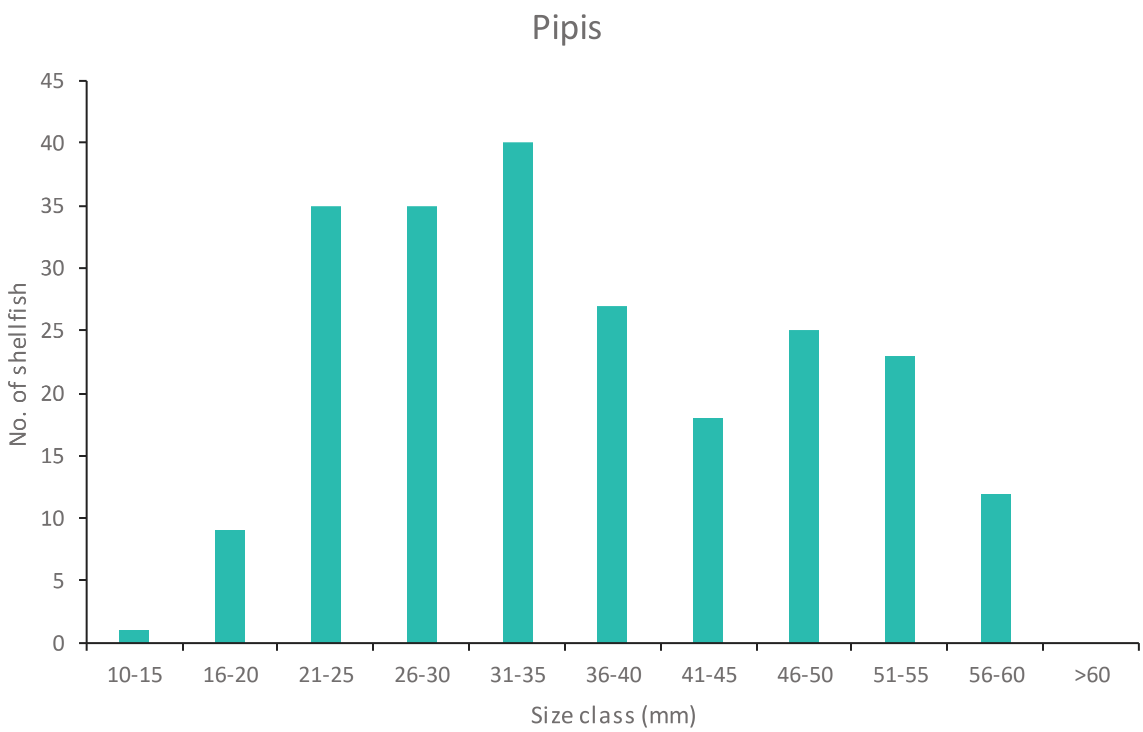

Figure 6: Size frequency of all pipis surveyed

Table 6: Pipi length frequency distribution summary statistics (mm)

Mean	Median	Mode	Range
36.36	33	32	15 - 60

4.5.2 Cockles (*Austrovenus stutchburyi*)

Cockles were found in 7 of the 10 quadrats sampled, and they were most abundant in the lower intertidal zone. The mean density of cockles was 41 per m^2 so the cockle population would be considered as a cockle 'bed'. Length frequency data and summary statistics are shown in Figure 7 and Table 7: Cockle length frequency summary statistics (mm).

There is no legal minimum size for the harvest of cockles, but a generally accepted rule of thumb is that they are considered as harvestable at shell length greater than 30 mm (Pawley and Smith 2014). The mean density of harvestable cockles surveyed at the beach was 11 per m^2 which was below the accepted guideline used historically to define a harvestable shellfish population (Pawley and Smith 2014).

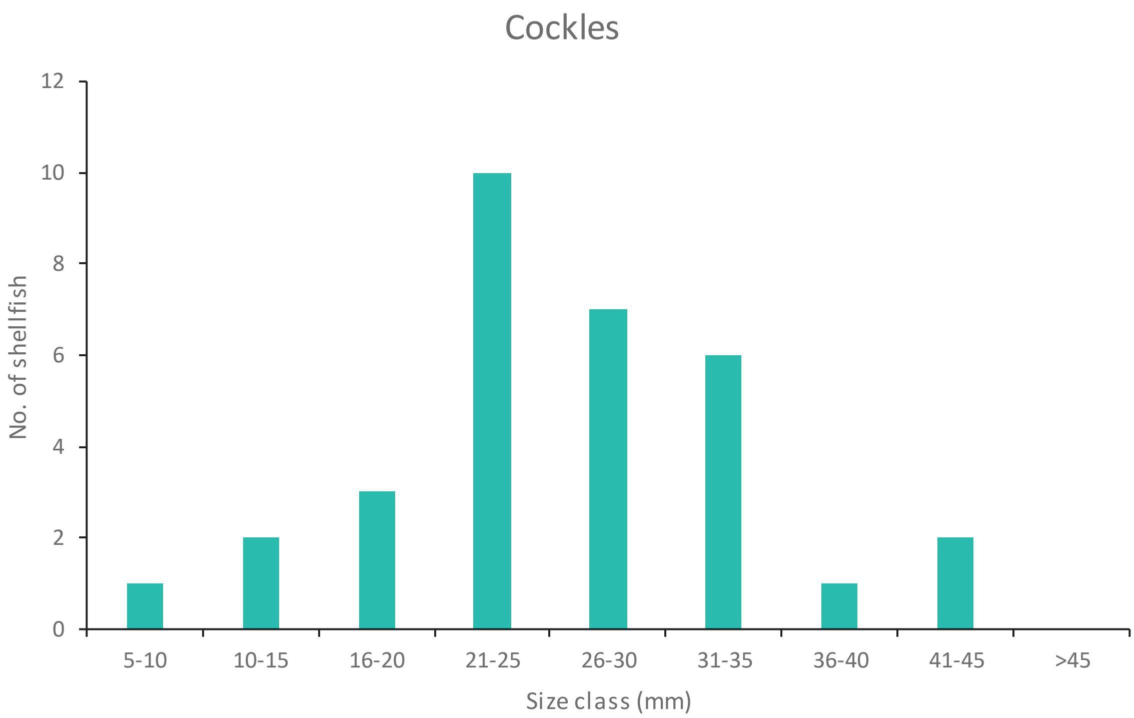

Figure 7: Size frequency of all cockles surveyed

Table 7: Cockle length frequency summary statistics (mm)

Mean	Median	Mode	Range
25.9	25	21	8 - 42

4.5.3 Heavy metals in shellfish flesh

Concentrations of heavy metals in pipis were similar in the samples collected from the slipway site (I1), the site in the middle of the shellfish bed (I2) and also the distant reference site at Te Haumi (Table 8 and Appendix E).

Schedule 19 of the Australia New Zealand Food Standards Code (2016 version) stipulates the following guidelines for concentrations of trace metals in shellfish tissue: Arsenic (inorganic): 1 mg/kg, Cadmium: 2 mg/kg (wet weight), Lead: 2 mg/kg (wet weight). There are no published guidelines for acceptable concentrations of chromium, copper, nickel or zinc in shellfish tissue, although the previous food standards (New Zealand Food Regulations 1984, revoked in December 2002) prescribed a copper guideline of 30 mg/kg (wet weight) in any food except animal offal and tea. The heavy metal concentrations in the pipis collected at all sites did not exceed levels stipulated in the New Zealand Food Standards and copper was well below that cited in the previous regulations.

Table 8: Heavy metal concentrations in shellfish flesh

Heavy metals (mg/kg)	Sample site		
	I1	I2	TH
Arsenic (total)*	1.1	1.12	1.43
Cadmium	0.034	0.047	0.049
Chromium	0.07	0.04	< 0.03
Copper	1.94	1.71	1.13
Lead	0.062	0.077	0.017
Nickel	< 0.10	0.11	0.09
Zinc	8.6	8.9	9.7

Note* Inorganic Arsenic is conservatively estimated to comprise about 10% of Total Arsenic (McMurtrie, 2012) so all levels of Inorganic Arsenic measured in the shellfish samples in this survey should be well below the Australia NZ Food Standard of 1 mg/kg.

5 ASSESSMENT OF ECOLOGICAL EFFECTS

5.1 Planning Context

Resource consents for activities at Opua are within the jurisdiction of the Northland Regional Council (NRC) and coastal dredging consents are governed by two coastal plans: The Northland Regional Coastal Plan (2004), and the Proposed Regional Plan (currently in draft form). For the purposes of this assessment, the policies and regulations under the Northland Regional Coastal Plan (2004) are considered. Under the Plan, Opua is designated as a Marine 4 (Mooring) Management Area. Capital dredging is a discretionary activity under Rule 31.6.7 (b), of the Coastal Plan. The alteration or extension of authorised structures and the erection of any new structure are discretionary activities under Rule 31.6.3 (k) and (l) respectively. The plan inter alia requires that the General Performance Standards identified as Rule 31.6.11 are met. The rules and standards of the Plan relevant to this assessment are addressed below, and a summary of assessment criteria with reference to relevant sections of the plan and corresponding comments in relation to ecological effects are provided in Appendix F.

5.2 Sediments

5.2.1 Sediment dynamics

It is estimated that ~430,000 tonnes per year of suspended sediment is delivered from a 916 km^2 area comprising the largest sub-catchments discharging to the Bay of Islands (i.e., Kawakawa, Waitangi, Kerikeri, Waipapa and Waikare, (MacDiarmid et al. 2009). The Kawakawa sub-catchment delivers about 80% of this combined annual total so that this sub-catchment is the primary source of terrigenous sediments (Swales et al., 2012). That catchment discharges into the greater Bay of Islands via the Veronica Channel. A large fraction of the annual sediment load will be composed of silt and clay and delivered by river runoff during storms. Some of the fine sediments will be deposited in the Waikare Inlet, but a proportion of the suspended storm loads will be dispersed as plumes to the central bay and other fringing estuaries and inlets due to the low settling velocities of fine silts (Swales et al 2012).

Sediment samples from within the proposed dredge footprint were composed of ~20% to 40% fine silts and clays. Although most sediment is removed as a cohesive mass by the proposed dredging method (hydraulic grab), inevitably there is some loss of material during the process. The amount lost to the water column is typically small based on experience with other small scale dredging operations which are commonly undertaken throughout Northland. Some of the material not captured in the dredge bucket can become suspended in the water column before ultimately sinking to the seabed, so there is likely to be some increased but localised turbidity associated with the dredging operation.

However, considering the very large quantity of sediment discharging into the Veronica Channel and the Bay of islands from the Kawakawa and Waikare catchments, the potential contribution to sediment load in the Bay of Islands from the dredging activity proposed by DOB is so small as to be insignificant. Furthermore, hydrodynamic modelling and field observations indicate that that there is only limited potential for fine sediment disturbed by the proposed dredging activity to disperse far beyond the close vicinity of the operations. To further mitigate against the possibility of adverse turbidity and sedimentation effects beyond the works area, it is recommended that a silt curtain is deployed around the dredging plant for the duration of the dredging operation. This has been discussed with the contractor and we understand is accepted as achievable notwithstanding that it imposes some difficulties in managing barge and vessel movements.

Construction of a subsurface erosion barrier in the intertidal zone at the northern end of the beach is proposed to prevent any potential erosion of the beach caused by changes to the intertidal and subtidal shore topography/bathymetry/ as a result of the dredging.

5.2.2 Contaminants in sediments

Concentrations of copper and zinc and lead were present at levels that may potentially have an in situ adverse biological effect in sediments at the slipway site and to a lesser extent at sites M and I3. It is understood that since 2002, DOB has had an approved management system for handling washdown water and stormwater from the boatyard hardstand. In 2012 further improvements were undertaken so that waterborne material is diverted to the trade waste (sewer). Those measures represent a significant improvement to environmental management at the site and a reduced risk of any contaminants entering the coastal marine area. Given that Walls Bay has been the site of vessel haul-out, slipway and vessel maintenance activities since the 1960’s and the site of a commercial boatyard since the 1970’s it is likely that much of the contaminant load found in intertidal sediments is the result of those historical activities, and DOB is now likely to be only a small contributor to the overall potential contaminant load in the wider area.

Contaminated sediment at the slipway that will be disturbed or dredged represents a very small proportion of the total dredged volume. Sediments at site M will be covered and effectively encapsulated by the mudcrete grids, and sediments represented by Site I3 are likely to originate from historical contamination that will not be affected or disturbed by the proposal.

Subtidal sediments sampled near the base of the slipway and at more distant points within the proposed dredge area did not exhibit elevated heavy metal concentrations and are also not a source of water quality concern.

Levels of arsenic and mercury exceeded ANZECC ISQG Low threshold values at all sites, but the concentrations were consistent across all the sites, and the relatively high levels of those metals are likely to be related to catchment geology rather than the boatyard activities. Elevated mercury and arsenic have been noted from estuarine sediments in other regions in the Bay of Islands and around New Zealand (e.g. Brown 2018b, Poynter 1989, Environment Waikato, 2007). It is known that high concentrations of mercury and arsenic in estuary sediments may originate from natural geochemical processes – often associated with volcanism (e.g. Environment Waikato, 2007).

In summary, the dredging operation will remove sediment from a portion of the beach and slipway area that is contaminated, to be transported to an approved disposal site on land. This effectively removes a quantity of historical contamination from the marine system and secures it on land. There is potential for a relatively small amount of contaminant to be resuspended during the dredging and structural operations. Most of this will be in a particulate form and not potentially bioavailable. The low current speeds and limited capacity for sediment transport indicate that there will only be very localised dispersal of this suspended sediment and any associated contaminants. If the recommendation to deploy a silt curtain to contain sediment around the dredging plant during the dredging operation is followed, the potential for dispersal of contaminants will be further reduced and effects from the proposed activity in relation to potential for resuspension of contaminants in the sediment are expected to be no more than minor.

5.3 Effects on Water Quality

Water quality effects during construction and dredging will be limited to some turbidity around the plant operating in shallow water. There is potential for resuspension of some of the contaminants in the sediments into the overlying waters during the dredging operations. Experience of similar operations, is that such effects from a small operation which is intermittent and interspersed with periods of no activity (due to the need to transport and offload material and cessation in work during night time etc), should result in turbidity effects being highly localised and of relatively short duration as the fine particles suspended in the water have a short distance to sink to the bottom. In conditions of low current speeds in marine waters (salt water), the settling time for turbidity only lasts hours (Goossens, H. and Zwolsman, J.G.). As explained above, most of the contaminated sediment that may be disturbed by the dredging operation will be removed and transported to an approved disposal site on land. Considering the low current velocities and limited capacity for sediment transport at the site, the risk of dispersal of contaminated sediment in the water column is low. The risk will be further mitigated if the recommendation to deploy a silt curtain to contain sediment around the dredging plant during the dredging operation is followed.

5.4 Effects on subtidal and intertidal habitat and biota

5.4.1 Subtidal and intertidal infauna and epifauna

The dredging will remove all the biota within the footprint of the proposed area to be dredged. This is to be dredged to a depth of 1.5 m below chart datum. The substrate after dredging is likely to be comprised of, or quickly recover to a sandy mud/gravel substratum similar to the existing substratum. The area is likely to be rapidly recolonised by the same or similar fauna that is described from the present survey.

All the taxa found at the proposed dredge area are common and widespread species in the Bay of Islands and in northern New Zealand coastal inlet environments. The most commonly sampled organisms identified from samples included the rice shell, *Theora lubrica* and the marine polychaete worms *Cossura consimilis* and *Prionospio aucklandica* that are tolerant of muddy (fine-grained sediment) (Norkko et al., 2002), and are unlikely to be detrimentally affected by the short term depositional effects and sediment suspended in the water column by the dredging activity. Those polychaete species are also known to be sensitive to pollutants (especially copper) (Waikato Regional Council, 2018), so their presence is in agreement with the finding that the subtidal sediments within the majority of the proposed dredge area are not polluted with heavy metals from the boatyard.

5.4.2 Intertidal shellfish bed

The survey of the edible shellfish population conducted in March characterised the pipi (*Paphies australis*) population in the intertidal zone on the beach as a harvestable pipi bed. The cockle (*Austrovenus stutchburyi*) population in the intertidal zone was identified as a 'bed' but that species did not occur in densities considered to be 'harvestable'. Pipi (*Paphies australis*) beds have value as a recreational fishing target species (e.g. Berkenbusch and Neubauer, 2016), a traditional food source, and in providing various ecosystem services including stabilising sandy substratum and reducing erosion (e.g. Williams and Hulme, 2014), and as a filter feeder that contributes to nutrient cycling and pollutant detoxification (MacDiarmid et al 2013). In the last 10 years there has been increasing concern around decreasing pipi populations (Berkenbusch and Neubaur, 2016, WIlliams and Hulme, 2014) and there are numerous anecdotal accounts of substantial declines in their distribution and abundance from many places around New Zealand, associated with increasing human-induced sedimentation and environmental stress, and/or strong recreational harvesting pressures (Morrison and Parsons, 2009).

Pipis have been shown to have a preference for inhabiting sediments with a low proportion of fine mud sediment (~ 3.4 % in Anderson 2008) and experiments have shown that high levels of suspended sediment can have adverse physiological effects on pipis including impaired feeding leading to poor condition (Nicholls et al., 2003) and impaired reproductive status (Gibbs and Hewitt, 2004). The existing pipi bed is likely to be exposed to regular fluxes in sediment concentration in the overlying waters and sediment settling on the substrate from natural catchment discharges and storm events. The scale of this exposure is likely at times to greatly exceed that generated by a small scale dredging operation of the type proposed. Deployment of the silt curtain as recommended will serve as a precautionary measure to mitigate any potential risk to the pipi bed from sedimentation associated with the dredging activity.

A small proportion (~5 %) of the pipi habitat will be disturbed during the installation of the subsurface erosion barrier designed to prevent erosion of the beach and pipi bed. Disturbance will comprise removal of pipis and some cockles directly within the footprint of the barrier (~10-20 m^2) and potential for damage to shellfish from machinery accessing the work area. During construction of the subsurface barrier, all machinery will access the work area from the northern end of the beach to minimise disturbance to the pipi habitat. Consideration was given to transplanting pipis that are currently located within the zone that will be subject to disturbance. However, such a transplant exercise is considered on balance to be unnecessary because the main bed (where there is the greatest concentration of pipis) is to the south of the area that will be disturbed, and the disturbance will be limited to a small proportion of less favourable pipi habitat. It is expected that pipis will naturally recruit back to any suitable habitat within the disturbed area with time after installation of the erosion barrier.

Testing of heavy metals in the pipi flesh found no evidence of accumulation of heavy metal contaminants above New Zealand Food Standards in the shellfish in spite of the elevated concentrations of some metals within the sediments. Those results suggest that in terms of heavy metal concentrations, the pipis on the beach at Walls Bay should be acceptable for human consumption. It should be noted that testing of shellfish flesh in this study was restricted to heavy metals because those are the class of contaminants commonly associated with boatyard activities. The testing of other contaminants that may affect the suitability of shellfish for human consumption such as bacteriological testing was beyond the scope of this assessment.

5.5 Conclusions

- The ecological features in the vicinity of the boatyard that are potentially influenced by the proposed structural and dredging activities are all common and widespread in the Bay of Islands and Northland. It is expected that within the timeframe of months to approximately a year, the substrate and biota is likely to return to the same or similar sandy mud/gravel substratum inhabited by the same or similar assemblage of biota. The effects to subtidal and intertidal biota from the proposed structural and dredging works are therefore expected to be no more than minor.
- In terms of ecological values, the harvestable pipi bed in the beach intertidal zone is the most important feature identified in the survey. Pipi populations are considered to be potentially vulnerable to the effects of excessive sedimentation. We assess this risk as low in this case because of the small amount of material likely to be lost in what is a small dredging project, and due to the inherently intermittent nature of the dredging operation. However, as a precautionary measure, it is recommended that a silt curtain be deployed around the dredging plant for the duration of the dredging operation to avoid any potential risk of detrimental effects of sedimentation to the pipi bed.
- Installation of a subsurface erosion barrier is designed to avoid potential erosion effects on the beach habitat and associated pipi bed over the longer term as a result of the dredging. Ecological effects associated with installation of the erosion barrier are expected to be no more than minor.
- There is likely to be some increased turbidity in the water column resulting from the suspension of fine silts and clays associated with the dredging operation. However, the potential contribution to sediment load in the Bay of Islands from the dredging activity proposed by DOB is insignificant when compared to the very large quantity of sediment discharging into the Veronica Channel and the Bay of Islands from the Kawakawa and Waikare catchments. Available hydrodynamic modelling information and field observations indicate that there is only limited potential for fine sediment disturbed by the proposed dredging activity to disperse far beyond the close vicinity of the operations. The proposed silt curtain deployment will further mitigate against the possibility of adverse turbidity and sedimentation effects beyond the works footprint.
- Sediments on the beach near the slipway are contaminated with elevated levels of copper, zinc and lead. The dredging activity will disturb a small area of contaminated sediment and that could lead to resuspension of some contaminants along with some sediment in the water column. However, most of the contaminated sediment disturbed by the dredging process will be removed and transported to an approved disposal site on land, thus removing this historical contamination from the marine ecosystem. On balance, effects from the proposed activities in terms of contaminants are expected to be no more than minor.
- The low current speeds and limited capacity for sediment transport predicted in the vicinity of the proposed dredging area indicate that there will only be very localised potential for dispersal of suspended sediment and any associated contaminants. This will be further limited by the use of a silt curtain. Shellfish beds and other ecological features beyond the site will not be put at risk or adversely affected or exposed to significant sediment, sediment associated contaminants or dissolved contaminants generated during the dredging process.
- Analysis of heavy metals in shellfish flesh found no evidence of accumulation of heavy metal contaminants in pipis collected from the pipi bed adjacent to the boatyard.

- There is evidence of localised contamination by some heavy metals close to the slipway and extending along the beach proper for some distance. It is likely that historical vessel maintenance, slipway and boatyard activities at the site since the 1960's contributed much of the existing contaminant load prior to the present owner taking control of the boatyard. We consider this is a well managed facility and improvements to the system for handling washdown water and stormwater from the boatyard hardstand implemented since 2002 represent improved environmental management and reduced potential for contaminants to enter the coastal marine area, and DOB is likely to be a small contributor to the overall potential contaminant load in the wider area.
- We conclude that the proposed upgrade to structures and deepening around the facility can be carried out with short term and minor ecological or water quality effects confined largely to the immediate works area.

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Appendix A:

Sediment grain size analysis test report

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TEST REPORT

Lab Job No: 8174-007

Your ref.: AA3213

Date of Issue: 19-06-2018

Date of Re-Issue: -

Page: 1 of 4

Test Report.

No. W18-332

PROJECT: **Grading Analysis**

CLIENT: 4Sight Consulting
Office 3, Shop 10
Oceans Resort Hotel, Marina Road
PO Box 402 053, Tutukaka 0153

ATTENTION: Stephen Brown

INSTRUCTIONS: Determination of the particle size distribution (wet sieving method)

TEST METHOD: NZS 4402:1986 2.8.1

SAMPLING METHOD: N/A

TEST RESULTS: As Per Laboratory Sheets attached

G. Breckon

Laboratory Technician

D.Krissansen

Approved Signatory

ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

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166 Bank Street
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E. info@geocivil.co.nz

DETERMINATION OF THE PARTICLE SIZE DISTRIBUTION

NZS 4402:1986 Test 2.8.1

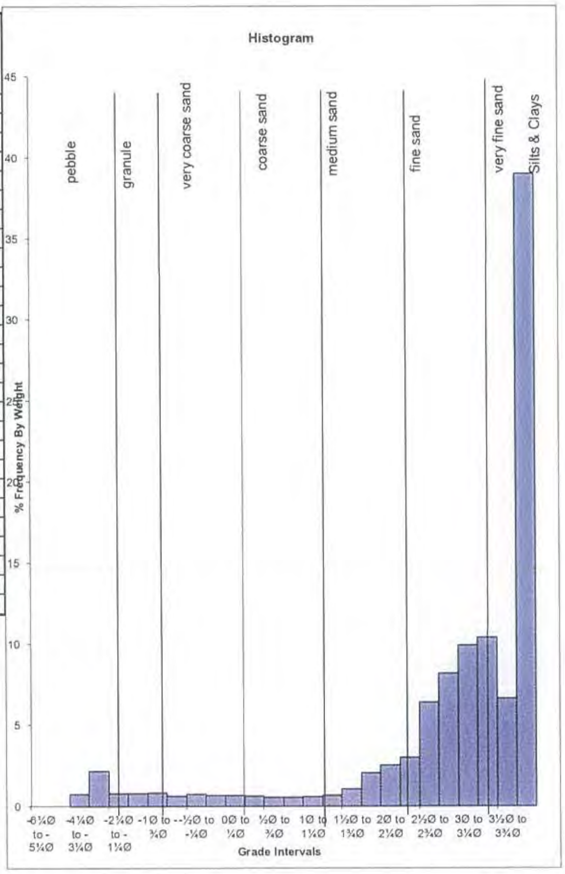
Client:	4 Sight Consulting	**Sample No.**	18-236	**Lab Job No:**	8174-007
Client Sample No:	S1	**Tested by:**	L.C	**Client Ref no:**	AA3213
Date Collected:	31/05/2018	**Date:**	18/06/2018	**Report no:**	W18-332
Test Details:	Wet sieving method	**Checked by:**	Brecko	**Page:**	2 of 4
History:	Natural	**Date:**	21/6/18		

Weight of dry Sample(grams): 406.63

GRADE INTERVALS	BS TEST SIEVE (mm)	WEIGHT RETAINED ON SIEVE (g)	% FREQUENCY (WEIGHT)	CUMULATIVE % FREQUENCY
-6¼Ø to -5¼Ø	37.5	0	0	0
-5¼Ø to -4¼Ø	19	0	0	0
-4¼Ø to -3¼Ø	9.5	0	0	0
-3¼Ø to -2¼Ø	4.75	3.02	1	1
-2¼Ø to -1¼Ø	2.36	8.82	2	3
-1¼Ø to -1Ø	2	3.16	1	4
-1Ø to -¾Ø	1.70	3.21	1	4
-¾Ø to -½Ø	1.40	3.32	1	5
-½Ø to -¼Ø	1.18	2.59	1	6
-¼Ø to 0Ø	1.00	2.97	1	7
0Ø to ¼Ø	0.850	2.64	1	7
¼Ø to ½Ø	0.710	2.65	1	8
½Ø to ¾Ø	0.600	2.55	1	9
¾Ø to 1Ø	0.500	2.17	1	9
1Ø to 1¼Ø	0.425	2.18	1	10
1¼Ø to 1½Ø	0.355	2.40	1	10
1½Ø to 1¾Ø	0.300	2.64	1	11
1¾Ø to 2Ø	0.250	4.23	1	12
2Ø to 2¼Ø	0.212	8.31	2	14
2¼Ø to 2½Ø	0.180	10.29	3	17
2½Ø to 2¾Ø	0.150	12.24	3	20
2¾Ø to 3Ø	0.125	25.94	6	26
3Ø to 3¼Ø	0.106	33.21	8	34
3¼Ø to 3½Ø	0.090	40.29	10	44
3½Ø to 3¾Ø	0.075	42.32	10	54
3¾Ø to 4Ø	0.063	26.97	7	61
smaller than 4Ø		158.51	39	100

sum 406.63
error/losses %

Mean Size		-	Ø
Standard Deviation		-	Ø
Skewness		-	Ø



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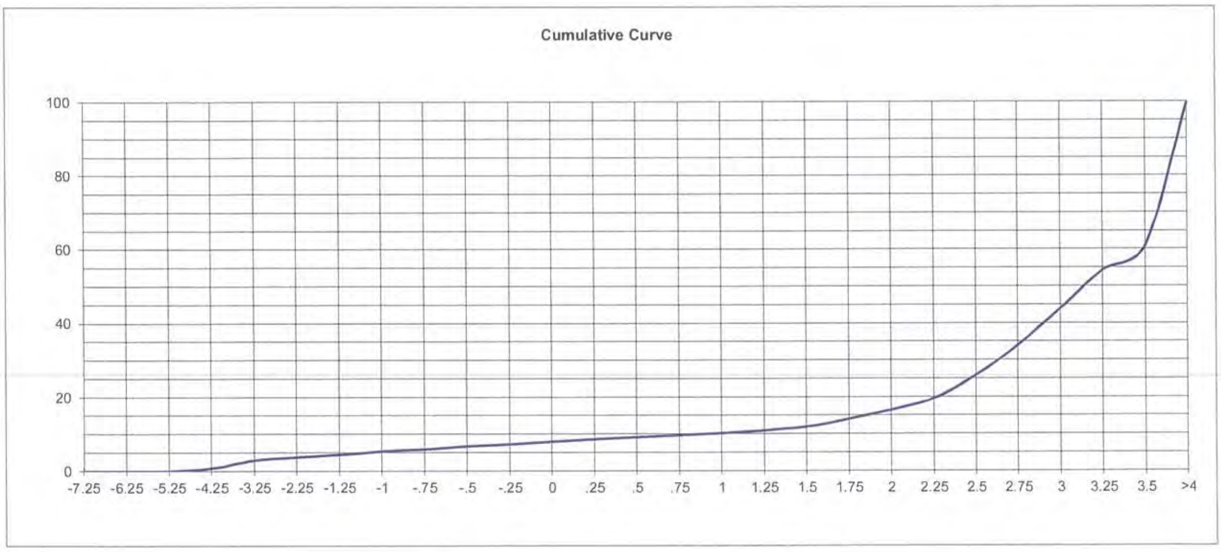

D. Krissansen
Approved Signatory

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DETERMINATION OF THE PARTICLE SIZE DISTRIBUTION

NZS 4402:1986 Test 2.8.1

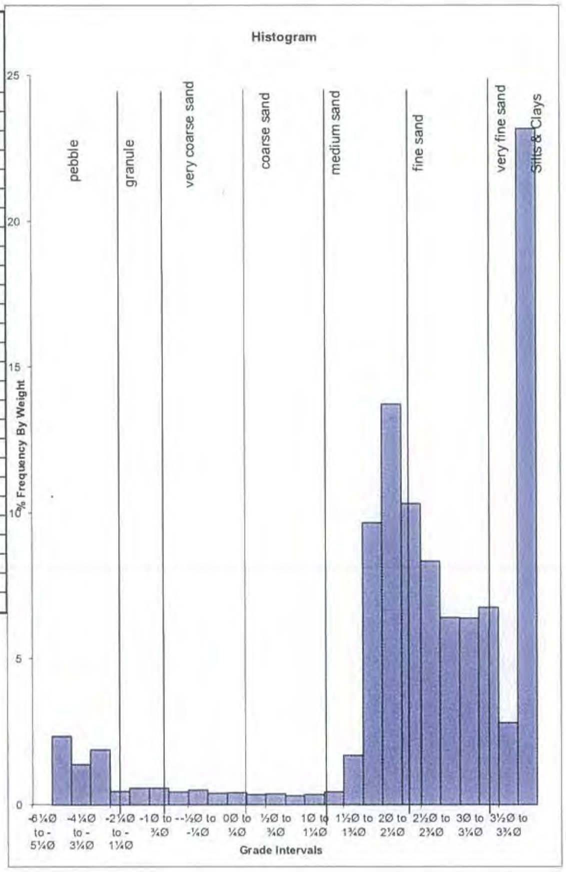
Client:	4 Sight Consulting	**Sample No.**	18-237	**Lab Job No:**	8174-007
Client Sample No:	S3	**Tested by:**	N.K	**Client Ref no:**	AA3213
Date Collected:	31/05/2018	**Date:**	13/06/2018	**Report no:**	W18-332
Test Details:	Wet sieving method	**Checked by:**	CBrecko	**Page:**	3 of 4
History:	Natural	**Date:**	21/6/18		

Weight of dry Sample(grams): 522.68

GRADE INTERVALS	BS TEST SIEVE (mm)	WEIGHT RETAINED ON SIEVE (g)	% FREQUENCY (WEIGHT)	CUMULATIVE % FREQUENCY
-6¼Ø to -5¼Ø	37.5	0	0	0
-5¼Ø to -4¼Ø	19	0	0	0
-4¼Ø to -3¼Ø	9.5	12.29	2	2
-3¼Ø to -2¼Ø	4.75	7.21	1	4
-2¼Ø to -1¼Ø	2.36	9.79	2	6
-1¼Ø to -1Ø	2	2.39	0	6
-1Ø to -¾Ø	1.70	2.92	1	7
-¾Ø to -½Ø	1.40	2.97	1	7
-½Ø to -¼Ø	1.18	2.25	0	8
-¼Ø to 0Ø	1.00	2.63	1	8
0Ø to ¼Ø	0.850	1.98	0	9
¼Ø to ½Ø	0.710	2.14	0	9
½Ø to ¾Ø	0.600	1.82	0	9
¾Ø to 1Ø	0.500	1.94	0	10
1Ø to 1¼Ø	0.425	1.62	0	10
1¼Ø to 1½Ø	0.355	1.76	0	10
1½Ø to 1¾Ø	0.300	2.22	0	11
1¾Ø to 2Ø	0.250	8.87	2	12
2Ø to 2¼Ø	0.212	50.49	10	22
2¼Ø to 2½Ø	0.180	71.75	14	36
2½Ø to 2¾Ø	0.150	53.98	10	46
2¾Ø to 3Ø	0.125	43.66	8	54
3Ø to 3¼Ø	0.106	33.52	6	61
3¼Ø to 3½Ø	0.090	33.34	6	67
3½Ø to 3¾Ø	0.075	35.37	7	74
3¾Ø to 4Ø	0.063	14.63	3	77
smaller than 4Ø		121.14	23	100

sum	522.68	
error/losses		%

Mean Size		-	Ø
Standard Deviation		-	Ø
Skewness		-	Ø



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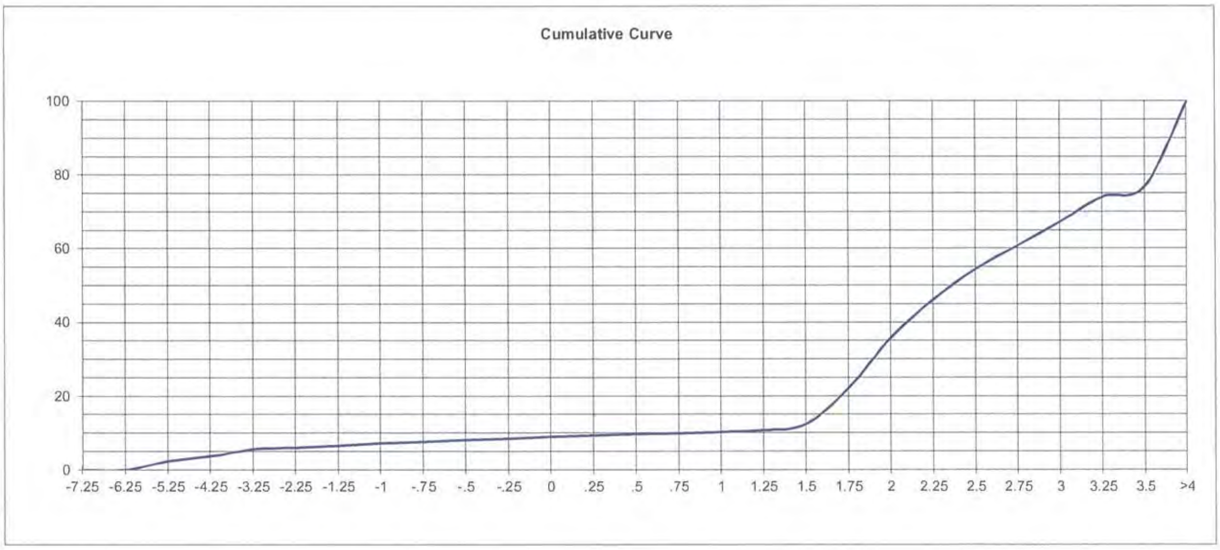

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DETERMINATION OF THE PARTICLE SIZE DISTRIBUTION

NZS 4402:1986 Test 2.8.1

Client:	4 Sight Consulting	**Sample No.**	18-238	**Lab Job No:**	8174-007
Client Sample No:	SC	**Tested by:**	L.C	**Client Ref no:**	AA3213
Date Collected:	-	**Date:**	18/06/2018	**Report no:**	W18-332
Test Details:	Wet sieving method	**Checked by:**	Brecker	**Page:**	4 of 4
History:	Natural	**Date:**	21/6/18		

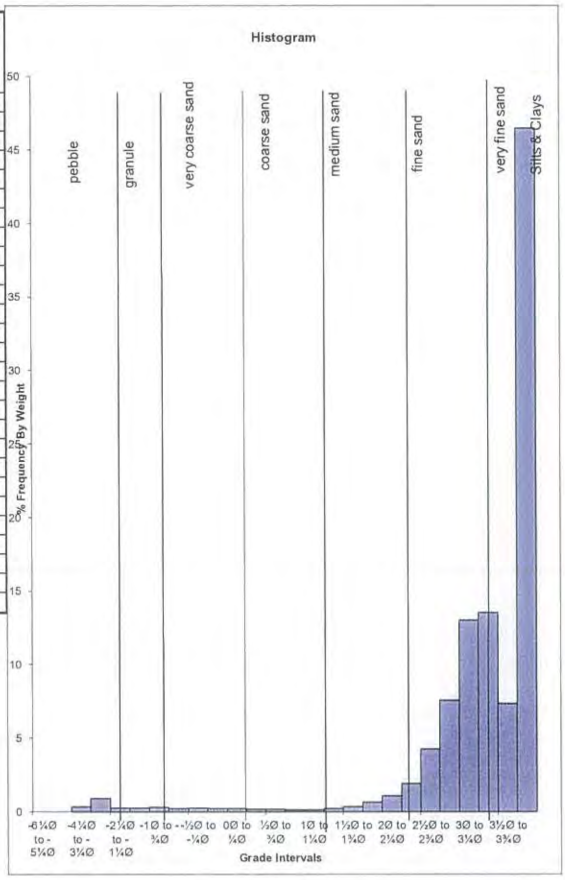
Weight of dry Sample(grams): 461.48

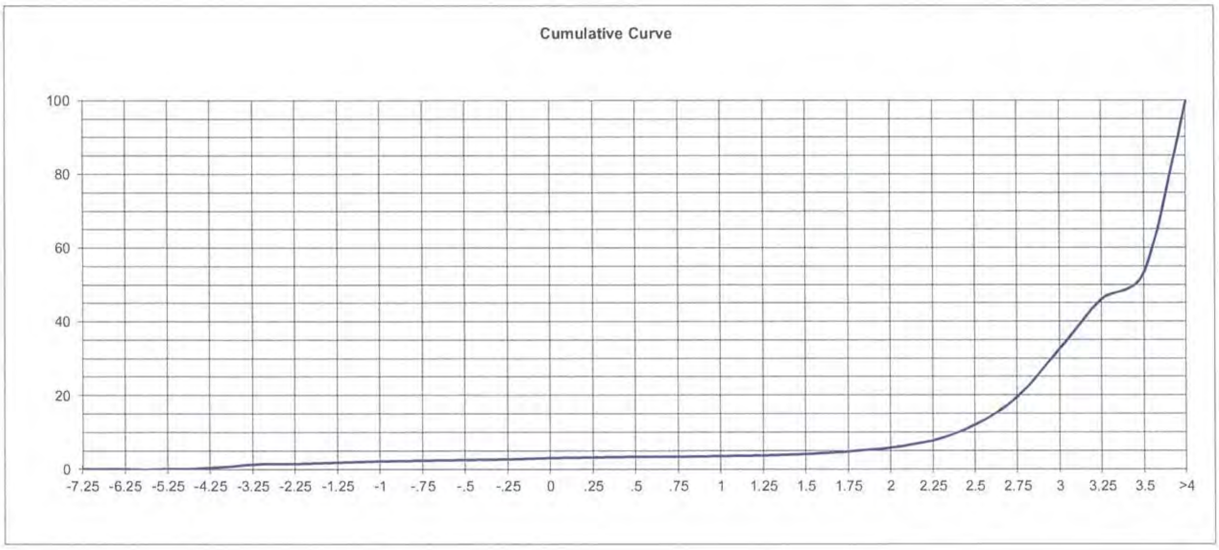
GRADE INTERVALS	BS TEST SIEVE (mm)	WEIGHT RETAINED ON SIEVE (g)	% FREQUENCY (WEIGHT)	CUMULATIVE % FREQUENCY
-6¼Ø to -5¼Ø	37.5	0	0	0
-5¼Ø to -4¼Ø	19	0	0	0
-4¼Ø to -3¼Ø	9.5	0	0	0
-3¼Ø to -2¼Ø	4.75*	1.65	0	0
-2¼Ø to -1¼Ø	2.36*	4.2	1	1
-1¼Ø to -1Ø	2*	1.26	0	2
-1Ø to -¾Ø	1.70*	1.21	0	2
-¾Ø to -½Ø	1.40*	1.28	0	2
-½Ø to -¼Ø	1.18*	1.07	0	2
-¼Ø to 0Ø	1.00*	1.09	0	3
0Ø to ¼Ø	0.850*	0.9	0	3
¼Ø to ½Ø	0.710*	0.92	0	3
½Ø to ¾Ø	0.600*	0.82	0	3
¾Ø to 1Ø	0.500	0.85	0	3
1Ø to 1¼Ø	0.425	0.53	0	3
1¼Ø to 1½Ø	0.355	0.66	0	4
1½Ø to 1¾Ø	0.300	0.88	0	4
1¾Ø to 2Ø	0.250	1.58	0	4
2Ø to 2¼Ø	0.212	3.07	1	5
2¼Ø to 2½Ø	0.180	5.07	1	6
2½Ø to 2¾Ø	0.150	8.87	2	8
2¾Ø to 3Ø	0.125	19.63	4	12
3Ø to 3¼Ø	0.106	34.96	8	20
3¼Ø to 3½Ø	0.090	60.17	13	33
3½Ø to 3¾Ø	0.075	62.49	14	46
3¾Ø to 4Ø	0.063	33.92	7	54
smaller than 4Ø		214.40	46	100

sum 247.08
error/losses %

Mean Size		-	Ø
Standard Deviation		-	Ø
Skewness		-	Ø

Note: *Predominantly shells and organics





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Appendix B:

Analysis of heavy metals in sediment samples

Hill Laboratories
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R J Hill Laboratories Limited
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Certificate of Analysis

Client:	4SIGHT Consulting Limited	**Lab No:**	1995978 SUPv1
Contact:	Stephen Brown	**Date Received:**	07-Jun-2018
	C/- 4SIGHT Consulting Limited	**Date Reported:**	12-Jun-2018
	PO Box 402053	**Quote No:**	92650
	Tutukaka 0153	**Order No:**	AA3213 AEE
		Client Reference:	AA3213 AEE
		Add. Client Ref:	Marine Sediments
		Submitted By:	Stephen Brown

Sample Type: Sediment

Sample Name:		S1 31-May-2018	S2 31-May-2018	S3 31-May-2018	SC 31-May-2018
Lab Number:		1995978.1	1995978.2	1995978.3	1995978.4
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	20.8 ± 2.1	23.4 ± 2.4	32.2 ± 3.3	21.2 ± 2.2
Total Recoverable Cadmium	mg/kg dry wt	0.0284 ± 0.0069	0.0272 ± 0.0069	0.0302 ± 0.0071	0.0249 ± 0.0068
Total Recoverable Chromium	mg/kg dry wt	14.1 ± 1.7	15.3 ± 1.9	17.0 ± 2.1	15.1 ± 1.9
Total Recoverable Copper	mg/kg dry wt	10.7 ± 1.6	12.1 ± 1.8	35.2 ± 5.0	11.7 ± 1.7
Total Recoverable Lead	mg/kg dry wt	10.0 ± 1.3	10.3 ± 1.3	15.7 ± 1.9	10.4 ± 1.3
Total Recoverable Mercury	mg/kg dry wt	0.268 ± 0.033	0.352 ± 0.043	0.410 ± 0.050	0.333 ± 0.041
Total Recoverable Nickel	mg/kg dry wt	7.24 ± 0.74	8.25 ± 0.84	8.57 ± 0.87	7.54 ± 0.77
Total Recoverable Zinc	mg/kg dry wt	82 ± 14	90 ± 15	120 ± 20	85 ± 14

Sample Name:		ISL 31-May-2018	M 31-May-2018	I3 31-May-2018	I5 31-May-2018
Lab Number:		1995978.5	1995978.6	1995978.7	1995978.8
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	37.3 ± 3.8	24.5 ± 2.5	30.5 ± 3.1	27.3 ± 2.8
Total Recoverable Cadmium	mg/kg dry wt	0.0640 ± 0.0098	0.0344 ± 0.0073	0.0249 ± 0.0068	0.0493 ± 0.0085
Total Recoverable Chromium	mg/kg dry wt	12.3 ± 1.5	9.5 ± 1.2	13.1 ± 1.6	11.5 ± 1.4
Total Recoverable Copper	mg/kg dry wt	368 ± 52	319 ± 45	230 ± 33	29.2 ± 4.1
Total Recoverable Lead	mg/kg dry wt	67.4 ± 8.1	53.2 ± 6.4	68.2 ± 8.2	22.7 ± 2.8
Total Recoverable Mercury	mg/kg dry wt	0.207 ± 0.026	0.118 ± 0.016	0.208 ± 0.026	0.212 ± 0.027
Total Recoverable Nickel	mg/kg dry wt	14.3 ± 1.5	10.6 ± 1.1	10.1 ± 1.1	13.3 ± 1.4
Total Recoverable Zinc	mg/kg dry wt	431 ± 69	257 ± 42	205 ± 33	113 ± 19

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

Summary of Methods

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

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Sample No
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%.	-	1-8
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 - 0.4 mg/kg dry wt	1-8
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-8

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

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

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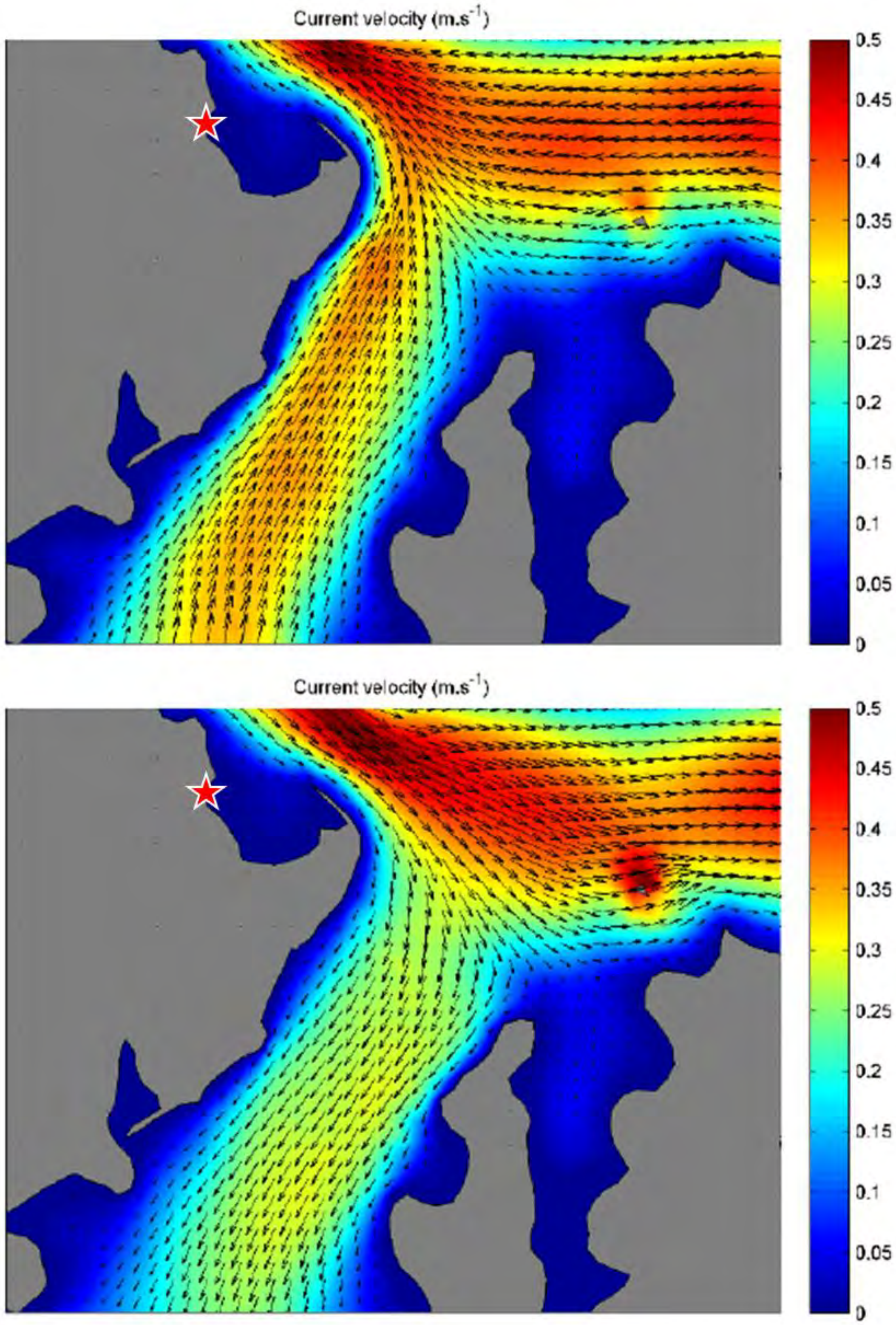
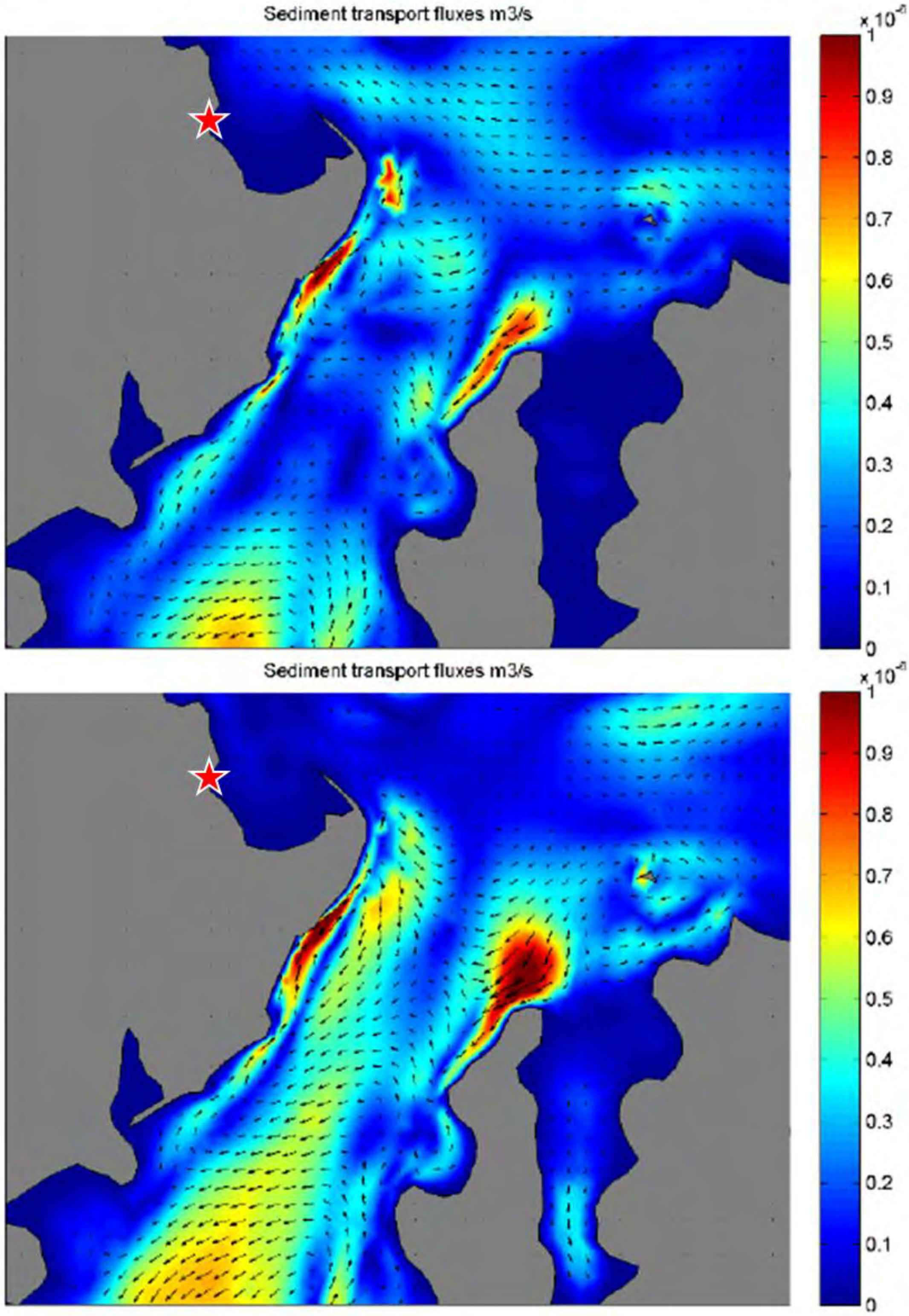
Martin Cowell - BSc
Client Services Manager - Environmental

Appendix C:

Modelled currents and SedimentTransport Capacity



a) Depth-averaged peak spring ebb (top panel) and spring flood (bottom panel) tidal currents in the vicinity of Opua. Red star denotes location of Doug's Boatyard (Reproduced from MetOcean Solutions 2013)



b) Predicted sediment transport capacity over a neap tidal cycle (top panel) and spring tidal cycle (bottom panel) in the vicinity of Opua. Red star denotes location of Doug's Boatyard. (Reproduced from MetOcean Solutions 2013)

Appendix D:

Infauna

Species	Intertidal Sites				Subtidal Sites			
	ISL	M	I3	I5	S1	S2	S3	SC
ANTHOZOA							1	
NEMERTEA			1	2	3	4	1	1
NEMATODA	1							
POLYCHAETA								
Aonides trifida	4			120				
Armandia maculata					5	7	16	2
Asychis cf. *amphiglyptus*					14	18	8	4
Boccardia (Paraboccardia) syrtis	2		1		6	4	1	5
Capitella sp.		2		14				
Cirratulidae						3	5	
Cossura consimilis					2	9	9	5
Dorvilleidae					1		4	
Glycera lamelliformis		1				1	2	
Glyceridae (unidentified juveniles)					7	1	20	
Goniadidae						1	2	2
Hesionidae			1					
Heteromastus filiformis					30	44	140	10
Lumbrineridae					4	1		1
Macroclymenella stewartensis					8	7		5
Magelona sp.								1
Nereididae (unidentified juveniles)	2	2					26	
Paradoneis sp.					6	17	10	
Pectinaria australis					7	2	1	2
Phylo novazealandiae					4	7		10
Polydora sp.					1	9	2	
Polynoidae					1	1		
Prionospio aucklandica						1	2	
Prionospio yuriel					1		1	
Scoloplos cylindrifer				1				
Sigalionidae							2	
Syllidae	1		2	2	7	8	1	1
Terebellidae					1			
OLIGOCHAETA	1							
GASTROPODA								
Cominella glandiformis								1
Philine sp.					2	1		1
BIVALVIA								
Arcuatula senhousia	3	1						
Arthritica sp.					2			
Austrovenus stutchburyi							1	
Bivalvia sp. A							1	1
Bivalvia sp. B					1			1
Bivalvia sp. C							2	
Macomona liliana							2	
Nucula sp.					2			
Paphies australis	1	2	4	1				
Theora lubrica					70	50	122	50
CRUSTACEA								
Alpheus richardsoni					2	1		
Amphipoda except Phoxocephalidae	2		1					
Amphipoda Phoxocephalidae	1						1	
Eurylana sp.			1					
Isopoda Sphaeromatidae	2	1						
Nebalia sp.					1			
Ostracoda sp. A					5	2	1	1
Ostracoda sp. B					1			
Ostracoda sp. C					16	2	1	
HOLOTHUROIDEA							3	

Appendix E:

Analysis of heavy metals in shellfish

Hill Laboratories
TRIED, TESTED AND TRUSTED

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Certificate of Analysis

SUPv1

Client:	4SIGHT Consulting Limited	**Lab No:**	1995962
Contact:	Stephen Brown	**Date Received:**	07-Jun-2018
	C/- 4SIGHT Consulting Limited	**Date Reported:**	19-Jun-2018
	PO Box 402053	**Quote No:**	92483
	Tutukaka 0153	**Order No:**	AA3213 AEE
		Client Reference:	AA3213 AEE
		Add. Client Ref:	Marine Shelfish (Pipis)
		Submitted By:	Stephen Brown

Sample Type: Shellfish

	Sample Name:	I1 31-May-2018	I2 31-May-2018	TH 31-May-2018	
	Lab Number:	1995962.1	1995962.2	1995962.3	
Arsenic	mg/kg as rcvd	1.10 ± 0.16	1.12 ± 0.16	1.43 ± 0.21	-
Cadmium	mg/kg as rcvd	0.0339 ± 0.0048	0.0471 ± 0.0067	0.0488 ± 0.0069	-
Chromium	mg/kg as rcvd	0.069 ± 0.011	0.0407 ± 0.0070	< 0.03 ± 0.0056	-
Copper	mg/kg as rcvd	1.94 ± 0.28	1.71 ± 0.24	1.13 ± 0.16	-
Lead	mg/kg as rcvd	0.0624 ± 0.0089	0.077 ± 0.011	0.0165 ± 0.0027	-
Nickel	mg/kg as rcvd	< 0.10 ± 0.019	0.105 ± 0.020	0.093 ± 0.019	-
Zinc	mg/kg as rcvd	8.6 ± 1.3	8.9 ± 1.3	9.7 ± 1.4	-

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

Summary of Methods

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

Sample Type: Shellfish

Test	Method Description	Default Detection Limit	Sample No
Shucking of Shellfish*	Removal of tissue from shell.	-	1-3
Homogenise*	Mincing, chopping, or blending of sample to form homogenous sample fraction.	-	1-3
Biological Materials Digestion	Nitric and hydrochloric acid micro digestion, filtration.	-	1-3
Arsenic	Biological materials digestion. Analysis by ICP-MS.	0.02 mg/kg as rcvd	1-3
Cadmium	Biological materials digestion. Analysis by ICP-MS.	0.0008 mg/kg as rcvd	1-3
Chromium	Biological materials digestion. Analysis by ICP-MS.	0.006 mg/kg as rcvd	1-3
Copper	Biological materials digestion. Analysis by ICP-MS.	0.010 mg/kg as rcvd	1-3
Lead	Biological materials digestion. Analysis by ICP-MS.	0.002 mg/kg as rcvd	1-3
Nickel	Biological materials digestion. Analysis by ICP-MS.	0.02 mg/kg as rcvd	1-3
Zinc	Biological materials digestion. Analysis by ICP-MS.	0.2 mg/kg as rcvd	1-3

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

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

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J. M. Sritharan

Malar Sritharan BSc
Laboratory Technician - Food and Bioanalytical

Appendix F:

Northland Regional Coastal Plan: Assessment criteria summary

Relevant assessment criteria: NRCP		Comment
General Criteria	32.1.3	No significant cumulative adverse ecological effects identified.
	32.1.4	As above.
	32.1.9	Dredging is required but has been kept to a minimum. Precautionary mitigation measures to minimise risk to an ecological feature are recommended: Deployment of a silt curtain to contain sediment around the dredging plant for the duration of the dredging operation to avoid the risk of detrimental effects of sedimentation to the pipis is recommended.
	32.1.11	There will be none other than minor effects on local bathymetry, substrate composition, biodiversity, biological productivity, distribution and abundance of biota or natural migration of fish and mobile marine species.
	32.1.16	There will be none other than minor effects on local marine plants/algae.
	32.1.17	Any damage to the marine habitat will be rapidly naturally remediated and will not lead to other than short term adverse effects.
	32.1.20	Disturbance and damage to the seabed and biota will be naturally remediated.
	32.1.22	There will be none other than minor short-term effects on local water quality.
Structures	32.2.1.8	The proposed structures are of a similar size and scale and position to existing structures, so no additional adverse ecological effects are expected.
	32.2.1.13	As above.
Dredging	32.2.5.1	Alternative dredging methods have not been investigated as the dredging method chosen is the most practical and is accepted to have the least potential to effect water quality or cause losses of material.
	32.2.5.3	The volume of material to be dredged is estimated to not be no more than 4265 m^3.
	32.2.5.5	Future maintenance dredging if required and infrequent, would have similar minor ecological effects.
	32.2.5.6	The dredging will not cause other than minor, localised water quality effects.
	32.2.5.7	The dredging will not stimulate algal blooms.
	32.2.5.8	Due to the small scale of the area and depth to be dredged, and the relatively low current speeds at the site, the dredging is unlikely to have any more than a minor effect on water movement patterns and long-term water quality and sediment quality.
	32.2.5.9	Dredging effects are likely to be no more than minor. Where a potential effect on the adjacent shellfish bed has been identified, provision of precautionary mitigation measures has been recommended (use of a silt curtain to contain suspended sediment to protect the shellfish bed during the dredging operation).

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