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Water Resource Management Solutions

Crude Shipping Project

Proposal to Deepen and Partially Realign the Approaches to Marsden Point

Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals

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Preamble

The New Zealand Refining Company Limited (trading as 'Refining NZ' or 'RNZ') operates a crude oil refinery at Marsden Point on the southern side of the Whangarei Harbour mouth (see Figure 1). Deep water access to Marsden Point from Bream Bay is via a natural tidal inlet that varies in depth from 15 to 32 metres (see LINZ, 2010, LINZ, 2004 and Figure 2).

Figure 1: Locality Diagram for Marsden Point Oil Refinery.

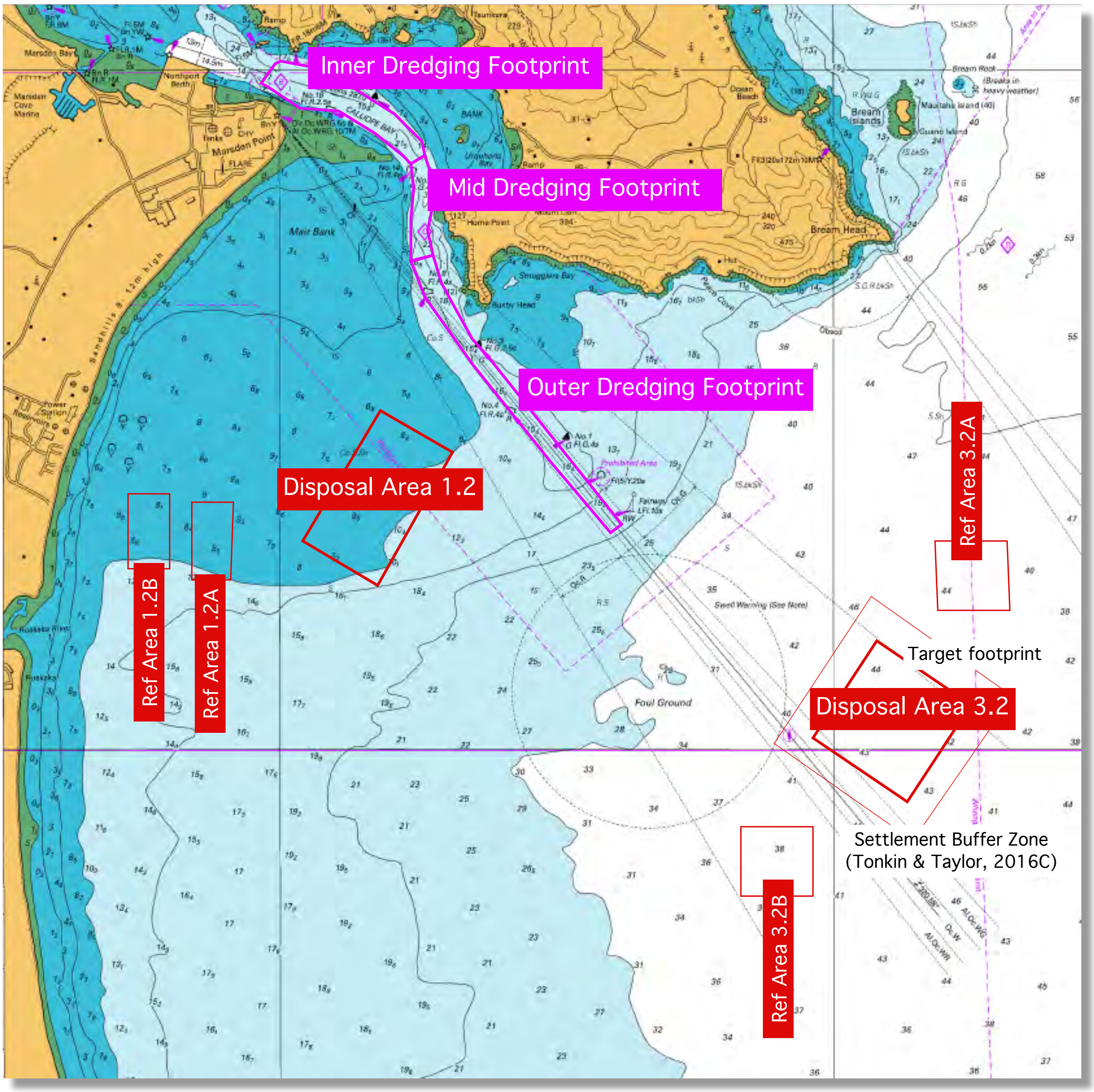
Crude oil supply to the refinery is currently delivered by smaller fully-loaded "Aframax" ships and larger partially-loaded "Suezmax" ships. "Suezmax" ships can only be partially loaded due to existing port draft requirements.

There would be financial and efficiency returns for RNZ if fully-loaded "Suezmax" ships could access the Marsden Point berthing terminal from Bream Bay (Tonkin & Taylor, 201A).

To this end, RNZ is applying for resource consents required:

- to partially realign the access channel to provide safe navigational access for fully-loaded "Suezmax" ships,
- to remove / replace / relocate / add to navigational aids along the new channel alignment (see Figure 3 and Royal HaskoningDHV, 2016C),
- for targeted capital and maintenance dredging to achieve and maintain a minimum depth to support 16.6m ship draught in the access channel, and
- to dispose of dredged materials.

Figure 2: Study Area Showing Footprints for Proposed Dredging and Disposal of Dredged Material (Chart courtesy of LINZ, 2010).



With reference to Figure 2, a range of access channel alignments have been evaluated[1] but only the preferred access footprint (Option 4.2) is considered and described in this Assessment of Ecological Effects (see Figures 3 and 4).

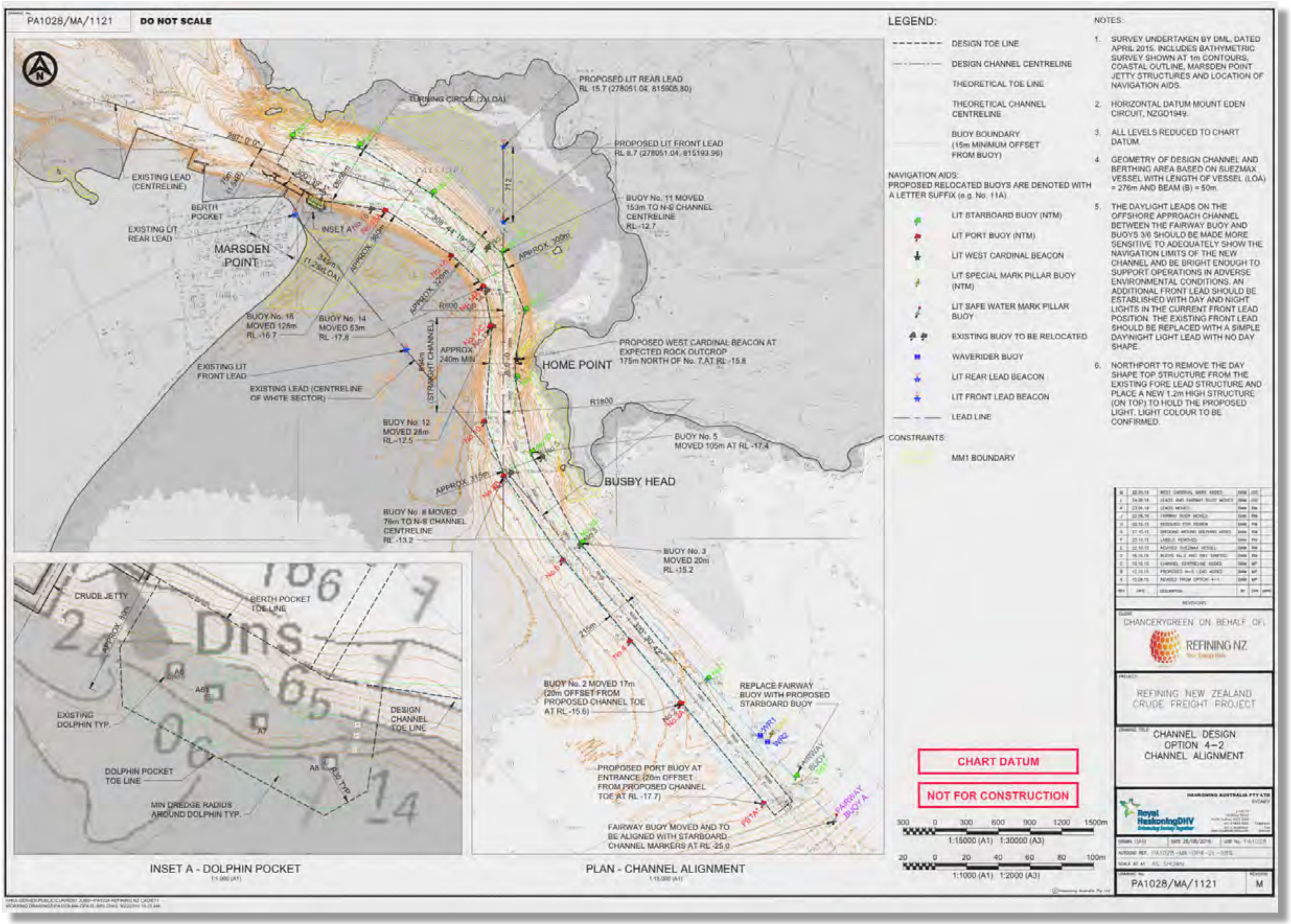
Similarly, a range of preferred options for offshore disposal sites have been evaluated[2] but only the preferred options (Areas 1.2 and 3.2) are considered and described in this Assessment of Ecological Effects (AEE).

These choices were the subject of a mid-point multi-criteria alternatives assessment by Tonkin & Taylor (2017C)

1 MetOcean Solutions (2016B), Royal HaskoningDHV (2016A), Tonkin & Taylor (2017A).

2 MetOcean Solutions (2016B), Tonkin & Taylor (2017A), West and Don (2016B), Kerr and Grace (2016E).

Figure 3: Proposed changes to Navigational Aids for Channel Alignment Option 4.2.



1.0 Executive Summary

The ecological context for these resource consent applications is that both the proposed dredging footprint and the footprint of proposed disposal areas 1.2 and 3.2 (see Figure 2) are occupied by soft-bottom benthic communities that colonise seabed materials (silts, sands, shell and gravel) that are actively sorted / moved by tidal and wave-induced disturbance effects.

Benthic communities within these soft-bottom areas of seabed are typical of the coastal environment off the north-east coast of the North Island and are included within the Marine 2 (Conservation) Management Area as recognised and defined in the Regional Coastal Plan for Northland (Northland Regional Council, 2004). They are generally dominated by sand dollars, starfish, polychaete worms, hermit crabs, flatfish, shellfish and crabs.

Proposed dredging activities would physically remove existing benthic communities from a substantial proportion of the footprint shown in Figure 2 and the placement of dredged material within Disposal Areas 1.2 and 3.2 (see Figure 2) would bury and effectively eliminate existing benthic communities within part or all of these areas.

This would result in a short-term displacement (c. 6 to 24 months – Coffey, 2017A) of benthic communities (that include shellfish resources and fish food reserves) within disturbed areas until they are expected to be recolonised by a similar assemblage of taxa that occur at a similar depth on the surrounding soft-bottom seabed.

Invasive taxa (marine pests) are also potential re-colonisers of the vacant niche that would be created by proposed disturbance activities, but are considered to be a low risk as they have not proved problematic at other comparable dredging programmes at the Ports of Auckland, Tauranga or Otago.

Benthic communities such as kelp beds and sponge gardens that occur on hard-bottom areas of Northland's Coastal Marine Area (rock and stable boulders) are of high ecological value[3] and whilst they would not be directly affected by proposed disturbance activities, submerged reefs and rocky shorelines adjacent to disturbance activities are potentially vulnerable to sediment plumes and sedimentation effects that can be associated with dredging activities and the disposal of dredged material within the Coastal Marine Area.

In this regard, there are two soft-bottom Marine 1 Management Areas (Mair Bank and Calliope Bank) and two hard-bottom Marine 1 Management Areas (Motukaroro Island Whangarei Marine Reserve and Home Point) immediately adjacent to the proposed dredging footprint (see Figure 4) where existing values are to be protected.

These management areas are from Map A3 of the Northland Regional Coastal Plan (Northland Regional Council, 2004) and it is important that their conservation values are protected from potentially adverse turbidity, sedimentation and potential fuel spill effects, for example, that can be associated with dredging activities and the disposal of dredged material.

Three Mile reef is a fishing area west of Disposal Area 3.1 (see foul ground in Figure 2 and Greenaway, 2015). Whilst not afforded any particular recognition in the Operative Regional Coastal Plan, it is recognised that Three Mile reef has local recreational and ecological value within the study area.

Table 1 provides a summary of the actual and potential ecological effects of the proposed dredging programme, the associated avoidance, remediation and compensation measures, and the magnitude of the effects post the application of the avoidance, remediation and compensation measures.

[3] e.g. Golder (2010), Hay and Grant (2004), Kamo High School (2002), Kerr and Moretti (2012), Kerr and Grace (2006A), Kerr and Grace (2006B), Morrison (2003) and Morrison (2005).

Figure 4: Marine 1 (Protection) Management Areas adjacent to the proposed dredging footprint in the approaches to Marsden Point.

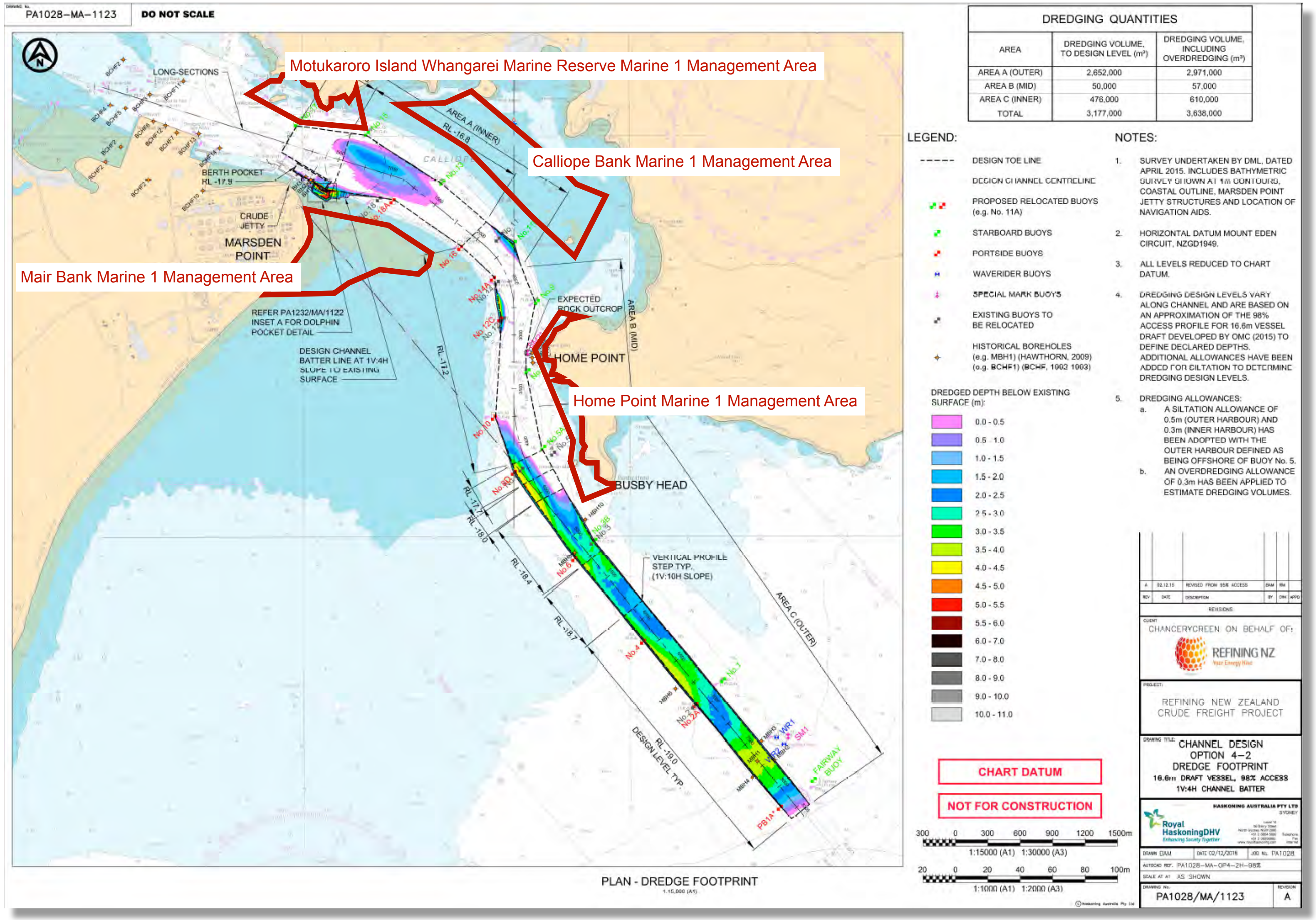


Table 1: Summary of Ecological Effects of Proposed Dredging Activities (excluding Marine Birds and Marine Mammals)).

				Actual Effects	Potential Effects	Avoidance Factors	Remediation / Compensation	Final Significance
Dredging Activities (see Figure 2)								
	Disturbance and removal of bed material							
		Seabed Effects						
			Bathymetry	Increased water depth	Changed currents / sediment transport / wave climate	Not required (MetOcean Solutions, 2016B)	Not required (MetOcean Solutions, 2016B)	Less than minor (MetOcea Solutions, 2016B)
			Exposure of new surficial sediments	Removal of benthic communities and some biological armouring	Change sediment type / texture / transport	Not required as vibrocores show similar sediment will be exposed	Contribution to enhancement of local harbour water quality / seagrass habitat for example	Minor to moderate, localise short term loss of benthos within dredging footprint
		Water Column Effects						
			Sediment Plumes	Increased sedimentation and turbidity within dredging footprint	Dissolved Oxygen sags / toxicity / sedimentation issues outside of dredge footprint	Dredged material is not contaminated and has a low silt content	Manage turbidity thresholds at boundary of adjacent habitats	Avoid effects on adjacent reef habitats, avoid / mitiga effects on others
			Suspended Solids	Increased concentration within dredging footprint	Increased concentration outside dredging footprint	Monitor and respond to turbidity limits in adjacent communities	Not applicable for adjacent reef habitats.	Avoid effects on adjacent reef communities, avoid / mitigate for effects on othe
			Turbidity	Increased value within dredging footprint	Increased value outside dredging footprint	Monitor and respond to turbidity limits in adjacent communities	Not applicable for adjacent reef habitats.	Avoid effects on adjacent reef communities, avoid / mitigate for effects on othe
			Light penetration	Decreased value within dredging footprint (but no attached macrophytes present)	Decreased value outside dredging footprint	Managed via response to turbidity limits in adjacent habitats	Not applicable for adjacent reef habitats.	Avoid effects on adjacent reef communities, less tha minor effects on others.
		Effects on Communities						
			Plankton	Less than minor due to high replenishment rates	Less than minor due to high replenishment rates	Not required	Not required	Less than minor
			Benthos	Removal & death of resident benthos from dredging footprint	Adventive pests may colonise vacant niche	Not applicable	Contribution to local enhancement of harbour water quality / seagrass habitat for example	Minor to moderate, localise short term loss of benthos within dredging footprint
			Fish and Wildlife	Minor, localised, disturbance and avoidance during dredging activities	Minor, localised, and short-term reduction in available food supplies	Not applicable	Not required	Less than minor outside c dredging footprint

Table 1 continued.

			Actual Effects	Potential Effects	Avoidance Factors	Remediation / Compensation	Final Significance
Dredge in transit between dredging / disposal sites							
		Water Column Effects	None if zero discharge from dredge	None if zero discharge from dredge	Not applicable	Not Applicable	none
		Effects on Communities	None if zero discharge from dredge	None if zero discharge from dredge	Not applicable	Not Applicable	none

Table 1 continued.

				Actual Effects	Potential Effects	Avoidance Factors	Remediation / Compensation	Final Significance
Disposal Sites for Dredged Material (see Figure 2)								
	Disturbance and Deposition of bed material							
		Water Column Effects						
			Sediment Plumes	Increased sedimentation increased turbidity within disposal footprint	Dissolved Oxygen sags / toxicity / sedimentation issues outside of disposal area	Not required. Material not contaminated and with low silt content.	Not required if placement confined to disposal area	Less than minor outside c disposal footprint
			Suspended Solids	Increased concentration within disposal footprint	Increased concentration outside disposal footprint	Monitor and respond to turbidity limits in adjacent habitats	Not required if placement confined to disposal area	Less than minor outside c disposal footprint
			Turbidity	Increased value within disposal footprint	Increased value outside dredging footprint	Monitor and respond to turbidity limits in adjacent habitats	Not required if placement confined to disposal area	Less than minor outside c disposal footprint
			Light penetration	Decreased value within disposal areas (but attached macrophytes not present)	Reduced value outside disposal footprint	Managed via response to turbidity levels in adjacent habitats	Not required due to lack of attached macrophytes within disposal areas	Less than minor outside c disposal footprint
		Effects on Communities						
			Plankton	Less than minor due to high replenishment rates	Less than minor due to high replenishment rates	Not required	Not required	Less than minor
			Benthos	Burial & death within disposal footprint	adventive pests may colonise vacant niche	Not applicable	Contribution to local enhancement of harbour water quality / seagrass habitat for example	Minor to moderate, localise short term loss of bentho: within disposal areas
			Fish and Wildlife	Minor, localised, disturbance and avoidance during disposal activities	Minor, localised, and short-term reduction in available food supplies	Not applicable	Not required	Less than minor outside c disposal footprint

Table 1 continued.

			Actual Effects	Potential Effects	Avoidance Factors	Remediation / Compensation	Final Significance
Changes to Navigation Aids (see Figure 3)							
		Water Column Effects	Less than minor because of limited footprint	Less than minor because of limited footprint	Not applicable	Adoption of Best Industry Practices	Less than minor
		Effects on Communities	Less than minor because of limited footprint	Less than minor because of limited footprint	Not applicable	Adoption of Best Industry Practices	Less than minor

Table 1 considers the:

- disturbance and removal of bed material from the proposed dredging footprint,
- transport of seabed material between the dredging and disposal areas,
- disposal of dredged material at offshore disposal sites, and
- effects of changes to navigation aids for Alignment Option 4.2.

It is considered that bathymetric changes at dredging and disposal sites will have less than minor effects on current wave climate and water currents (Tonkin & Taylor, 2017B; MetOcean Solutions, 2016B).

Survey and analytical results presented in this AEE provide reassurance that the concentration of metals and potentially toxic organic materials associated with seabed materials that are to be relocated from the access channel to the two nominated disposal sites are not likely to be associated with toxicity issues (Maritime Safety Authority of New Zealand, 1999).

Similarly, a low proportion of silt and organic matter in seabed materials that will be dredged and disposed of is expected to avoid water quality issues in plumes (such as excessive turbidity and dissolved oxygen sags) beyond a reasonable mixing zone down-current of disturbance activities.

Stewart (2017) established a 1:1 correlation between the concentration of suspended solids ($g.m^{-3}$) and turbidity (Nephelometric Turbidity Units [NTU]) when these particular seabed sediments are temporarily suspended in the water column. This permits real time monitoring of potential sedimentation effects (suspended solids concentrations) during proposed disturbance activities using field turbidity meters.

Provided there is no discharge from the Trailing Suction Hopper Dredger when it is in transit between dredging and disposal sites, no ecological effects are expected to be associated with the transport of material between dredging and disposal areas.

Due to the limited footprint and construction methodology involved, the ecological effects of modifying navigation aids for Alignment Option 4.2 are expected to be less than minor.

Therefore, provided adverse sedimentation effects can be confined to the nominated footprint of both dredging and disposal footprints,

- water column effects,
- effects on plankton, fish and wildlife, and
- effects on adjacent coastal habitats (particularly the more sensitive rocky intertidal areas, submerged reefs and ecologically significant banks),

are expected to be localised and minor or less than minor.

Potential sedimentation effects down-current of dredge activities are to be managed by responding to real time turbidity recorders on the boundaries of adjacent habitats.

Provisional turbidity limits / thresholds have been derived / are being developed that require the following responses in terms of concurrent operational controls on dredging / dredged spoil disposal activities.

- Level 1: the reason for elevated suspended solids concentrations down-current of the operational dredge need to be investigated,
- Level 2: operational changes are required by the dredge to reduce down-current suspended solids concentrations, and
- Level 3: suspended solids concentrations down-current of the operational dredge result in dredge activities being stopped.

Best management practices are also proposed to avoid, to the greatest extent practicable, the potential for issues such as hydrocarbon spillages within, and adjacent to disturbed areas. Navigational and environmental risk have been separately assessed (Bilderbeck and Oldham, 2016: Oldham and Bilderbeck, 2017) and it has been concluded there would be benefits of improved navigational safety resulting from the RNZ dredging proposal.

The capital dredging programme would result in the short term (6 to 24 months) displacement / reduction of benthic productivity within a 4.37 km^2 (437 ha) area of seabed (see Figure 2 and Coffey, 2017A). While these soft-bottomed areas include indigenous taxa, they are not of national or regional significance and no benthic taxa within these predominantly sandy sites are considered to be endangered or at risk.

Nevertheless, due to the local and short-term effect of proposed dredging activities on benthic productivity, some form of compensation is considered to be appropriate. Compensation in the form of a contribution to the enhancement of the overall health of the Whangarei seagrass communities within and adjacent to the study area is recommended for consideration (Coffey and Stewart, 2017).

A monitoring programme is recommended to describe the effects of the dredging programme separately from other temporal ecological changes that are occurring within the study area.

The baseline description of pre-impact community structure by Bioresearches, Kerr and Associates and the Cawthron Institute (within and adjacent to areas that would be disturbed by the proposed dredging programme) is considered to be robust in terms of providing a comparison with post impact surveys of the same areas. However, a benchmark description of seagrass and shellfish communities (that are in a current state of flux) requires to be undertaken immediately prior to capital dredging activities.

2.0 General Introduction to the Existing Environment and Existing Values within the Study Area (see Figure 2)

The character of an area of marine coastline is largely determined by latitude and the water currents that flood it.

Notwithstanding direct developers such as marine gastrods and lecithotrophic larvae (e.g. some fish and some benthic invertebrates such as tunicates) most benthic invertebrates have a planktotrophic larval development where larvae join the plankton and are dispersed by water currents. If adequate quality habitat is available downstream of where planktotrophic marine organisms spawn and form offspring, sessile organisms will settle out of the plankton to colonise benthic habitats and pelagic / demersal taxa will form part of the downstream water column community.

Along the north-east coast of New Zealand (from North Cape down to East Cape), the most influential current is the East Auckland Current that introduces a tropical / subtropical element into the marine flora and fauna from the Kermadec and Three Kings Islands.

Commercial fisheries such as crayfish, paua, cockles, pipi, scallops, fin fish and edible seaweeds rely on recruitment from resident populations upstream of a particular locality. This explains much of the resilience of marine communities to overfishing and disturbance events in that once such disturbance factors cease, there is the potential for recruitment via planktonic larvae to recolonise previously compromised habitats.

In contrast to waters south of the subtropical convergence, the East Auckland Current is warmer, more transparent and more saline than subantarctic waters and supports kelp forests to a depth of 30 m on rocky reefs along the eastern coast of Northland.

The setting of the East Auckland Current during summer is associated with a world renowned big game fishery off the Northland coast down to White Island in the Bay of Plenty. The most prized catches include billfish such as marlin.

The East Auckland Current occasionally delivers a range of novel taxa such as sun fish, sea turtles, sea snakes, manta and devil-spined rays to Northland's east coast (Morrison, 2005).

The most informative articles describing the extraordinary marine biodiversity that occurs on the open coast and offshore islands of Northland are arguably that of Morrison (2005) and Andrew and Francis (2003).

2.1 Climate and Exposure

Northland, with its low elevation and close proximity to the sea is characterised by a mild, humid, and rather windy climate. Summers are warm and tend to be humid, while winters are mild, with many parts of the region having only a few light frosts each year. Rainfall is typically plentiful, all-year round, with sporadic very heavy falls. However dry spells do occur, especially during summer and autumn.

Most parts of Northland receive about 2000 hours of sunshine per year. It can be very windy in exposed areas and occasionally Northland experiences gales, sometimes in association with the passage of depressions of tropical origin (Chappell, 2013).

In enclosed waters, such as Whangarei, Kaipara, and Hokianga Harbours, wind generated waves are unlikely to exceed two metres. This is because winds required to generate such waves would need to be either a steady 70 $km.hr^{-1}$ or more (a very rare event in Northland), or would require a longer fetch than the enclosed harbours provide (Chappell, 2013).

On the east coast of Northland, swells from an easterly or north-easterly direction tend to predominate. These can originate from tropical cyclones well to the north of New Zealand or from anticyclones far to the east. Of all swells observed on the eastern coast the frequency of those less than one metre is about 40 percent, while for those greater than two metres is eight percent (Gorman et al., 2003).

Whilst Bream Head and the Hen and Chicken Islands offer some protection to Bream Bay in terms of the wave climate (see Figure 1), the entrance to Whangarei Harbour can be very exposed in occasional south-easterly storms.

In Bream Bay, seawater temperatures vary from 24-25°C in summer and 13-14.5°C in winter (Golder (2010).

2.2 Bathymetry, Water Currents and Seabed / Shoreline Types

Whangarei Harbour is a drowned river valley system that covers some 10,000 ha and includes 5,400 ha of intertidal flats, 1,400 ha of mangroves and 200 ha of saltmarsh (Morrison 2003).

The harbour is connected to Bream Bay via a 2.4 km wide inlet between Marsden Point and Home Point. The main channel extends inland some 24 km in a north-westerly direction and then divides into two arms, the Hātea River in the north and the Mangapai River in the south.

The harbour drains a catchment of 29,507 ha that has been heavily modified, with a large amount of native vegetation cleared for urban use in the north-west and agricultural land use in the east and south.

Water currents within Bream Bay and at the mouth of the harbour have been measured and modelled by MetOcean Solutions (2016B). Relatively low wind speeds, low to moderate wave heights and moderate tidal currents are associated with the confines of the entrance channel. Calm conditions (winds less than 2 $m.s^{-1}$) occur more than 90% of the time and moderate to low wave climate (sea and swell wave heights less than 1 m) occur for more than 90% of the time at the entrance to the channel. Within the mid and inner parts of the channel, wave heights are less than 0.6 m 99% of the time. Peak tidal velocities reach 2.0 to 2.5 knots over the length of the channel (MetOcean Solutions, 2016B).

Bream Bay and Whangarei Harbour tides have a period of 12 hours and 25 minutes, and a mean tidal range of 1.36 m for neap tides to 2.25 m for spring tides (LINZ, 2004, 2010).

Bream Bay is a sand-dominated environment, forming a key part of offshore sand resources present on this coastline that extend southward to Pakiri Beach. Soft shorelines also dominate the southern (right bank shores of the lower harbour and entrance channel (see Figure 4). Calliope and Mair Banks fringe the deep sandy-shell channel in the lower harbour.

The 18 km stretch of coastline along Bream Bay from Marsden Point to the Waipu River Mouth (see Figure 1) is largely comprised of clean exposed beach with up to 5 m high fore dunes accreting and eroding in response to storm events. Bream Bay has a wide (80 m) mid to low tide platform seaward of a relatively narrow (9 m) mid to high tide rise to an upper beach platform at the seaward base of the fore dune (Coffey, 2004).

However, the northern shoreline of Bream Bay (Busby Point to Bream Head) is a predominantly rocky headland that bottoms out onto sand in approximately 10 m water depth, with small sandy beaches in the western sector of the northern shoreline and in Smugglers Bay.

Similarly, the downstream section of Whangarei Harbour and northern (left bank) shoreline of the entrance includes hard shore communities between Busby Head and Home Point, at High and Motukararoro Islands, and on headlands between Darch Point and Home Point.

Moreover, there is an area of foul ground shown on Marine Chart NZ 5219 (Approaches to Marsden Point, LINZ, 2010) inshore of Disposal Area 3.2 (see Figure 2) that is known locally as three-mile reef.

Kerr and Grace (2016D) have logged reference photoquadrats for this area that show it includes a rocky–boulder lined seabed that supports a low-profile reef community that is partially / intermittently covered by sand and shell movement along the seabed.

2.3 Soft Seabed Sediment Quality and Sediment Transport

Basement rock for Whangarei Harbour and catchment area consists of greywacke from the Waipapa Group, which is overlain by sedimentary rocks, andesitic volcanic facies and quaternary sand and mud deposits (Northland Harbour Board 1989). The landform behind Bream Bay is dominated by Quaternary dune sands (Edbrooke and Brook, 2009).

The sand in Bream Bay consists of feldspar (65-70%), quartz (25%), rock fragments (1 -4%), heavy minerals (1-4%), shell (1-2%), and a variable amount of organic material (Christie & Barker 2007) and is generally low in organic carbon (Golder, 2010).

West and Don (2016B) and Tonkin & Taylor (2017B) have described the chemical characteristics and particle size composition of soft seabed sediments within the proposed dredging footprint which were relatively “clean” predominantly medium and fine sands with low silt contents (less than 6%).

Kerr and Grace (2016C) have described soft sediment quality within Disposal Area 1.2. Kerr and Grace (2016B) and the Cawthron Institute (Appendix B) have described soft sediment quality within Disposal Area 3.2.

Black (1983) reported sediment transport occurs in a northerly direction in Bream Bay towards Mair Bank then out of Whangarei Harbour via the main channel.

2.4 Occurrence and Quality of Reef Structures and Hard Shorelines

Within the study area, reef structures and hard shorelines occur along the northern shoreline of Bream Bay (Busby Point to Bream Head). In the downstream section of Whangarei Harbour, hard shore communities also occur between Busby Head and Home Point, at High and

Motukararoro Islands (including the marine reserve), and on headlands between Darch Point and Home Point.

Kerr and Associates (2016A) have described reef structures and hard shoreline communities adjacent to the dredging footprint in the downstream section of Whangarei Harbour.

The high quality of these habitats has been confirmed by Golder (2010), Hay and Grant (2004), Kamo High School (2002), Kerr and Moretti (2012), Kerr and Grace (2006A), Kerr and Grace (2006B), Morrison (2003) and Morrison (2005).

2.5 Water Quality

2.5.1 Introduction and Background

Water quality in Bream Bay and in the Lower Whangarei Harbour (see Figure 5) is generally good, as a result of regular tidal flushing with ocean water (Andries, C., 2010; Beca Planning, 2002; Cornelisen, et. al., 2011; Golder, 2010; Griffiths, R., 2013; MWH, 2009; Northland Regional Council, 2004; Northland Regional Council and Whangarei District Council, 2012; Northland Regional Council, 2012) and supports high habitat quality in the four Marine 1 Management Areas shown in Figure 4.

Figure 5: Water Quality Sampling Sites Monitored by Northland Regional Council (2011).

Tweddle et. al. (2011) have summarised 10 years of monitoring data for 16 sites in Whangarei Harbour (see Figure 5) and MWH (2009) have reported on baseline water quality monitoring sites in the lower Whangarei Harbour and in Bream Bay between 2008 and 2009 (Figure 6).

The MWH (2009) water quality data were sourced from field sampling that was undertaken by Northland Regional Council staff for Whangarei District Council at nine sites in Bream Bay, Whangarei Harbour entrance and Ruakaka River over the period June 2008 to May 2009. Surface water samples were collected on seven occasions, including ebb and flood tides, and dry and wet weather.

Figure 6: Water Quality Sites Monitored by MWH (2009).

Northland's Regional Coastal Plan (Northland Regional Council, 2004) has adopted water quality standards for coastal waters (see Table 2). These standards specify acceptable changes to ambient water quality as a result of a discharge for example and in the lower Whangarei Harbour, a general quality standard CA applies.

In the case of Bream Bay which is a Marine 2 (Conservation) Management Area, general performance standards as listed in section 31.4.13 of the Regional Coastal Plan apply (Northland Regional Council, 2004).

Section 31.4.13 of the Regional Coastal Plan states that discharges to water shall, after reasonable mixing, comply with the relevant receiving water quality standards and shall not contain any contaminants which could cause:

(i) the production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials.

(ii) any conspicuous change in the colour or visual clarity of the receiving waters.

(iii) any emission of objectionable odour.

(iv) accumulation of debris on the foreshore or seabed underlying or adjacent to the discharge point.

(v) any significant adverse effects on aquatic life or public health.

The requirements of section 31.4.13(c) of the Regional Coastal Plan closely reflect section 107(1) of the RMA and Policy 4.4.1 of the Northland Regional Policy Statement (Northland Regional Council, 2016B).

Neither the Regional Coastal Plan nor the RMA define an appropriate mixing zone. Instead, this is to be determined having regard to the attributes of a particular location (for instance, currents, tides, bathymetry, and roughness coefficient of the seabed).

Table 2: Coastal water quality standards (Northland Regional Council, 2004).

	Standards for Coastal Waters
Standard	General Quality Standard CA (for lower Whangarei Harbour)
Purpose	Provides for virtually all uses and protection of marine ecosystems
Natural temperature	Not changed by more than 3°C
Natural pH	Not changed by more than 0.2 units
Concentration of dissolved oxygen	Not reduced below 80% saturation
Natural visual clarity	Not reduced more than 20%
Natural hue	Not changed more than 10 Maunsell units
Natural euphotic depth	Water deeper than $0.5.z_{eu}$ not changed more than 10% Water shallower than $0.5.z_{eu}$ maximum reduction in light at sediment bed not more than 20%
Oil/grease film, scum, foam, odour	No conspicuous oil or grease film, scums or foams, floatable or suspended materials, or emissions of objectionable odour
Toxic Metals	
Total Arsenic	50 mg/m^3
Total Cadmium	2 mg/m^3
Total Chromium	50 mg/m^3
Total Copper	5 mg/m^3
Total Lead	5 mg/m^3
Total Zinc	50 mg/m^3
Faecal Coliforms	Based on not fewer than 10 samples for any 30-day period median < 14/100 ml 90%ile < 43/100 ml
Nutrients (Default standards in the absence of specific site investigations)	DRP 1-10 mg/m^3 NO3-N 10-60 mg/m^3 NH4-N <5 mg/m^3
Other toxicants and parameters	As per Table 2.1 of ANZECC Water Quality Guidelines 1992

Here, a reasonable mixing zone within Bream Bay is considered to be in the order of 300m (20 x average water depth), however in proximity to some hard-shore communities (e.g. Home Point) only 100m is available for a mixing zone (Tonkin & Taylor, 2016C).

The same performance standards as Section 31.4.13 of the Regional Coastal Plan for Marine 2 (Conservation) Management Areas, apply to Section 31.7.12 for Marine 5 (Port Facilities) Management Areas in which dredging activities will occur in the lower Harbour.

In terms of the Section 31.4.13(v) of the Regional Coastal Plan and Chapter 19 of the Regional Coastal Plan (Northland Regional Council, 2004), humans are not expected to come into contact with sediment plumes that might be generated by proposed disturbance activities and survey and analytical results presented in this AEE, provide reassurance that seabed materials that are to be relocated from the access channel to the two nominated disposal sites are not contaminated with toxic metals or potentially toxic organic materials (Maritime Safety Authority of New Zealand, 1999).

2.5.1a Harbour Sites

Tweddle et. al. (2011) reported that sites within Whangarei Harbour with the best water quality ("judged according to Coastal Water Quality Standards, Table 2) are located close to the harbour entrance and sites with the worst water quality are located in the Hātea River and the Mangapai River.

Sites near the entrance of the harbour are more heavily influenced by coastal water, while sites in the Hātea and Mangapai Rivers, are more influenced by freshwater input from rivers and streams. By ranking sites based on results from seven parameters, the site with the best water quality was located at Marsden Point and the site with the worst water quality was located in the Waiharohia Canal.

Of the parameters where default trigger values have been developed by ANZECC, the median value was within the recommended guideline for turbidity, dissolved oxygen (%) and enterococci at all sites.

Four sites had a median value that fell outside of the guideline value for faecal coliforms; all 16 sites had a median value outside of the guideline value for dissolved reactive phosphorus; 10 sites had a median that fell outside of the guideline value for total phosphorus; 13 sites had a median value that fell outside of the guideline value for nitrate-nitrite nitrogen; and nine sites had a median value that fell outside of the guideline value for ammonium.

Water temperatures were lower in Blacksmith Creek than One Tree Point, Snake Bank, Marsden Point or Mair Bank. Dissolved Oxygen concentrations were highest and the enterococci numbers were lowest in the harbour entrance.

Nutrients were present at the lowest concentrations at the Harbour entrance but some such as Dissolved Reactive Phosphorus exceeded Table 2 guideline values at all harbour sites.

2.5.1b Bream Bay Sites

MWH (2009) found nutrient levels are higher in winter and become depleted over summer. The principal cause of nutrient depletion is uptake by microalgae (phytoplankton and microphytobenthos), which reach their highest concentration in late winter and spring. Three sources of nutrient replenishment are identified, these being recycling from the seafloor, inputs from deep oceanic upwelling and inputs from terrestrial sources following freshes or floods in the Ruakaka River and other watercourses.

The results of this monitoring programme confirm that the Ruakaka River has a significant influence on the water quality of a large portion of Bream Bay at times of fresh or flood. Other watercourses discharging to upper Whangarei Harbour and Bream Bay will also contribute to changes in Bream Bay water quality in wet conditions.

2.5.2 Suspended Solids, Turbidity and Light Penetration

Water quality data that are of particular interest to this assessment are those relating to water clarity and suspended solids, as these can be potentially affected by dredging activities and the disposal of dredged materials. However, in some instances nutrient release from sedimentary pore waters related to the disturbance of benthic sediments may also be of concern during dredging activities.

Table 3 summarises the turbidity data generated by Tweddle et. al. (2011) for the Whangarei Harbour monitoring sites shown in Figure 5.

Harbour sites (from Tweddle et. al., 2011) that were of particular interest to this study were Marsden Point and Mair Bank which are in the Lower Harbour (see Figure 5).

The ANZECC (2000) default trigger values for turbidity in estuarine and marine environments are 0.5-10 NTU (note this is for south eastern Australia as there are no trigger values established for NZ). None of the sites had median values for turbidity that exceeded 10 NTU (see Table 2). The highest median values for turbidity (lowest water clarity) were found at sites close to freshwater inputs in the Mangapai River and the Hātea River.

Sites with the lowest median turbidity (highest water clarity) were located near the harbour entrance at One Tree Point, Blacksmith’s Creek, Marsden Point and Mair Bank, where freshwater inflows are likely to have less influence on water quality. However, it is of interest that turbidity at Snake Bank ranged from 1.0 to 15.3 NTU.

Both turbidity and Secchi depth visibility are measures of water clarity. Table 4 summarises Secchi depth visibility at a number of Whangarei Harbour sites (Tweddle et. al. (2011).

Table 3: Turbidity (NTU) at 16 sites in Whāngārei Harbour, 2000-2010.

Site Name	No. of Samples	Range (NTU)	Median (NTU)	% of samples within guideline value (<10 NTU)
One Tree Point	25	0.5 – 5.7	1.0	100
Blacksmith's Creek	18	1.0 – 3.4	1.0	100
Marsden Point	38	0.4 – 6.6	1.0	100
Mair Bank	39	0.2 – 2.4	1.0	100
Snake Bank	18	1.0 – 15.3	2.1	94
Tamaterau	39	1.0 – 37.0	2.9	92
Town Basin	25	3.4 – 63.0	5.0	92
Onerahi	18	2.5 – 12.4	5.1	89
Lower Port Road	18	3.6 – 11.9	5.4	89
Kaiwaka Point	22	3.4 – 11.7	5.4	91
Kissing Point	50	2.8 – 92.0	5.4	94
Riverside Drive	18	3.4 – 11.1	5.7	94
Waiharohia Canal	18	3.4 – 13.2	6.6	83
Portland	18	4.0 – 18.1	7.4	78
Limeburners Creek	25	4.1 – 67.0	7.9	88
Mangapai	18	4.6 – 15.2	9.3	67

There are currently no ANZECC default trigger values for Secchi depth. A similar spatial trend to turbidity was observed, with the lowest median Secchi depths (lowest water clarity) found in the Hātea River and Mangapai River, and the highest median Secchi depths (highest water clarity) found near the harbour entrance.

Table 4: Secchi depth visibility in Whāngārei Harbour, 2000-2010.

Site Name	No. of Samples	Range (m)	Median (m)	% of samples within guideline value
Marsden Point	37	0.9 – 9.0	4.5	N/A
Blacksmith's Creek	15	1.6 – 6.0	4.0	N/A
Mair Bank	34	1.8 – 7.5	3.85	N/A
One Tree Point	24	2.0 – 6.3	3.8	N/A
Snake Bank	14	1.3 – 7.0	3.65	N/A
Tamaterau	33	0.3 – 4.7	2.4	N/A
Onerahi	17	0.9 – 2.2	1.5	N/A
Kaiwaka Point	18	0.47 – 1.8	1.4	N/A
Lower Port Road	17	0.8 – 1.7	1.3	N/A
Portland	17	0.6 – 2.1	1.3	N/A
Town Basin	18	0.5 – 1.9	1.23	N/A
Kissing Point	47	0.15 – 2.1	1.2	N/A
Waiharohia Canal	17	0.7 – 2.0	1.1	N/A
Riverside Drive	17	0.7 – 1.8	1.0	N/A
Limeburners Creek	21	0.3 – 2.2	1.0	N/A
Mangapai	17	0.2 – 1.5	0.9	N/A

Median Secchi disc values of 3.65 to 4.5 m for One Tree Point, Snake Bank, Blacksmith Creek, Marsden Point and Mair Bank represent good water clarity (>2.0 metres).

Water clarity can be reduced by the growth of phytoplankton and human activities that increase levels of suspended solids entering the coastal environment. High levels of material in the water column can restrict light transmission which affects the amount of photosynthesis (primary production) of aquatic plants and consequently other species that are dependent on them such as fish, zooplankton and shellfish.

Seaweeds and seagrass typically require more light for photosynthesis than phytoplankton and are particularly susceptible to reduced light levels resulting from suspended sediments by nature of being attached to the seabed (Thrush *et al.*, 2004). High concentrations of

suspended sediments can also clog fish gills and reduce the ability of fish to see prey and detect predators (ANZECC, 2000).

MWH (2009) reported turbidity and suspended solids data for the lower Whangarei Harbour and Bream Bay between June 2008 and May 2009. Suspended solids and turbidity levels were elevated in the Ruakaka River (Site 9) but generally low at the harbour entrance and in offshore sites, although some variability was evident at most locations. During the heavy rainfall event of 16 June 2009, high suspended solids concentrations were recorded in the Ruakaka River and in the Bay, offshore and south of the river mouth. On that occasion, on the ebb tide, a clearly visible coloured and turbid plume extended from the river mouth out into the Bay and to the south. That plume would be expected to migrate to the north on the flood tide (MWH, 2009).

There was a poor correlation between turbidity and suspended solids concentrations for this data base (MWH, 2009). However, on the basis of turbidity reaching 23.7 NTU at Site 3 in December 2008, it appears that background levels of turbidity may occasionally exceed the ANZECC guideline of 10 NTU.

Stewart (2017) has analysed back up vibrocore samples from the dredging foortprint (see Section 4.1.1b) and has established there is a 1:1 relationship for Total Suspended Solids ($g.m^{-3}$) and Turbidity (NTU) when these bed materials are suspended in the water column.

This relationship is important for relating plume modelling data (based on suspended solids data) to the ANZECC (2000) default trigger values for turbidity in estuarine and marine environments.

2.5.3 Water Quality at Marsden Point and Mair Bank

Water quality at Marsden Point and Mair Bank between 2000 and 2010 in relation to Northland Coastal Water Quality Standards is summarised in Table 5 (Tweddle et. al., 2011).

Table 5: Water quality at Marsden Point and Mair Bank (Tweddle et. al. (2011) in relation to coastal water quality standards CA (Northland Regional Council, 2004).

Parameter and standard	Marsden Point: Median (range)	Mair Bank: Median (range)
Turbidity <10 NTU	1.0 (0.4 – 6.6)	1.0 (0.2 – 2.45)
Dissolved oxygen >80% saturation	96.8 (80.9 – 137.2)	98.1 (81.2 – 135.5)
Enterococci <140/100mL	5 (1 – 31)	5 (1 – 42)
Faecal Coliforms <14/100ml	1 (1 – 20)	1 (1 – 68)
Total Phosphorus <0.03 mg/L	0.015 (0.005 – 0.03)	0.014 (0.005 – 0.032)
Dissolved Reactive P 0.01 mg/L	0.008 (0.005 – 0.015)	0.007 (0.005 – 0.028)
Nitrate nitrogen <0.015 mg/L	0.015 (0.001 – 0.057)	0.017 (0.001 – 0.050)
Ammonium (<0.015 mg/l)	0.005 (0.005 – 0.36)	0.005 (0.005 – 0.37)

Turbidity records at both Marsden Point and Mair Bank were fully compliant with < 10 Nephelometric Turbidity Units during this sampling period.

Dissolved oxygen saturation was also fully compliant with CA water quality standard of > 80% saturation.

Enterococci counts were all <140 cfu per 100ml, with 98% and 97% compliance with the Faecal Coliform standard of <14 cfu per 100ml for CA water quality.

Marsden Point samples were 100% compliant with the Total Phosphorus threshold of 0.03 milligrams per litre. Mair Bank samples were 87% compliant with the Total Phosphorus threshold of 0.03 milligrams per litre. Dissolved Reactive Phosphorus concentrations at Marsden Point were 65% compliant with a CA water quality standard of 0.01 mg/l compared to 73% of samples at Mair Bank.

Compliance with a CA water quality standard of 0.015 mg/l for Nitrate Nitrogen was 50% for Marsden Point samples and 46% for Mair Bank samples.

Compliance with a CA water quality standard of 0.015 mg/l for Ammonium Nitrogen was 89% for Marsden Point samples and 87% for Mair Bank samples.

2.5.4 Water Quality within Bream Bay

Specific water quality data for Bream Bay was provided by MWH (2009) to support the resource consent application by Whangarei District Council to discharge wastewater from the Ruakaka wastewater treatment plant via an offshore diffuser in Bream Bay. That data showed that freshwater inputs from the Ruakaka River can adversely impact water quality in Bream Bay during wet weather events, but generally the Bay is flushed with highly transparent oceanic water that may during winter and spring, support phytoplankton blooms.

2.6 Marine Community Structure

Golder (2010), Hay and Grant (2004), Kamo High School (2002), Kerr (2016A and 2016B), Kerr and Moretti (2012), Kerr and Grace (2006A, 2006B, 2016C, 2016D and 2016E), Morrison (2003) and West and Don (2015, 2016A and 2016B) have all described the high biodiversity of marine communities in Bream Bay and the Lower Whangarei Harbour.

2.6.1 Plankton

Plankton is a combination of phytoplankton, zooplankton, bacteria and dispersing larvae. Marine phytoplankton around the New Zealand shoreline includes some 620 species of diatom and 230 marine species dinoflagellates.

Phytoplankton provide nearly half of the earth's atmospheric oxygen, they regulate carbon dioxide levels in the water and atmosphere and they are the founding organisms of aquatic food webs.

The distribution and quantity of phytoplankton depends on light penetration, the stability of water layers and the availability of nutrients. Around New Zealand there is usually a spring-time bloom of phytoplankton algae in surface waters. At this time, surface temperatures rise, sunlight hour's increase and nutrients become abundant following winter cooling and the stirring action of storms. Phytoplankton grow and reproduce rapidly, doubling their population each day and sometimes reaching nuisance proportions. Increased growth may raise toxicity levels and deplete the water of oxygen. However, phytoplankton usually exhaust their nutrient supply before this happens. Phytoplankton numbers are generally kept in check by grazing zooplankton.

Zooplankton around the New Zealand shoreline include about 1,000 species of foraminifera and 150 species of radiolarian, but it is the copepods that form the most important link from phytoplankton to other animals in the food chain. Bacteria digest copepod faeces, and by doing so, release nutrients back into the water that help sustain the phytoplankton.

Within Bream Bay coastal waters nutrient levels are higher in winter and become depleted over summer. The principal cause of nutrient depletion is uptake by phytoplankton, which reach their highest concentration in late winter and spring. Three sources of nutrient replenishment are recycling from the seafloor, inputs from deep oceanic upwelling and inputs from terrestrial sources following freshes or floods in the Ruakaka River and other watercourses (MWH, 2009).

There is also ample evidence that extensive algae blooms within the study area might be directly related to oceanic upwelling driven by north-westerly wind stress MWH (2009).

A few phytoplankton species produce powerful toxins. In suitable conditions, they can grow and reproduce in great abundance, creating what is called a toxic bloom. They produce poisons that accumulate in the bodies of filter-feeding shellfish such as oysters, mussels, pipi and cockles. Usually the shellfish remain unaffected, but the fish, shore birds and marine mammals which eat them can be poisoned and die. In humans, they can cause paralysis, respiratory difficulty, memory loss or diarrhoea.

New Zealand has recorded four types of toxin, with at least 34 different species responsible. An extensive toxic algal bloom affected the north-east coast of the North Island during the summer of 1992-1993 and caused food poisoning to a large number of people (>100) who ate shellfish contaminated with the toxins (MacKenzie et al. 1995). The effects of the bloom extended from the Firth of Thames/Coromandel area to at least as far north as Bream Bay and Whangarei Harbour. Following this outbreak, shellfish toxins have been regularly monitored. It is becoming increasingly common for areas of the North Island coast and the Marlborough Sounds to close shellfish gathering during spring and summer.

Whangarei Harbour has a history of such issues which resulted in the Northland Regional Council imposing restrictions on dredging in Whangarei Harbour outside of winter months. The rationale for imposing dredging restriction in the harbour was that dredging during the summer “high risk period”, might lead to the generation of new blooms by re-suspending the resting cysts of the micro-algae that caused the problem in the water column.

Mackenzie (2009) undertook a risk evaluation of dredging and the potential for harmful algal bloom initiation in Whangarei Harbour, and recommended the seasonal restriction on dredging in Whangarei Harbour could be relaxed. The species that caused the 1992 – 1993 event has no known benthic resting cyst in its life cycle and there is nothing to suggest that toxic shellfish blooms will reoccur in the harbour as a result of earlier incidents.

In terms of monitoring marine plankton around the New Zealand coast, the traditional approach of using plankton nets or settling plankton from water samples for counting under an inverted microscope has now largely been replaced by Ocean colour data from the NASA Seaviewing Wide Field-of-view Sensor (SeaWiFS) being used to estimate chlorophyll a concentrations in sea water.

New Zealand northern subtropical and Tasman Sea waters have a classical cycle of spring and autumn chlorophyll blooms consistent with production being co-limited by nitrate and light. Subantarctic waters have a low-magnitude annual cycle of chlorophyll abundance that peaks in early autumn, consistent with production being predominantly limited by a combination of iron and light (Murphy et. al., 2001).

2.6.2 Benthos

These are the bottom-dwelling communities that will be adversely impacted by the dredging, disposal and navigation aid modification / construction activities described in Section 3. Fish, marine mammals and marine birds have the ability to avoid disturbance areas.

In addition to literature surveys (West and Don, 2015A; Coffey 2016B), the source of the novel benthic database generated on behalf of RNZ for this AEE is summarised in Table 6.

West and Don (2016A) described benthos, sediment particle size and sediment chemistry in three candidate disposal areas that have not progressed to the identification of the preferred disposal sites. That information is still useful in terms of describing adjacent soft bottom sites.

West and Don (2016B) have provided a detailed description of the existing marine ecology in the dredging footprint (benthos, sediment particle size and chemistry for surficial sediments). The sampling footprint used by West and Don (2016B) extended beyond the final Option 4.2 dredging footprint, particularly in the outer channel (see Figure 7).

Table 6: Source of ecological data (excluding marine mammals and birds) generated on behalf of RNZ that has been used for this Assessment of Environmental Effects.

		Work Undertaken / reported by:			
		Field Sampling	Benthic ID and Counts	Contaminant Testing	Particle Size Analysis
Dredging Footprint					
	Photoquadrats	West & Don 2016B			
	Grab & Dredge Samples	West & Don 2016B*	West & Don 2016B*	Hill Labs*	WU*
	Vibrocore Samples	Tonkin & Taylor 2016C		Hill Labs (App C)	WU (App C)
Disposal Area 1.2					
	Photoquadrats	Kerr & Grace 2016E			
	Diver Core Samples	Kerr & Grace 2016E**	Cawthron (App A1)	Hill Labs **	WU **
Reference Areas 1.2A and 1.2B					
	Photoquadrats	Kerr & Grace 201CE			
	Diver Core Samples	Kerr & Grace 2016C**	Cawthron (App A1)	Hill Labs**	WU **
Disposal Area 3.2					
	Photoquadrats	Kerr and Grace 2016D			
	Grab Samples	Cawthron	Cawthron (App A2)	Hill Labs (App B)	WU (App B)
Reference Areas 3.2A and 3.2B					
	Photoquadrats	Kerr and Grace 2016C			
	Grab Samples	Cawthron	Cawthron (App A2)	Hill Labs (App B)	WU (App B)
Adjacent Habitats: Soft Bottomed					
	Photoquadrats	Kerr & Ass. 2016A			
		Kerr & Ass. 2016B			
	Photoquadrats	West & Don 2016A			
	Grab & Dredge Samples	Kerr & Ass. 2016A***	Kerr & Ass. 2016A***		WU ***
		Kerr & Ass. 2016B^	Kerr & Ass. 2016B		WU ^
	Grab & Dredge Samples	West & Don 2016A^^	West & Don 2016A	Hill Labs^^	WU ^^
Adjacent Habitats: Hard-Bottomed					
	Photoquadrats	Kerr & Ass. 2016B	Kerr & Ass. 2016B		
		Kerr and Grace 2016D			
	Photoquadrats & Video	West & Don 2016B			

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The habitats adjacent to the dredging footprint were described in two phases. The first phase involved a preliminary qualitative description of 18 transects as shown in Figure 8 (Kerr and Grace 2016A). On the basis of that survey and a consideration of the sensitivity of adjacent habits to potential turbidity / sedimentation effects that could arise from proposed dredging activities, the specific sites shown in Figure 9 were quantitatively surveyed by Kerr and Associates (2016A).

The baseline description of hard bottom sampling sites was done by Kerr and Associates; sediment particle size was carried out by Waikato University and benthos in soft bottom core samples were identified and counted by the Cawthron Institute.

Figure 7: Overlay of Figures 2.2 and 2.3 of West and Don 2016B in relation to the final Dredging Footprint Option 4.2.

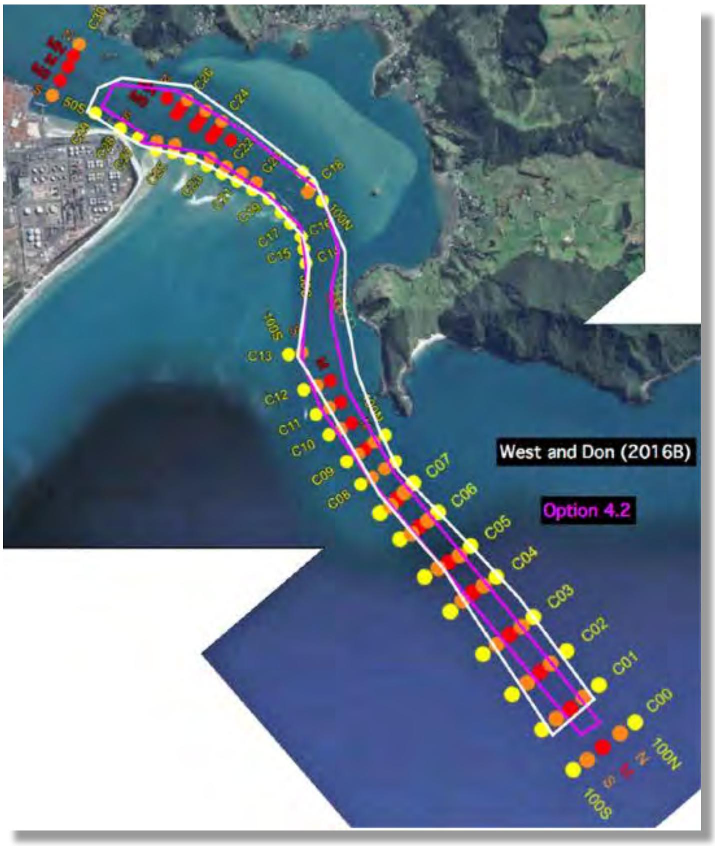
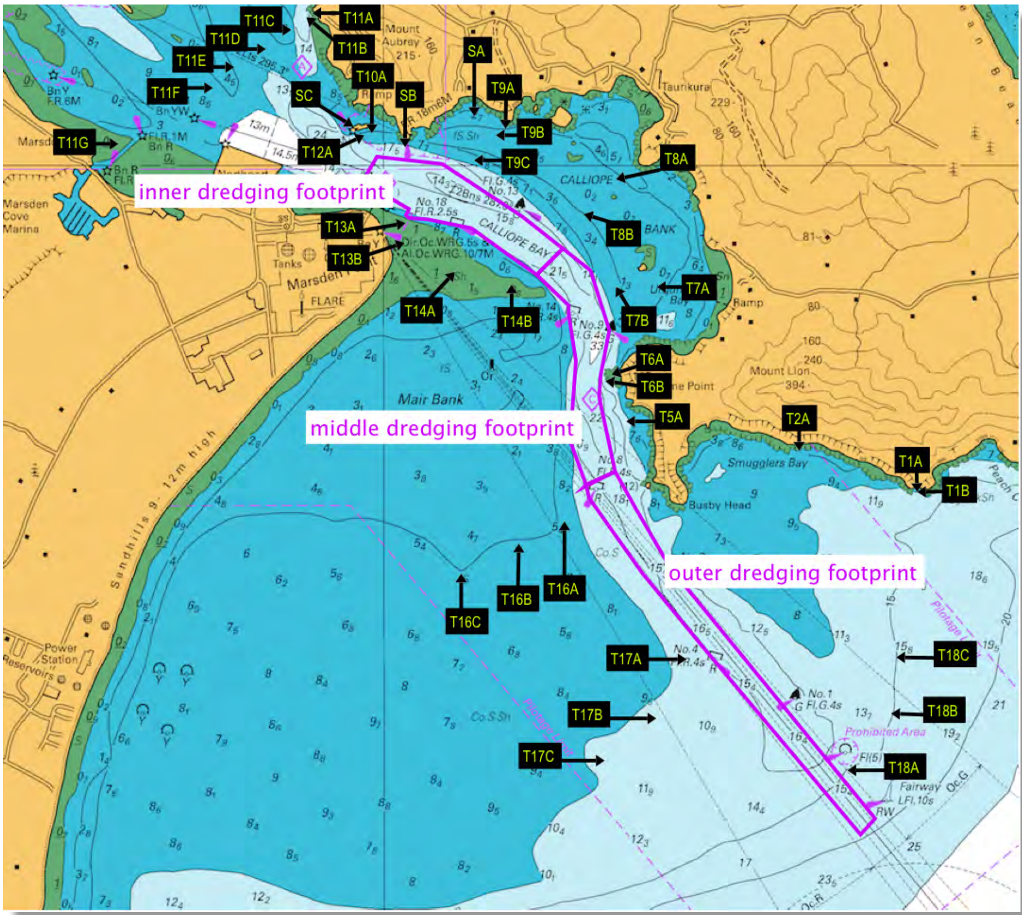


Figure 8: Locality of the 18 transects qualitatively described by Kerr and Grace (2016A) to select specific sampling sites for a baseline description of communities potentially affected by proposed dredging activities.

Figure 9: Sampling Localities for a Baseline Description of Habitats Adjacent to the Dredging Footprint that was undertaken by Kerr and Associates 2016A).



West and Don (2016B) also described 15 sites close to Home Point that are outside the dredging footprint.

The description of these foul ground sites now provides a baseline description of hard-bottom sites adjacent to the dredging footprint to complement those hard-bottom sites described by Kerr and Associates (2016A).

Kerr and Associates (2016D) have also provided reference photographs from the foul ground at 3-mile reef as shown in Figure 2.

Hard-bottom sites were non-destructively described with fixed photoquadrats.

Soft bottom communities have been described by a combination of photoquadrats within a particular sampling site (that have recorded surficial sediment texture and epibenthos) and five random sediment samples from which infauna has been sieved, identified and counted.

Where appropriate, additional soft bottom samples have been collected and analysed for sediment particle size and contamination status (see Table 6).

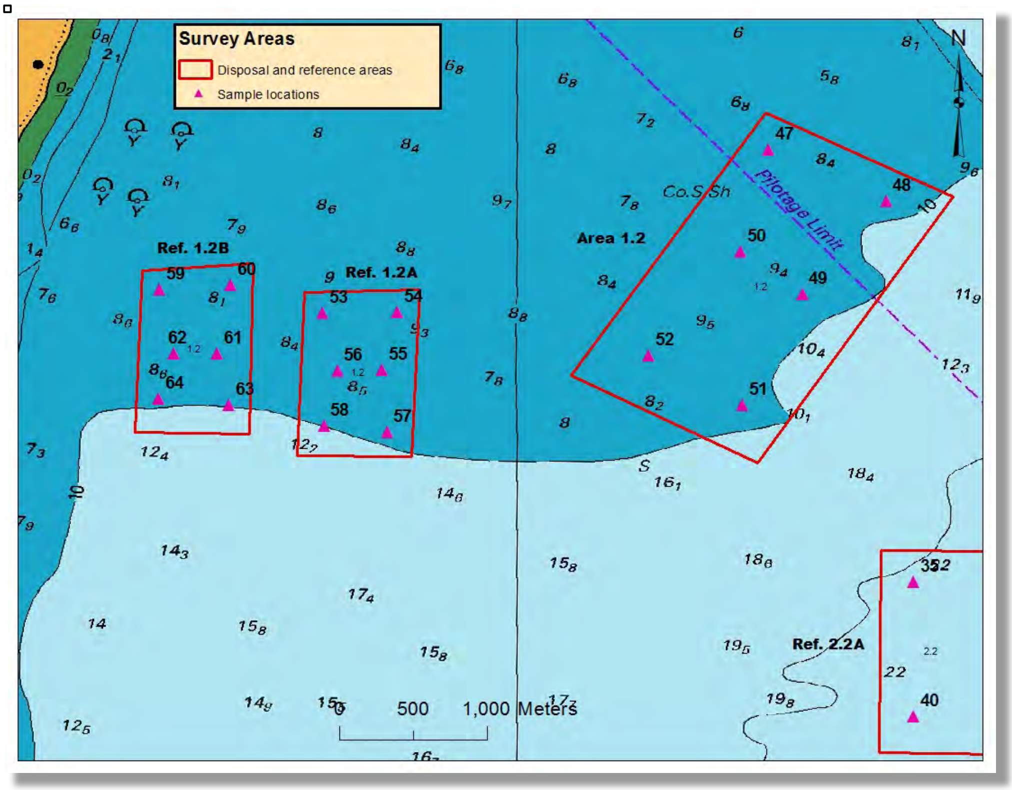
There is a great deal of supporting information, particularly photoquadrat and video records that has been obtained to benchmark baseline community structure and habitat types within the study area. This information is available to interested parties on request from Refining New Zealand.

A soft copy of the videos and photographs will be provided to the Northland Regional Council once the resource consent application for the project is lodged.

The underwater photography that had been produced by Bioresearches and Kerr and Associates is of a very high standard and will be used to monitor the effects of the dredging operation and the disposal of dredged material on hard shorelines where the same specific quadrats can be relocated and re-photographed in a time sequence.

In terms of offshore Disposal Area 1.2 for dredged material, Kerr and Grace (2016E) undertook the sampling for a baseline ecological survey and have reported on sediment particle size analysis and the contamination status of samples submitted to the Cawthron Institute for analysis (see Figure 10).

Figure 10: Sampling Sites 47 to 64 used by Kerr and Grace (2016C) to describe disposal site 1.2 and reference sites 1.2A and 1.2B within Bream Bay (see Figure 2). From Figure 2 of Kerr and Associates (2016C).



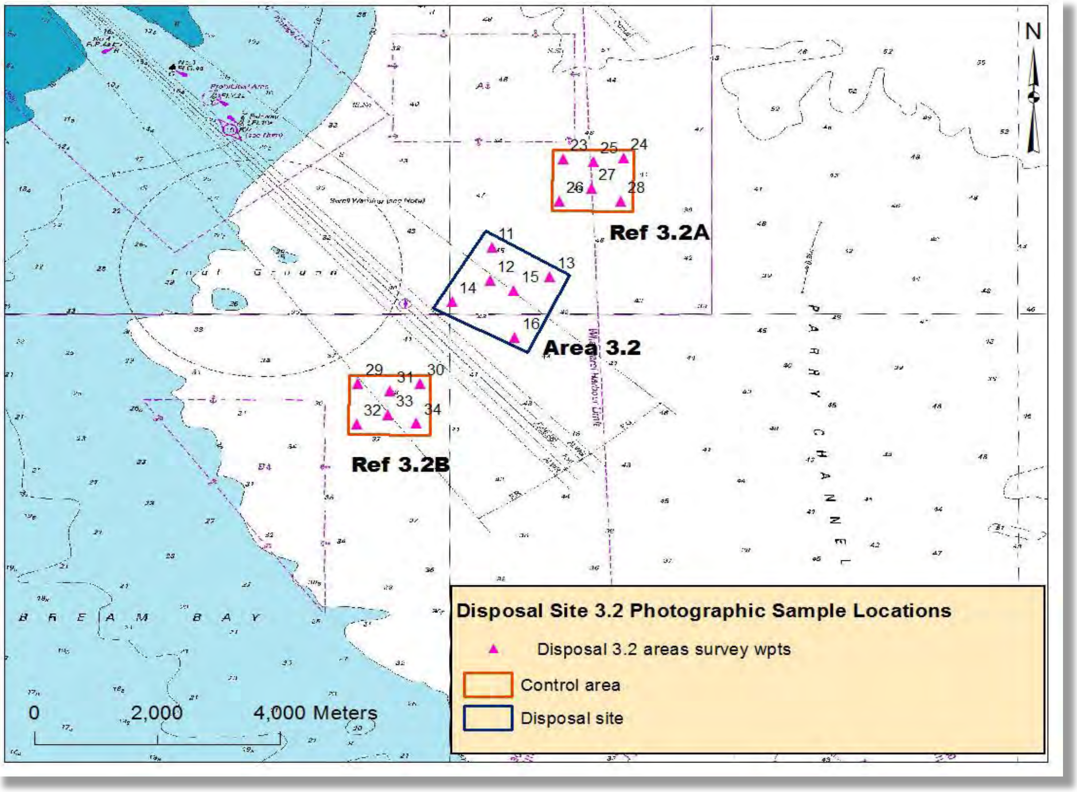
These results of benthic sample analyses (five replicates for each of samples 47 to 64) are attached as Appendix A1.

In terms of Disposal Area 3.2, Kerr and Grace (2016A) undertook a preliminary ecological assessment (sediment particle size and soft-bottom benthos) of the site in January 2016.

The Cawthron Institute then undertook a quantitative survey of Disposal Area 3.2 and Reference Sites 3.2A and 3.2B in early May 2016 (see Figure 11). Data they have provided on sediment particle size and the contamination status of sediments are summarised in Appendix B. Identification and counts of soft bottom benthos at the 18 sites shown in Figure 11 (five replicates per site) are summarised in Appendix A2. A comparison of the two disposal sites and reference sites is provided by Kerr and Associates (2016C).

Both the proposed dredging footprint and the footprint of Disposal Areas 2.1 and 3.2 are soft bottom areas of seabed that support a benthic community that is considered typical of the coastal environment off the north-east coast of the North Island.

Figure 11: Sites 11 to 16 (Area 3.2), 23 to 28 (Ref Area 3.2A) and 29 to 34 (Ref Area 3.2B) sampled by the Cawthron Institute within Bream Bay (see Figure 2). From Figure 2 of Kerr and Associates (2016D).



2.6.2a Open Sandy Beaches in Bream Bay

Crustacea of the open sandy beaches in Bream Bay include the sea-slater (*Scyphax ornatus*), common sandhopper (*Talorchestia quoyana*), isopods of the families Sphaeromidae and Eurydicidae, paddle crab (*Ovalipes catharus*), ghost shrimp (*Callianiassa filholi*) and mantis shrimp (*Squilla sp*.). The tuatua (*Paphies subtriangulata*) is the most common bivalve on this and other east coast beaches. (Kerr 2005).

2.6.2b Sub-Tidal Sand Flats in Bream Bay

Benthic communities through the subtidal sand flats in Bream Bay are generally dominated by sand dollars *(Fellaster zelandica),* the starfish *(Patiriella regularis)*, polychaete worms, hermit crabs *(Pagurus sp.)* flatfish, the morning star shell *(Tawera spissa),* the gastropod *Amalda depressa* and crabs *(Ovalipes catharus and Petrolisthes sp.),* together with *Circomphalus yatei, Dossinia subrosea, Pahies australis, Ostea sp., Sigapatella sp., Austrominius sp. and mysids* (Golder, 2010).

2.6.2c Disposal Area 1.2

Benthos within the shallower Disposal Area 1.2 (see Appendix A1) was dominated by nematodes, urchins (echiniodea), polychaetes (members of the Paraonidae, Syllidae), amphipods (including members of the Haustoridae and Phoxocephalidae), the isopod *Exosphaeroma sp*. and cumacea.

2.6.2d Disposal Area 3.2

Benthos within deeper Disposal Area 3.2 and its reference sites was dominated by nematodes, oligochaetes, polychaetes (the spionid *Spiophanes modestus*, the nereid *Nerididae sp. A*, the onuphid *Onuphis aucklandensis* and members of the Maldanidae, Paraonidae, Syllidae [including *Sphaerosyllis sp.*), amphipods (particularly members of the Phoxocephalidae), bryozoans and ostracods (see Appendix A2).

2.6.2e The Dredging Footprint

The fine sand habitat that was most common within the dredging footprint supported the most diverse benthos that was dominated by smaller biota such as polychaete worms and amphipods (West and Don, 2016B).

A coarse sand habitat that was present both seawards and inshore of Busby Head differed slightly in composition inshore compared to seawards. Seawards of Busby Head the biota was dominated by the bivalve *Tawera spissa* and the primitive chordate, *Epigonichthys hectori*. Inside the harbour mouth the coarse sand habitat was dominated by the community defining bivalve *Venerupis largillierti* and juvenile gastropods (West and Don, 2016B).

The shell gravel habitat had a higher proportion of larger species than the sandy habitats. The species composition was different from the sandy habitats with 36 taxa only found in the shell gravel habitat. The community defining bivalve *Tucetona laticostata* and the primitive chordate, *Epigonichthys hectori* were abundant in the shell gravel seaward of Home Point, but almost absent inside the harbour mouth. Inside the harbour mouth the shell gravel had greater numbers of the bivalves *Corbula zelandica* and *Venerupis largillierti* and juvenile gastropods. (West and Don, 2016A).

West and Don (2016A) concluded that no species of marine invertebrates or marine fish reported as present in the dredge area are listed as “Threatened” or “At Risk” and that the habitats within the proposed dredge area were not considered to be of national significance.

2.6.2f Soft-bottom communities in the lower Whangarei Harbour

Beds of pipi (*Paphies australis*), and cockle (*Austrovenus stutchburyi*) are present on intertidal and adjacent subtidal sandy substrates within the lower harbour and scallops (*Pecten novezealandiae*) are locally common in subtidal channels and in Bream Bay.

However, it is of some concern that benthic communities on Mair Bank have undergone significant recent changes, without a satisfactory explanation of cause and effect (Williams and Hume 2014).

The most recent study commissioned by RNZ is by Pawley (2016) who reported that:

- the bathymetry of Mair Bank appears to have changed since the 2010 and 2014 surveys. Mair Bank is no longer separated from neighbouring Marsden Bank by a channel, and the northern edge now extends further (compared to 2014). This view is supported by Williams and Hume (2014),
- both the total abundance and biomass of pipis have reduced significantly since his 2010 survey. The total population has declined from around 460 million (2010) to around 4.95 million individuals, and the 2016 estimate of absolute biomass, 44.7 t, is around only 1% of the 2010 estimate (4,450 t) and less than 1% of the 2005 estimate (10,542 t).

Between 1986 and 2010, the average commercial landings of pipi from Whangarei Harbour was 176.6 tonnes per annum (Report from the Fisheries Assessment Plenary, May 2014). It is now non-existent (Pawley, 2016). This report did not consider cockle populations.

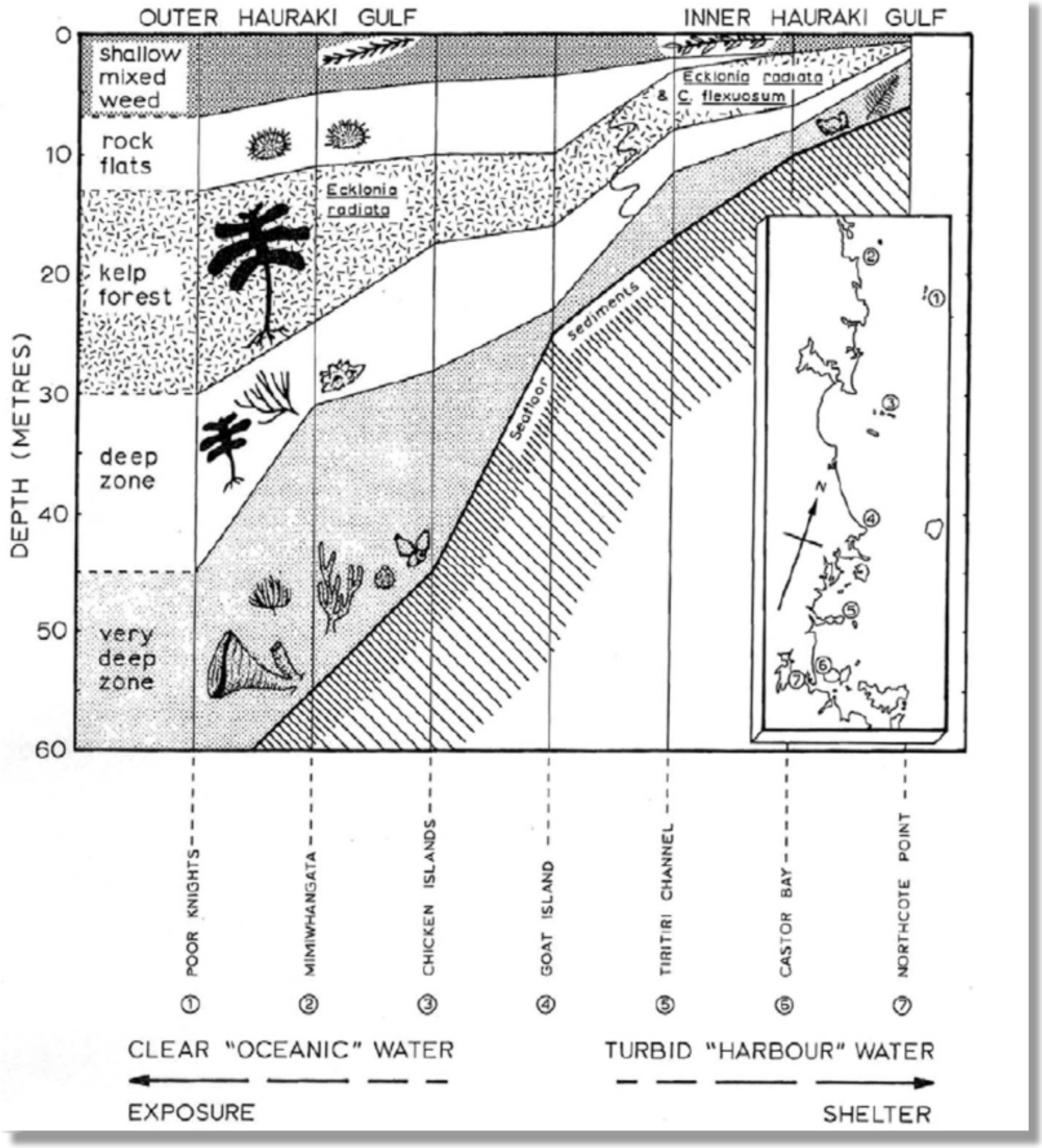
In recent years, an expanding bed of green-lipped mussels (*Perna canaliculus*) has established on Mair Bank (Pawley, 2016 and pers. comm. Riaan Elliot, Refining NZ).

Moreover, seagrass beds at One Tree Point are currently recovering from a former dieback event (NIWA, 2004, 2005), so it is important to benchmark these changes that are not associated with the proposed dredging programme.

2.6.2g Hard-shore habitat and submerged reefs within the study area

The zonation of hard shore communities between Darch Point and Bream Head (see Figure 8) have been characterised by Kerr (2005) and are consistent with generalised zonation of hard shores in the Hauraki Gulf (see Figure 12).

Figure 12: Generalised zonation on hard shores in the Hauraki Gulf (Kerr, 2005).



The sheltered rocky intertidal shore is characterised by zones of barnacles (*Chamaesipho columna*), rock oysters, *Pomatoceros* tubeworms, red algae (*Corallina* sp.) and brown algae Neptune's necklace (*Hormosira banksii*).

A range of mobile and attached invertebrates with adaptations to avoid desiccation (e.g. chitons, crabs and shellfish), remain in the intertidal zone as it is dewatered between high tides, whilst other mobile animals such as fish return to the intertidal zone on a rising tide.

The sublittoral fringe (at and immediately below low tide) consists of large brown algae (notably species of *Carpophyllum* and *Cystophora*) that are typically separated from submerged forests of tall-growing kelp by rock or kina flats.

The kelp forests are dominated by the attached brown alga *Ecklonia radiata*, whose canopy provides shelter for a wide range of fish and mobile / attached invertebrates.

Rock overhangs and caves are common throughout the rocky shore profile and the taxa that colonise these shaded habitats add to the diversity of the zones depicted in Figure 4.

Below the *Ecklonia* forest there are deep and very deep zones dominated by sponge gardens. Throughout the rocky profile a diverse range of fish and mobile and attached invertebrates can be found on and under the cover of seaweeds and within the deep sponge gardens.

Within more turbid harbour waters, kelp forests may only penetrate to a depth of 10 m, whereas on clearer, open coast, they can extend to a depth of 30 metres (see Figure 12).

MacDiarmid et. al., (2013) have nominated sensitive marine benthic habitats in New Zealand that include the kelp beds and sponge gardens featuring in Figure 12.

2.6.3 Fish

(Kerr and Moretti, 2012) report that the six most common fish in the Motukaroro Island, Whangarei Marine Reserve are goatfish (*Upeneichthys lineatus*), jack mackerel (*Trachurus novaezelandiae*), parore (*Girella tricuspidata*), spotty (*Notolabrus celidotus*), sweep (*Scorpis lineolatus*) and snapper (*Pagrus auratus*). This is also likely to be the case for other reefs within the study area.

Others include (Kerr and Moretti, 2012) banded wrasse (*Notolabrus fucicola*), blue maomao (*Scorpis violaceus*), butterfish (*Odax pullus)*, butterfly perch (*Caesioperca lepidoptera*), conger eel (*Conger wilsoni*), demoiselle (*Chromis dispilus*), eagle ray (*Myliobatis tenuicaudatus*), John dory (*Zeus faber*), kahawai (*Arripis trutta*), kelpfish (*Chironemus marmoratus*), kingfish *(Seriola grandis)*, koheru (*Decapterus koheru*), leatherjacket (*Parika scaber*), black pipefish (*Stigmatopora nigra)*, parore (*Girella tricuspidata*), piper (*Hyporhamphus ihi*), red moki (*Cheilodactylus spectabilis*), scarlet wrasse (*Pseudolabrus miles*), short-tail stingray (*Dasyatis brevicaudata*) and silver drummer (*Kyphosus sydneyanus*).

Blue mackerel *(Scomber australasicus)*, yellow-eyed mullet *(Aldrichetta forstefl),* grey mullet *(Mugil cephalus), (Pseudocaranx dentex)*, butterfly perch (*Caesioperca lepidoptera*) and marblefish (*Aplodactylus arctidens*) are also caught along the coast and within the Whangarei Harbour (Fisher & Bradford 1998, Mason & Ritchie 1979).

A number of subtropical species present at the Hen and Chickens Islands also occur around Bream Head (the nearest mainland point), such as half-banded perch (*Hypoplectodes* sp.), single-spot demoiselle (*Chromis hypsilepis*), red pigfish (*Bodianus unimaculatus*) and *Coris sandageri*, the Sandager's wrasse (per. obs).

Flounder are known to be in Whangarei Harbour (pers. obs.) and eels and whitebait migrate through the harbour to freshwater streams.

Northland Regional Council has recently sponsored a "fish ladder"' in a culvert under Whangarei's Western Hills bypass to enable native fish access to the Kirikiri Stream from Whangarei Harbour for example (Scoop Regional Independent News, 25 August, 2015).

It is expected that pelagic fish in general (but not shellfish) have the ability to avoid potential disturbance activities that are described in Section 3. However, epibenthic taxa such as flounder and goatfish maybe more likely to be smothered by dredged material being placed at the nominated disposal sites.

2.6.4 Marine Birds

Marine Birds have been described by Don (2015 and 2016) and a separate avifauna report is to accompany the resource consent application that is lodged by Refining NZ. As a consequence, marine birds are not addressed further in this report.

2.6.5 Marine Mammals

The impacts of marine dredging activities on marine mammals have recently been reviewed by Todd et. al. (2014) and are the subject of a stand-alone report by Clement and Elvines (2016).

Therefore, marine mammals will not be considered further in this report.

2.6.6 Noise

Pine and Styles (2015) and Styles (2017) have provided a separate airborne and underwater acoustic assessment for the Whangarei Harbour Entrance and Marsden Point.

Therefore, noise and the effects of noise on wildlife will not be considered in this report.

2.7 Recreational and Commercial Harvesting of Marine Resources

The Bream Bay coastline (Northland Regional Council, 2004) is an important commercial and recreational fishing / diving area, with the main target species including kahawai (*Arripis trutta*), kingfish (*Seriola grandis*), snapper (*Pagrus auratus),* lobsters (*Jasus edwardsii* and *J. verreauxi*) and scallops (*Pecten novaezelandiae*).

Other shellfish are also harvested along the Bream Bay coastline (MWH, 2009), in estuaries and within Whangarei Harbour. These populations include cockles, pipis, tuatua, paua and various oyster species. However, as noted in in Section 2.6.2.f, in terms of commercial shellfish harvesting, the pipi resource at Mair bank has been depleted in recent years and was effectively non-existent as of 2016 (Pawley, 2016).

Reference to Greenaway (2015 – Section 4.2) shows the access channel and the major disposal area for dredged spoil are within an area of high recreational boat usage area in Bream Bay and Whangarei Harbour.

Recreational matters are being addressed by Rob Greenaway and will not be considered further in this report.

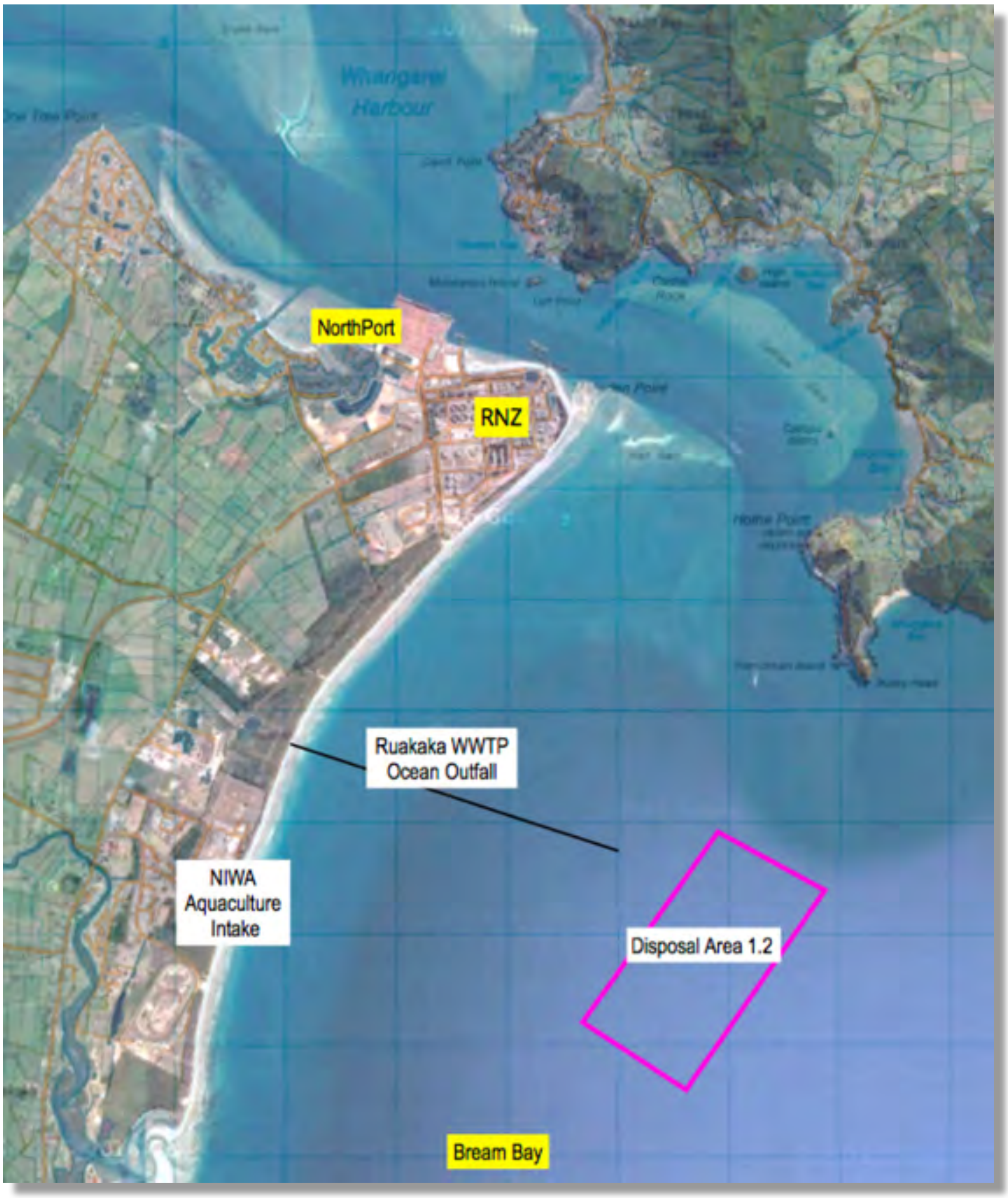
Commercial fishing is to be addressed by Rick Boyd and will also not be considered further in this report.

2.8 Other Uses, Discharges and Disturbance Activities

There are a number of other uses, discharges and disturbance activities within the Study Area that are not associated with the proposed RNZ dredging activities.

It is important that the effects of the RNZ dredging programme are described separately from the effects of the following existing and / or proposed uses of the area (see Figure 13).

Figure 13: Locality Diagram for other uses, discharges/disturbance activities in the Study Area.



In addition, the potential for cumulative effects to arise as a result of activities by any of these third parties occurring in conjunction with the proposed RNZ dredging have been considered.

2.8.1: Northport Limited

The adjacent deep-water cargo port facility at Northport (see Figure 13) is also associated with large vessel movements, stormwater discharges and consent provisions for maintenance dredging activities.

The principal cargos that are handled at Northport are *Pinus radiata* logs, wood chips, phosphate rock, cement clinker and packaged cargos.

Sweeny (2015) reported that, with the exception of two out of seven occasions during 2014 and 2015 when total suspended solids exceeded 50 $g.m^{-3}$, and an unexpected spike in aluminium concentrations in the stormwater discharge from Northport to the lower Whangarei Harbour, all conditions of consent were currently being met. This was supported by a

Stormwater Discharge Review for Northport Ltd by Poynter and Kane (2015) that was attached as Appendix V to the Northport stormwater monitoring report for 2014 / 2015.

There are also maintenance dredging provisions for the Northport deep water cargo port to maintain a working depth of 14.5 m for the facility (Coastal Permit No. 2).

During pre-lodgement consultation undertaken by RNZ, concerns were raised regarding potential tannin and resin acid discharges to the harbour from the Northport Stormwater treatment system (sourced from open storage areas for logs and wood chips). It was suggested that if these materials had accumulated in the seabed that would be disturbed by the proposed RNZ dredging programme, there was the potential for them to be remobilised in the water column as a result of dredging activities.

Resin acids and tannins are compounds which occur naturally in wood. These materials, on release to aquatic environments, have been reported to cause toxicity in some biota. Most toxicity has been reported in relation to freshwater fish and resin acids, and is best documented for salmonid species (e.g. *Salmo gairdneri* and *Oncorhynchus mykiss*) in lakes and rivers.

Poynter and Kane (2015) have provided a review on this matter for the 2014 / 2015 stormwater monitoring report for Northport Limited (Sweeny, 2015). Poynter and Kane (2015) report resin acids have not been measured in the port stormwater discharge. However, pond influent total resin acids have been measured and concentrations are low. For example, 0.19 $g.m^{-3}$ Total Resin Acids were present in a pond influent sample collected on 15/12/2014.

There is no ANZECC 2000 threshold for resin acids and no "*Action Value*" for total resin acids, therefore the pond influent sampling was undertaken only for trend analysis purposes.

Poynter and Kane (2015) considered concentrations of resin acids would be reduced to trace levels very quickly in close proximity to the Northport stormwater discharge and that resin acid toxicity is not considered to pose environmental concern for the Northport stormwater discharge. Poynter and Kane (2015) included a summary of a literature review they had undertaken on resin acid toxicity as Appendix E to their report to support their views.

Given these findings, resin acids and tannins were not analysed for in sediments to be disturbed by the proposed dredging programme and are not discussed further within this report.

Northport hold resource consents enabling the future extension of their facilities to include a new Berth 4 [NRC, 2004]. Whilst there is no indication as to when these extant consents may be implemented, the potential cumulative effects of further wharf extensions in conjunction with the Refining NZ dredging programme have been considered. From an ecological perspective, the key effect would be turbidity and sedimentation, particularly with regard to those more sensitive receiving environments, being the rocky reef habitats. Discharge limits conditions placed on the Northport resource consents, together with the proposed real-time monitoring, and response mechanisms, applying to the Refining NZ dredging proposal, are considered to be adequate to avoid, remedy or mitigate potentially adverse cumulative effects that could occur.

2.8.2: The Ruakaka Wastewater Treatment Plant (WWTP) Ocean Outfall.

An ocean outfall has been consented for the Ruakaka WWTP but it has yet to be constructed / commissioned (see Figure 13, and MWH, 2009). It was prudent therefore, to locate Disposal Area 1.2 at a non-interactive (0.5 km) distance from the planned diffuser for this outfall. This was done during revised phases of the project (Tonkin & Taylor, 2016B).

Accordingly, due to this separation distance, cumulative effects are unlikely to occur. Further, the Ruakaka WWTP is expected to result in different contaminants to the Refining NZ disposal operations, the latter expected to have only short-term effect on sedimentation.

2.8.3: NIWA Aquaculture Facility

A seawater supply and discharge is required at the NIWA Aquaculture Centre at the former Marsden B Power Station Site.

This facility is located to the south west of the Ruakaka WWTP and so is considered to be at a non-interactive distance (c. 3 km) from the proposed RNZ dredging and disposal site 1.2 for dredged material and is not considered further in this report.

2.9 Marine Sites of Special Scientific or Conservation Value

The Northland Regional Coastal Plan recognises four marine sites of special scientific or conservation value within and / adjacent to the Study Area (see Figure 3).

The first is the Motukaroro Island Whangarei Marine Reserve (established under the Marine Reserves Act 1971). This area is also zoned as the Reotahi[4] Marine 1 Management Area in the Regional Coastal Plan. The area was established as the Whangarei Marine Reserve for the purpose of preserving it in its natural state as the habitat of marine life for scientific study. The Reotahi Marine 1 Management Area zoning recognises the following values: protected areas, birds, ecosystems, habitat values. Marine reserve habitat features include high species diversity including subtropical species.

Two other areas (Calliope and Mair Bank Marine 1 Management Areas) are zoned in the Regional Coastal Plan on the basis of the following values: protected areas, ecosystems, birds, habitats, coastal landforms. The Plan records that inter-tidal areas provide internationally significant habitat for international migratory and NZ endemic wading and wetland birds, including threatened species.

The fourth area, (Busby Head) Marine 1 Management Area is zoned under the Regional Coastal Plan on the basis of the following values: protected areas, ecosystems, habitats. The Plan specifically records that rocky shore internationally significant habitat for NZ endemic wading and coastal birds, including threatened species.

The Marine 1 (Protection) Management Area is applied to those areas within Northland's coastal marine area identified as being Areas of Important Conservation Value. The priority in these areas is the protection of those significant described values specifically identified as occurring within each particular area.

The Calliope Bank, Mair Bank and Busby Head Marine 1 Management Areas are considered to be of regional significance. The Motukaroro Island Whangarei Marine Reserve is considered to be of national significance because it forms part of a national network of marine protected areas that have been created for scientific study.

Northland Regional Council has recently released its draft Northland Regional Plan (Northland Regional Council, 2016A). While the rules in the draft plan do not currently have legal effect, the three Marine 1 Management Areas of the northern side of the access channel would no longer be separate but would be part of a continuous “Significant Ecological Area” on the northern side of the harbour entrance and the Mair Bank Marine 1 Management Area on the south side of the heads would be enlarged (see Figure 14).

It is agreed that Castle Rock, High Island and other rocky points between Reotahi Bay and Busby Point should appropriately be included as significant ecological areas and that the northern shoreline of Bream Bay from Busby Point to Bream Head would quality for a similar status.

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[4] Boundaries coincide with the Motukaroro Island Marine Reserve, as indicated in the Regional Coastal Plan Maps, map sheets A3, B25, C13.

Figure 14. Significant Ecological Area overlay proposed in the draft Northland Regional Plan at the entrance to Whangarei Harbour (compare and contrast with Figure 4).

"Significant Bird Areas" are part of a more extensive overlay area than Significant Marine Ecological Areas and include the sandy shoreline of Bream Bay (see Don, undated).

However, given the current ecological condition of Mair Bank where there has been a significant, recent population decrease for pipi and a recent proliferation of green-lipped mussels (Pawley, 2014; Pawley, 2016) without a satisfactory explanation of why such changes are occurring (Williams and Hume 2014), it is more difficult to justify an expansion of the Mair Bank site in terms of current ecological values.

These areas of elevated ecological significance can be grouped into two headings for the purposes of the NZ Coastal Policy Statement (Department of Conservation, 2010) ('NZCPS').

- First, are those areas falling within Policy 11(a) of the NZCPS, being: the marine reserve, kelp beds, and sponge gardens associated with the rocky reef habitats extending roughly from Motukaroro Island to Busby Point. These areas contain nationally significant examples of indigenous community types.
- Second are the remaining coastal areas which fall within Policy 11(b) of the NZCPS, including the channel, disposal areas, Calliope and Mair Banks, and Three Mile Reef.

In accordance with the NZCPS, within the areas covered by Policy 11(a) it is necessary to avoid all adverse effects of activities.

Within the areas covered by Policy 11(b) of the NZCPS, the requirement is to avoid significant effects, and to avoid, remedy or mitigate other effects of activities.

3.0 Description of Proposed Disturbance Activities

3.1 Introduction and Background

The Marsden Point Oil Refinery is located at Marsden Point and is the only oil refinery in New Zealand, making the refinery one of New Zealand's nationally strategic infrastructural assets. The oil refinery's location was chosen due to the deep water at Marsden Point, low risk of earthquakes, flat topography of the site and close proximity to large residential populations in the North Island (MWH, 2009).

Construction started in 1962, and the refinery was opened in 1964. An expansion between 1979 and 1981 included the installation of a hydrocracker and a 170-km long pipeline to Wiri in South Auckland. In 2005, the refinery undertook another expansion to allow for the de-sulphurising of diesel and removing of benzene from petrol to occur on site.

Another expansion of the refinery in 2009 increased the refinery's capacity by 15%, which equates to approximately 135,000 barrels per day or some 80% of all fuel products in New Zealand (MWH, 2009). A \$365 x10^6 CCR project to produce petrol at the plant has also been completed recently (McNeill, 2016).

Current deep-water access to Marsden Point from Bream Bay is via a natural tidal inlet that varies in depth from 15 to 32 metres (see Figure 2). This is adequate for vessels visiting the Northport log berth that requires 14.5 m clearance, and for smaller "Aframax" vessels visiting the refinery, but not for fully loaded "Suezmax" oil tankers that require a 16.6 m clearance.

Therefore, crude oil supply to the refinery is currently delivered by smaller fully-loaded "Aframax" ships and larger partially-loaded "Suezmax" ships.

Royal HaskoningDHV (2016C) and Tonkin & Taylor (2017A) have evaluated alternatives to dredging (primarily ship-to-ship transfer, and a single buoy mooring system), and a range of access channel alignments but only the preferred access footprint (Option 4.2) is considered and described in this report. The preferred dredging footprint (Option 4.2) avoids rock / boulder outcrops on the western side of Home Point that were evaluated by West and Don (2016A), so dredging activities would be restricted to soft-bottom communities that have been described by West and Don (2016A). Similarly, a range of disposal location options have been considered and evaluated (MetOcean Solutions, 2016B; Tonkin & Taylor, 2017A; West and Don, 2016B and Kerr and Grace, 2016E). Following refinement through the process of scoping the proposal, only the preferred options (Disposal Areas 1.2 and 3.2) are considered and described in this report (see Figure 2).

The anticipated capital dredge volume is a total of 3,638,000 m^3 (Royal HaskoningDHV, 2016C). This can be broken down into 610,000 m^3 (from the inner channel alignment), 57,000 m^3 (from the mid channel alignment) and 2,971,000 m^3 (from the outer channel alignment). The area or footprint of direct disturbance within the entrance channel (see Figures 2 and 4) involves a total area of 1.62 square kilometres. Up to 97.5% of capital dredgings would be disposed of in disposal area 3.2 (see Figure 2 and Tonkin % Taylor 2017A).

The average annual rate of sedimentation in the dredged footprint is assessed to be between 56,000 to 122,000 m^3 per annum (i.e. up to 4% of the capital dredge volume) with the main areas of focus expected to be the berth pocket and the outer section (Tonkin & Taylor, 2017A). Maintenance dredging may need to occur every 2 to 5 years in the berth pocket area and in targeted areas of the inner and mid channel to maintain navigable draft around the jetty dolphins. Assuming uniform distribution of sedimentation within the outer section, the 0.5 m sedimentation allowance could be reached within 5 to 20 years requiring a maintenance dredging campaign in this area (Tonkin & Taylor, 2017A).

Maintenance dredgings may be disposed of on land or in either of disposal areas 1.2 and / or 3.2 (Tonkin & Taylor 2017B). Tonkin and Taylor (2017A) consider the capital dredging programme is likely to last up to six months with maintenance dredging involving smaller vessels and a shorter time frame.

3.2 Dredge Type and Management

The dredge methodology is described in detail in the reports prepared by Tonkin & Taylor (2017C) and Royal HaskoningDHV (2016B) as part of this application. A brief summary is provided here.

Dredgers are generally hydraulic or mechanical. A hydraulic dredger delivers dredged material to the discharge site or to temporary storage (e.g. a hopper) in the form of a slurry (e.g. Trailing Suction Hopper Dredgers [TSHD] and Cutter Suction Dredgers [CSD]).

Trailing suction hopper dredgers are self-propelled ships with hoppers (dredged material storage internal to the hull). They have articulated dredging pipes, or “drag-arms”, that extend to the sea bottom. They dredge at low speeds while underway. The drag-head can be either passive or active. No additional power is applied to a passive head and material to be excavated is scoured by hydraulic flow induced by the suction at the drag-head. An active drag-head uses power to drive cutting teeth or high-pressure water jets to excavate the material and to aid in forming a solid/water slurry.

Cutter Suction Dredgers are stationary hydraulic dredgers that use centrifugal pumps to produce the flow required to mobilise and transport dredged material.

A mechanical dredger collects dredged material in a bucket or grab and then places it directly into the discharge site or into a temporary storage device for transport to a discharge site. Alternatively, the temporary storage device can remain on site and the dredged material is re-handled (e.g. pumped through a pipeline or transported away using a truck or a barge). An example of a mechanical dredger is a Backhoe Dredger (BHD).

A Backhoe Dredger is generally an excavator mounted on a dredging pontoon and is suitable for dredging soils made of an unconsolidated, heterogeneous mixture of clay, sand, pebbles, cobble and boulders. They can also handle fragmented or soft rock. To ensure stability and counter the large digging forces of the BHD, the pontoon is anchored and its position maintained by spud poles.

A dredging operation involves four phases: excavation, lifting, transportation and placement.

- Excavation is the physical removal of sediment from the seabed and can be done using hydraulic forces and/or mechanical forces.
- Lifting is the vertical transport of the dredged material from the seabed to the water surface and can be achieved using hydraulic or mechanical means.
- Transportation is the process of transferring the dredged material from the excavation site to the placement site.
- Placement of the dredged material at a designated site involves disposal of dredged material at an underwater or onshore location.

There are also a range of ancillary vessels that are required to support a dredging operation. These include:

- survey vessels to complete hydrographic survey of the dredged areas. These are typically small craft (around 9 to 11 m in length) and will be present within the vicinity of the project area (channel and disposal areas) for the project duration,
- a crew boat for the transfer of project staff between the dredger and shore. This typically is a small launch 8 to 15 m in length averaging 4 trips per day, and
- a tug for towing the bottom dump barge to the disposal location that could make two trips per day.

All support vessels will generally sail within the shipping channel, but due to the shallower draft of these vessels they can go outside the channel if shipping traffic is present.

Royal HaskoningDHV (2016B) conclude preferred dredging methodology is to use a TSHD for mid and outer dredging footprint and a BHD for the berth pocket (inner dredging footprint).

With regard to the capital dredging programme, Tonkin and Taylor (2017A) advise as follows:

- The TSHD dredging operation would be up to 24 hours per day, seven days per week whereas the BHD dredging operation within the berthing area would only occur during daylight hours, seven days per week, subject to any noise restrictions.
- The majority of capital dredging (up to 97.5%) could be placed within Disposal Area 3-2. The area of placement is 2.5 km^2 with a maximum area of 5.75 km^2 defining the outer boundary of where placed sediment may settle. This area is situated around 45 m below Chart Datum to the south east of the channel. Disposal Area 3.2 has been sized to enable all capital and maintenance dredging to be placed within the area for the maximum duration of the consent period allowed (35 years). The average height of the placement mound after the capital dredging campaign would be 1.5 m with a maximum height of less than 2.5 m. The average height after 35 years assuming the majority of maintenance dredging is placed in this area would be less than 4 metres.
- Some sediment (2.5 to 5%) will be placed in the nearshore Area 1-2, a 2.5 km^2 area of seabed situated on the southern end of the ebb tidal delta in water depth of between 7 and 15 m Chart Datum. Disposal Area 1.2 is designed to enable placed sediment to be slowly transported landward during higher energy wave events to maintain sediment volumes on the ebb delta. It is also sufficiently large to enable different locations to be targeted for the placement of maintenance dredging. If the dredged sediment is placed uniformly in this area the average depth would be around 0.06 m. However, it is more likely that there would be a smaller area targeted within this larger area during each campaign, with average placement depths of around 0.6 m (i.e. covering an area of around or 10% of the total placement area).
- Both marine disposal areas comprise sand of a similar composition to the channel area to be dredged.
- Land based locations may also be used to dispose of some of the capital dredging although this will only be undertaken where there is a demand by others, and they have the necessary environmental authorisations (including resource consents) in place to enable the use. Given that any land-based options will be authorised via other processes, they are not considered further in this report.
- When the TSHD reaches the marine disposal area it reduces speed and manoeuvres itself via GPS to the allocated area where the load can be discharged. When the vessel is at the correct location the dredge-master opens the bottom doors and the sediment drops out of the hopper.
- The BHD is likely to be required for dredging around the berthing area and is not expected to be used for the main dredging activity. The dredged material would either be placed in a barge for marine disposal or transported for land based disposal.

4.0 Assessment of Environmental Effects of Proposed Disturbance Activities

4.1 Area affected by capital dredging and disposal

The capital dredging programme proposed would displace benthos from 1.62 km^2 of seabed within the entrance channel and the disposal of dredged spoil would bury benthos in 2.5 km^2 of Disposal Area 3.2. (Tonkin & Taylor, 2017A). In terms of disposal area 1.2, only 10% of the area (0.25 km^2) is expected to be used for capital dredging, hence benthos will be displaced from a total area of 4.37 km^2 of seabed as a result of the capital dredging programme.

4.1.1 Prediction of Seabed Effects

4.1.1a Bathymetry and Topography

Tonkin and Taylor (2017A) illustrate the change in bathymetry for the dredging footprint as a result of capital dredging in their Figure 2-1 (Channel design depths for Option 4-2, 98% access channel - Source: RHDHV, 2016B).

Tonkin and Taylor (2016D) expect the peak depth within Disposal Area 3.2 to reduce by up to 4 m (10% of existing) as a result of the disposal of dredged material at that site. On average, the expected mound height (and therefore depth reduction) in Area 3.2 would be 1.5 metres.

MetOcean Solutions (2016B) expect a less than minor difference in tides, currents or wave heights as a result of this change and in the medium to long term the mound will be expected to reduce (depending on the volume and frequency at which additional maintenance dredgings are added to the site).

The specific detail of the size and shape of mounds of dredged material is currently intended to be left to detailed design and tendering. In any event, post placement effects of the sorting of dredged materials placed within Disposal Areas 1.2 and 3.2 (due to water currents generated by wind and wave action) are not expected to interfere with the rate or succession of benthic taxa that recolonise these disturbed areas.

As a consequence, the changes to the bathymetry and topography are not expected to cause any adverse effects on the marine ecology adjacent to the disturbed areas.

4.1.1b Sediment Texture and Contaminants

Surficial sediment texture and heavy metal content were sampled and described in all three proposed disturbance areas and four reference sites (West and Don, 2016B; Appendix B, Kerr and Grace 2016B, Kerr and Grace, 2016C – see Figure 2).

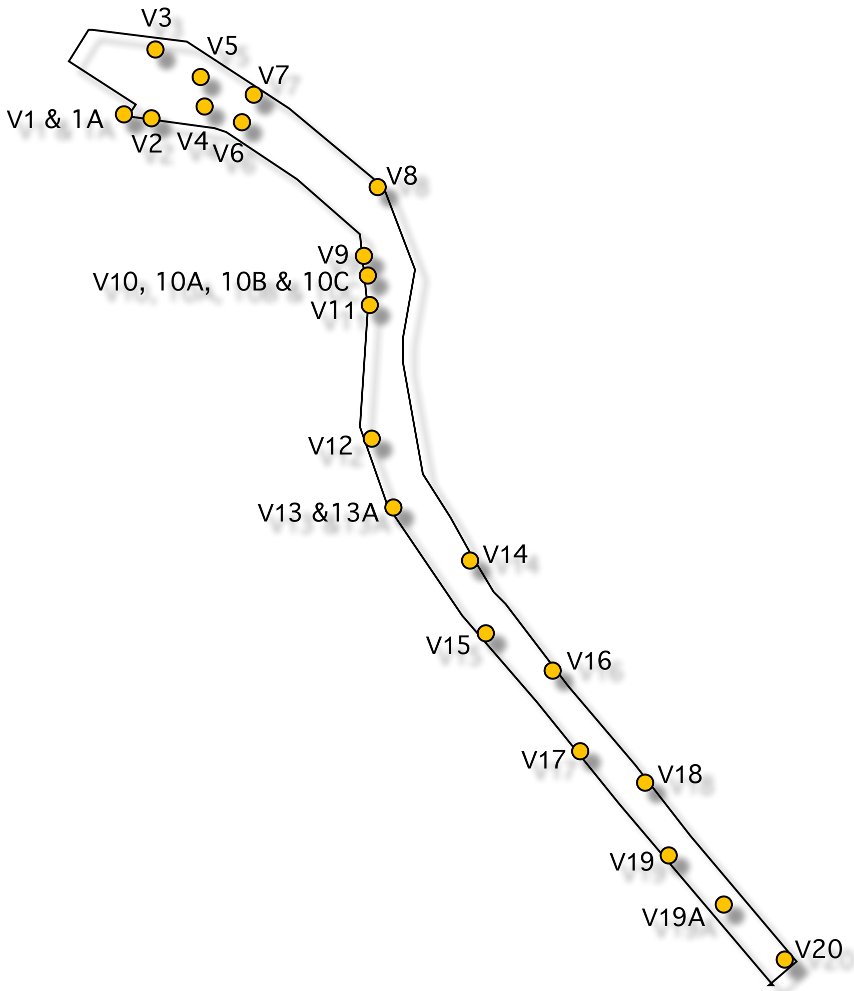
West and Don, 2016B also analysed surficial sediment samples from the dredging footprint for a comprehensive suite of organic materials (antifouling cobiocides, haloethers in SVOC, nitrogen containing compounds in SVOC, organochlorine pesticides in SVOC, other compounds in SVOC, other halogenated compounds in SVOC, phenols in SVOC, plasticisers in SVOC, polycyclic aromatic hydrocarbons in SVOC and total hydrocarbons).

Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel and Zinc were used as proxys or "indicators" for potential contamination of soft-bottom seabed sediments that would be disturbed by the disposal of dredged materials at disposal sites 1.2 and 3.2.

In a separate sampling exercise, Tonkin and Taylor (2017A) collected and analysed 26 depth-integrated vibrocores from the dredging footprint to describe sediment texture and contamination status through the profile of materials that would be dredged (see Figure 15).

Tonkin and Taylor (2017A) have considered sediment particle size distribution at the three disturbance areas and concluded "*Both marine disposal areas comprise sand sediments of a similar composition to the area to be dredged*" and hence the traditional objective of placing "like on like" would be achieved with the proposed dredging and relocation of dredged material.

Figure 15: Location of Vibrocore samples in relation to Dredging Footprint Option 4.2 (see Figure 3).



West and Don (2016B) concluded "*sediment chemistry and particle size were assessed at all sites to ascertain the risk associated with the disturbance of this material during dredging. The chemistry results were compared against the ANZECC interim sediment quality guidelines (where available). None of the surface sediment samples exceeded the ANZECC ISQG Low values with the exception of Fluoranthene, Phenanthrene and Pyrene at site C26S. This minor exceedance at one site suggests that no adverse effects are expected to occur from the redistribution of sediments during dredging or from the disposal of the dredge spoil at a nearby marine disposal site*".

Sampling site C26S is immediately south of the Option 4.2 dredging footprint (see Figure 7) but it is reasonable to assume that whilst Fluoranthene, Phenanthrene and Pyrene may be present in the inner basin sediments, they are not considered to be present at ecologically significant concentrations.

No potentially contaminated sediment was sampled within the surficial footprints of Disposal Areas 1.2, 1.2A or 1.2B (Kerr and Grace, 2016C) or within the surficial footprints of Disposal Areas 3.2, 3.2A or 3.2B (see Appendix B).

The sediment guidelines listed in Table 7 were approached for Nickel (20 v 21 mg/kg dry weight) in Vibrocore Sample V19A 0 – 0.5 m depth (see Appendix C1) and in the case of Vibrocore Sample V20 0 – 0.5 m depth (see Appendix C1) the Effects Range-Low was exceeded for Chromium (210 mg/kg dry weight) and Effects Range-High was exceeded for Nickel (123 mg/kg/dry weight).

Table 7: Thresholds of potential concern for heavy metals (ANZECC, 2000).

		Sediment Guideline Effects Range-Low	Sediment Guideline Effects Range-High
Total Recoverable Arsenic	mg/kg dry wt.	20	70
Total Recoverable Cadmium	mg/kg dry wt.	1.5	10
Total Recoverable Chromium	mg/kg dry wt.	80	370
Total Recoverable Copper	mg/kg dry wt.	65	270
Total Recoverable Lead	mg/kg dry wt.	50	220
Total Recoverable Mercury	mg/kg dry wt.	0.15	1
Total Recoverable Nickel	mg/kg dry wt.	21	52
Total Recoverable Zinc	mg/kg dry wt.	200	410

On this basis, back up samples for both V19A (0-0.5 m depth) and V20 (0-0.5 m depth) were submitted for elutriate testing (using seawater collected from Bream Bay) and a full range of organic analyses. Elutriate testing provides a better indication of what contaminants are biologically –available than standard chemical tests.

Reference to Appendix C2 (for V19A) and C3 (for V20) show all organic materials tested for were not detectable in either sample.

Chromium and Nickel were not detectable in the elutriate for Sample V19 and for Sample V20, total Chromium was < 0.0011 $g.m^{-3}$ in the elutriate sample and total Nickel was 0.014 $g.m^{-3}$ in the elutriate sample.

Given the results of the follow up elutriate testing that was conducted on samples from Vibrocore Sites V19A and V20, it was concluded that there are no issues with the potential contamination status of material to be disposed of from the proposed dredging footprint.

Overall therefore, no adverse contamination effects are anticipated, and the sediment sizes of the dredged material and that existing at the disposal sites are compatible.

As noted in Section 2.5.1, in terms of the Section 31.4.13(v) of the Regional Coastal Plan and Chapter 19 of the Regional Coastal Plan (Northland Regional Council, 2004), humans are not expected to come into contact with sediment plumes that might be generated by proposed disturbance activities and survey and analytical results presented in this AEE, provide reassurance that seabed materials that are to be relocated from the access channel to the two nominated disposal sites are not contaminated with toxic metals or potentially toxic organic materials (Maritime Safety Authority of New Zealand, 1999).

4.1.1c Sediment Transport

Black (1983) reported sediment transport occurs in a northerly direction in Bream Bay towards Mair Bank then out of Whangarei Harbour via the main channel.

Tonkin & Taylor (2017B) have recognised the benefit of placing dredged material within Disposal Area 1.2 as sediment transport to the north would nourish sediment supply to Mair Bank that is currently undergoing morphological changes (Pawley, 2016).

There are no adverse ecological effects associated with sediment transport that occurs as a consequence of sediment being placed in Disposal Area 1.2. Such transport is a naturally occurring process that existing communities are adapted to.

4.1.2 Prediction of Water Column Effects

4.1.2a Sediment Plumes

MetOcean Solutions (2016B) have gathered data on tides, waves and currents within the study area and have modelled expected sediment plumes under a range of conditions for both the winning and disposal of dredged material.

Potential sediment plume effects within the dredging footprint between Home Point and the Motukaroro Island Whangarei Marine Reserve are of greater concern than in the outer dredging footprint and at the two disposal areas. This is because the dredging footprint is immediately adjacent to hard-bottom habitat between Home Point and the Motukaroro Island Whangarei Marine Reserve, but the outer dredging footprint is surrounded by a less sensitive (soft-bottomed) receiving environment.

MetOcean Solutions (2016B) found that currents in the dredging footprint between Home Point and the Motukaroro Island Marine Reserve, are such that plumes will largely be confined to the deepest part of the channel with limited lateral dispersion into adjacent areas.

Tonkin & Taylor (2017A) consider the presence of predominantly medium and fine sands with low silt contents (less than 6%) that are to be dredged, significantly reduces the extent of turbid plumes during dredging and placement of sediment in the disposal areas. On that basis, they predict sediment plumes and overspill from the TSHD whilst winning dredged spoil will be manageable. This opinion has been supported by plume testing conducted by Brian Stewart of Ryder Consulting Limited and video monitoring of dredging around the dolphins at the Marsden Point Wharf.

In order to understand the potential ecological effects, there is a need to focus on overspill (return of decant water from the hopper) from a Trailing Suction Hopper Dredge adjacent to Marine 1 Management Areas (see Figure 4).

A conservative standard that the turbidity of plumes that enter the Marine 1 Management Areas should not exceed a level 2 threshold of 20 $g.m^{-3}$ / NTUs (or revisions thereof), see Table 8) is proposed to safeguard their nominated values (see Section 5.2). The achievement of these guideline values should ensure that the habitats and species with the areas adjacent to the dredging do not experience adverse effects.

Given the low organic matter content of the sands to be relocated (Appendix C), no water quality issues such as dissolved oxygen sags are expected to be associated with sediment plumes that are associated with winning and disposing of dredged material.

In this regard, West and Don (2016B) commented:

> "*higher percentages of very fine sands and silts will likely result in greater plumes of sediment discoloured water at the point of dredging and at the disposal site. In addition, there would be greater spread of fine sediments which could potentially smother some habitats, resulting in loss of or changes in biota. The proportion of very fine sand and silt is generally very low in the surface sediments in the proposed dredge area. The proportion of very fine sand is highest at the furthest extent offshore of the proposed dredge area (C01) and beyond (C00). Silt was only detected in abundance at two sites; C11M, mid channel adjacent to Frenchman Island. Both samples up and downstream from this site were considerably coarser, suggesting the sample was anomalous or the result or some peculiarity in the currents in this area. Similarly, silt was detected at site HP01 in the small bay between Home Point and Busby Head. Current flow data provided by Ocean Currents Ltd. (2015) showed that a counter current (eddy) is formed in this area on both the rising and falling tides; thus the deposition of silts is natura*l".

The soft-bottom taxa within and adjacent to the Disposal Sites for dredged material are less sensitive to sedimentation effects than the hard-bottom communities surrounding the dredging

footprint (Coffey, 2016A) and the special communities such as *Sabella* fan worm monitoring site described by Kerr and Associates (2016A).

Nevertheless, it is intended to restrict sedimentation effects to the nominated footprint at each of the disposal areas.

Following the initial placement of dredged material within either of the disposal areas, there will be subsequent movement / transport of that material on the seabed, albeit on a lesser scale than during the initial placement phase (as modelled by MetOcean Solutions, 2016B). This is particularly the case at Disposal Area 1.2 where longshore drift is expected to nourish Mair Bank with a supply of sand.

Clearly, these processes are occurring at present and resident benthic communities that have been described on and in the seabed, can cope with this low-level disturbance (i.e. sediment transport in response to waves and water currents). Consequently, no further adverse ecological effects are anticipated following the initial placement of dredged material within disposal areas.

4.1.2b Suspended solids, Turbidity and Light Penetration

Table 2 lists the guidelines for coastal water within the study area and refers to changes in the euphotic depth and light reduction at the sediment bed rather than suspended solids, turbidity and light penetration that are usually easier to model (MetOcean Solutions, 2016B).

In the present instance, it is the settlement of suspended solids onto sensitive taxa and community types that is of most concern, hence the use of suspended solids rather than turbidity as a reference standard. However, it is only turbidity that can be measured in real time on site during disturbance activities and therefore a robust correlation between these two parameters is required to manage proposed works.

A 1:1 relationship has been established between turbidity and suspended solids (see Section 2.5) that will allow suspended solids concentrations that arise from disturbance activities to be managed on the basis of real time turbidity monitoring.

Existing water quality is discussed in Sections 2.5.3 and 2.5.4. As a result of the proposed Crude Shipping Project, effects on water quality are likely to be limited to a reasonable mixing zone in the water column. These actual and potential effects are detailed below.

Within the lower Whangarei Harbour, dredging activities outside of a reasonable mixing zone, are not expected to compromise current water quality limits for Class CA waters.

Disposal of dredged material within Disposal Areas 1.2 and 3.2 is expected to comply with Clauses (i) and (iii) of Section 31.4.13(c) of the Regional Coastal Plan (see Section 2.5.1).

In terms of sediment plumes compromising water clarity, clause [ii] of Section 31.4.13(c) of the Regional Coastal Plan is expected to be met beyond a reasonable mixing zone of 300 m in Bream Bay.

4.1.2c Return of decant water to sensitive environments

The use of “overflow” or the discharge of decant water from the hopper of the dredge to increase the payload of dredged material moved by the barge on each movement from the dredging site to a disposal site increases the potential for TSHDs to generate turbidity (Royal HaskoningDHV, 2016A).

On moderate to larger dredges, overflow from the hopper back to the sea is likely to be via an outlet at the bottom of the hull (the keel) where a “green valve” or equivalent could be used to reduce air bubbles within the discharge both to reduce the potential for turbidity and to

increase the speed of settlement of the plume discharged from the keel of the dredger. This would be an appropriate means to minimise the effects on sedimentation and turbidity.

Sediment plume dispersion modelling has been undertaken by MetOcean Solutions (2016B) to determine potential sedimentation impacts at the dredging site. That modelling concludes that the plumes can be largely confined to the dredged channel.

4.1.2d Analysis against Regional Coastal Plan Performance Standards

Discharges to water are required to be assessed against the General Performance Standards in the Northland Regional Coastal Plan (Northland Regional Council, 2004). Relevant standards include, for disposal of dredged material within Disposal Areas 1.2 and 3.2, those standards listed in Section 31.4.13. In relation to dredging activities, including return of decant water, the standards in both Section 31.4.13 and Section 31.7.12 apply, given the area to be dredged includes areas zoned Marine 2 (Conservation) Management Area and Marine 5 (Port Facilities) Management Area. Within Sections 31.4.13 and 31.7.12, performance standard (c) is identical, and is the only relevant general performance standard concerning discharges to water. It reads:

(c) Discharges to water shall, after reasonable mixing, comply with the relevant receiving water quality standards and shall not contain any contaminants which could cause:

- *(i) the production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials.*
- *(ii) any conspicuous change in the colour or visual clarity of the receiving waters.*
- *(iii) any emission of objectionable colour.*
- *(iv) accumulation of debris on the foreshore or seabed underlying or adjacent to the discharge point.*
- *(v) any significant adverse effects on aquatic life or public health.*

The proposed dredging and disposal activities are expected to meet these performance standards. Outside a reasonable mixing zone (300m, or 100m in proximity to sensitive hard-shore communities) it is not expected that the proposed activities will result in any of the matters listed in (c) (i)-(iii). This is reflected in the modelling undertaken (MetOcean Solutions, 2016B). Further, video footage of a smaller, distinct, dredging operation undertaken by Refining NZ in December 2016 - February 2017 to undertake urgent emergency works around its berthing 'dolphins' did not reveal any oil or grease films, scums or foams, and no floatable materials. Moreover, video of the plume generated by the dredge indicated the plume was not associated with a conspicuous change in the colour or visual clarity after reasonable mixing.

In terms of standard (c)(iv), which refers to an accumulation of "debris" on the foreshore or seabed, a reasonable interpretation of this standard is that it seeks to avoid any accumulation of harmful contaminants from point source discharges (for example, litter/waste products associated with a wastewater outfall). It is of course a necessary aspect of a dredging and disposal project that there will be an accumulation of dredged material on the seabed. It is acknowledged that, construed narrowly, this particular performance standard could be interpreted as including disposal of any / all dredged material - although it could be expected the terminology used would reflect this, rather than the specific use of the term "debris". However, it is not considered to be a reasonable (nor intended) application of the standard. Accordingly, the proposed disposal activity can be considered to be compliant with the standard.

In terms of clause (v), which relates to significant adverse effects on aquatic life, it has been concluded that that adverse effects on benthos within the dredge and disposal areas should be minor to moderate, which is consistent with that performance standard (refer Section 2.5.1).

Overall, it is not expected there will be a compliance issue with any of the clauses of performance standards 31.4.13(c) or 31.7.12(c).

In terms of Regional Coastal Policy 21.4, there will be an effective net zero take of coastal water as a result of proposed dredging activities.

4.1.2e Summary and Recommendations

Given the:

(i) modelling of sediment plume dispersal,

(ii) reasonable / available mixing zone around the dredge and disposal footprints, and

(iii) real time turbidity monitoring at the boundary of sensitive rocky reef habitats,

water column effects are expected to be less than minor.

Coastal water quality standards discussed in Section 2.5.1 are expected to be met after reasonable mixing of sediment plumes generated by proposed dredging activities and the disposal of dredged material at disposal sites 1.2 and 3.2.

Derived turbidity limits / thresholds are proposed in Table 8 to manage suspended solids concentrations within adjacent sensitive communities.

These require the following responses in terms of concurrent operational controls on dredging / dredged spoil disposal activities.

- Level 1: the reason for elevated suspended solids concentrations down-current of the operational dredge need to be investigated,
- Level 2: operational changes are required by the dredge to reduce down-current suspended solids concentrations, and
- Level 3: suspended solids concentrations down-current of the operational dredge result in dredge activities being stopped.

Accordingly, it is recommended:

(1) real time turbidity recorders are installed and monitored on the boundaries of adjacent sensitive rocky reef communities during dredging activities (refer A and D in Table 8 and Section 7.2), and

(2) hand-held turbidity meter measurements are used to ensure compliance with thresholds where dredging and disposal activities are undertaken in proximity to other receiving environments (see B, C and E in Table 8 and Section 7.2).

The turbidity thresholds proposed in Table 8 (from Coffey, 2016D, Elliot 2017 and Tonkin & Taylor, 2017C) are also based on comparative studies conducted by the Ports of Tauranga and the Ports of Otago (Bryan et. al., 2014; Fenwick and Stenton-Dozey, 2015; Port of Tauranga, 2014; Warren et. al., 2015: Warren, 2016, Stewart, 2011, Stewart 2013 and 2015).

MetOcean Solutions (2017) calculated suspended sediment concentrations in the water column within disposal area 1.2 in relation to wave height using historical weather records. They found (see Table 3-4 of Tonkin & Taylor, 2017A) that average suspended solids concentrations in the water column exceeded 100 $g.m^{-3}$ for 10% of the year when wave heights exceed 1.5 m and hence it could be assumed resident benthos within that area were tolerant of at least 100 $g.m^{-3}$ of suspended solids for short periods of time.

On this basis, the Level 3 turbidity threshold of 40 proposed for Bream Bay by Coffey (2016D) has been increased from 40 to 100 for disposal area 1 because natural events involving high winds and extreme wave events, may on occasions, result in higher turbidity events than have been described in Section 2.5.2 (MetOcean Solutions 2017).

Similarly, Refining NZ (pers. comm. Riaan Elliot) have been trialling the deployment of continuous recording, data transmitting, turbidity meters on the Motukaroro Island Whangarei Marine Reserve Marine 1 Management Area boundary since May 2017 (see Section 7.2 and Figure 16) and have reported background turbidity records greater than 10 grams per cubic metre (see Table 8).

Table 8: Recommended turbidity thresholds (NTU) for the dredging programme. A and D relate to a six-hour average of one-minute interval records from fixed turbidity metres. B, C and E relate to hand-held turbidity meter readings as per Figure 17.

Location	Concern	Level 1 Threshold	Level 2 Threshold	Level 3 Threshold
A - Motukaroro Island Whangarei Marine Reserve Marine 1 Management Area	Rocky Reef Taxa	**15***	**20***	**25***
B - Calliope Bank Marine 1 Management Area	Shellfish benthic invertebrates	**15**	**20**	**35**
C - Mair Bank Marine 1 Management Area	Shellfish benthic invertebrates	**15**	**20**	**35**
D - Home Point Marine 1 Management Area	Rocky Reef Taxa	**15***	**20***	**25***
E - Bream Bay including Three Mile Reef	Shellfish benthic invertebrates	**20**	**25**	**40** (**100**** for Disposal Area 1.2

* provisionally based on RNZ data base (Elliot, 2017) for Location A between May and July, 2017.
** based on Table 3-4 of Tonkin & Taylor (2017B).

Therefore, the suspended solids standards / thresholds adopted in Table 8 can be considered to be conservative, precautionary and subject to revision on the basis of further monitoring data.

Neither the Regional Coastal Plan nor the RMA define an appropriate reasonable mixing zone. Instead, this is to be determined having regard to the attributes of a particular location (for instance, currents, tides, bathymetry, and roughness coefficient of the seabed). Here, a reasonable mixing zone within Bream Bay would be 300m, however in proximity to some hard-shore communities (e.g. Home Point) only 100m is available for a mixing zone (Tonkin & Taylor, 2016C).

4.1.3 Prediction of Effects on Marine Community Structure

4.1.3a Plankton

As described in Section 2.6.1, plankton is abundant along the north-east coast of the North Island and can on occasions bloom to nuisance proportions. The study area (including the mouth of Whangarei Harbour) is well flushed with open oceanic water with its associated plankton community.

It is considered very unlikely that the large-scale drivers for plankton productivity and potential toxicity within Bream Bay or the lower Whangarei Harbour would be affected by the dredging and disposal activities proposed.

Localised and transient effects of reduced light levels and fine particles clogging the filter feeding mechanisms of zooplankton could occur within sediment plumes generated by disturbance activities, but it is not considered that these short-term potential impacts warrant the imposition of a monitoring regime that specifically describes plankton.

Overall, any adverse effects on plankton associated with the proposed disturbance activities are predicted to be negligible, and are not expected to adversely impact on significant ecological areas.

4.1.3b Benthos

Soft-bottomed benthic communities are routinely subject to high turbidity / suspended solids concentrations during high energy wave events (MetOcean Solutions, 2017) and are considered tolerant of sediment plumes that will be generated when winning and disposing of dredged material.

However, soft-bottomed benthic communities within the area to be dredged (see Figure 4) will be removed with dredged material and very few are expected to survive excavation, transport and disposal at an alternative site.

Similarly, those benthic animals and occasional plants at disposal sites 1.2 and 3.2 on which dredged sediment is placed are expected to be buried and not survive.

The bulk of moribund benthic organisms that are buried at disposal sites would be decomposed by bacteria and fungi.

On the basis of a marine habitat map for Northland (Kerr, 2009), the conservation status of New Zealand marine invertebrates (Freeman et. al., 2013) and nominated sensitive marine benthic habitats in New Zealand (MacDiarmid et. al., 2013), it is concluded the indigenous fauna that would be removed from the dredging footprint and buried by the placement of dredged material in proposed disposal areas 1.2 and 3.2 (see Figure 2) is not of national or regional significance. No benthic taxa in these predominantly sandy sites are considered to be endangered or at risk.

However, surrounding some of these soft bottom areas (particularly those dredging locations within the Whangarei Harbour) that will be disturbed by proposed dredging activities are hard-bottom reef communities of high intrinsic, conservation and recreational value.

Capital dredging would impact on (displace) benthic communities from an area of 1.62 km^2, and disposal of that dredged material will disturb an area of 2.75 km^2 for a period of up to 12 months.

Shallow (<20m), high-energy, coastal environments tend to become recolonised more rapidly than deeper offshore environs environments following dredging activities and there are a wide range of variables that determine the rate of recolonisation (Coffey, 2017A).

However, on the basis of monitoring other dredging sites in New Zealand (Port of Auckland[5] Tauranga[6] and Otago[7]), it is expected that an ecologically constructive benthic community would have re-established within a period of 6 - 24 months (albeit of a smaller size class than perennial taxa that were displaced by the dredging event).

This is considered to be a localised, minor to moderate impact on benthic productivity (and available food for fish in the local area) and hence compensation is proposed (see Section 5 and Coffey and Stewart, 2017). There will be a progressive reduction in the level of these effects over time, and it is expected that the dredge and disposal areas will support an ecologically constructive community 6 - 24 months after proposed disturbance events (Coffey, 2017A).

It is recognised that whilst re-colonisation sequences that have occurred following dredging activities to maintain access to other NZ ports (see footnotes 5, 6 and 7) have generally

5 http://www.poal.co.nz/sustainability/environmental-management/dredging

6 http://www.environmentguide.org.nz/issues/marine/major-marine-development/im:2115/

7 www.portotago.co.nz/our-harbour/overview/

involved endemic benthic community types that were disturbed by dredging activities, adventive pests have the potential to become pests in areas that have been disturbed within dredging footprints or disposal grounds for dredged material (Inglis and Seaward, 2016; Ministry for the Environment and Statistics New Zealand, 2016).

Such adventive pests include *Arcuatula senhousia*, the Asian bag (or date) mussel, *Charybdis japonica* the Asian paddle crab, *Eudistoma elongatum* the Australian droplet tunicate, *Sabella spallanzanii* the Mediterranean fanworm, *Styela clava* the Clubbed tunicate, and *Theora lubrica* the Fragile clam.

Monitoring is required to check this does not happen.

The post-impact monitoring regime recommended in Section 7 includes drop-camera and physical sampling within the disturbed areas. In the event that adventive pests are found to have dominated the re-colonisation process within these areas, Refining NZ would notify the Ministry of Primary Industries ('MPI') and RNZ would co-operate / collaborate with any response plan MPI consider appropriate.

4.1.3c Fish

Local finfish stocks are expected to avoid planned disturbance activities and disturbed sites until their feeding grounds have recovered (Desprez, 2000; Sutton & Boyd, 2009; Slabbekoorn et al., 2010).

The proposed dredging and disposal activities are likely to result in in an initial reduction of the population of species such as snapper, kahawai and kingfish using the disturbance footprints, but a progressive recovery of these populations would be expected to be complete within the subsequent 6 to 24-month period (Coffey, 2017A).

Parties at consultation meetings conducted by RNZ have also raised the question of how the proposed dredging programme and disposal activities might impact on sharks and fish migrations to and from freshwater.

In response, Sharks are also expected to avoid areas that are subject to active disturbance due to reduced benthic production following a dredging or disposal event and are less likely to feed in disturbed areas until benthic production is re-established.

Eels have a strong sense of purpose in terms of migrating from fresh water to their breeding grounds in the tropical Pacific, and in returning home to fresh water as glass eels and elvers. Like most native fish (including whitebait) returning to fresh water from the sea, they have the ability to avoid obstacles, or to wait until conditions are suitable to continue with their migration. Consequently, the activities proposed by Refining NZ are not expected to adversely affect eels, either as individuals commencing or completing their migrations or as a population.

In terms of whitebait (primarily the young of: inanga (*Galaxias maculatus*), koaro (*G. brevipinnis*) and banded kokopu (*G. fasciatus*); inanga is by far the most commonly caught taxa. Giant kokopu (*G. argenteus*), short-jawed kokopu (*G. postvectis*) and smelt (*Retropinna retropinna*) are also occasionally present along with the young of many other fish such as eels, bullies and brown trout.

All whitebait species spend part of their life cycle in fresh water and part in the sea. Fish hatch in late autumn and are carried along rivers out to sea where they live and grow over the winter. In late winter and early spring whitebait migrate back up rivers and streams, finally settling and growing in bush covered streams and swamps. The start of the migration is thought to be influenced by river flows (i.e. shortly after floods) and phases of the moon. Mature inanga adults migrate downstream to lower river sections and estuaries to spawn in grasses covered by water during spring tides. The eggs remain in the grass until the next spring tide covers them again when the young hatch and are carried out to sea.

The effect of the proposed disturbance activities on fish feeding and fish migration is expected to be relatively minor with the most important effect being a temporary reduction in food availability for those taxa that feed on benthos in the entrance channel and disposal grounds for dredged material. In this regard, the fish species that feed in the disturbed areas are likely to avoid them in the short term, but will return as re-colonisation occurs. As such, the disturbance activities proposed are not considered likely to contravene Policy 11(b) of the Coastal Policy Statement (Department of Conservation, 2010) or provisions of the Northland Regional Policy Statement relating to Indigenous Ecosystems and Biodiversity (Northland Regional Council, 2016).

4.2 Maintenance Dredging and Disposal of Maintenance Dredgings

Maintenance Dredgings (up to 150,000 m^3 over 35 years) may be placed in any or all of disposal area 1.2, disposal area 3.2, or possibly on land (assuming any relevant consents or authorisations are separately obtained).

Disposal area 3.2 has been sized to enable all capital and maintenance dredging to be placed within the area for the duration of the maximum consent period allowed (35 years) and disposal area 1.2 is sufficiently large to enable different locations to be targeted for the placement of maintenance dredging as required to retain sand within the littoral system.

As discussed in Section 3, maintenance dredging may need to occur every 2 to 5 years in the berth pocket area and in targeted areas of the inner and mid channel to maintain navigable draft around the jetty dolphins. Assuming uniform distribution of sedimentation within the outer section, the 0.5 m sedimentation allowance could be reached within 5 to 20 years requiring a maintenance dredging campaign in this area (Tonkin & Taylor, 2016C).

All issues and comments in 4.1 above apply equally to maintenance dredging activities. The difference would be the reduced scale and the reduced duration of these effects. Tonkin and Taylor (2016C) report maintenance dredging will involve smaller vessels and a time frame of less than 6 months.

In terms of the recovery of benthos within disturbance areas, each successive disturbance event (which could occur as frequently as once every two years) will again remove the benthic community and re-colonisation will restart.

However, the difference is that if only 10% rather than 60% of a dredging / disposal footprint is involved with maintenance versus capital dredging activities for example;

- the area of reduced benthic productivity is reduced in a linear fashion, and
- the likelihood of recolonising taxa being recruited from adjacent seabed communities at a similar depth rather than from adventive organisms at adjacent wharf / berthing structures / areas is improved.

4.3 Ecological effects associated with potential Hydrocarbon Spillages

In terms of proposed capital dredging activities, the operation of dredge(s) for a six-month period within the study area would increase the risk of spills of oil and fuel and exhaust emissions (Royal HaskoningDHV (2016B).

Royal HaskoningDHV (2016B) advise that dredging operations have now improved with respect to environmental awareness and that the risk of an oil or fuel spill is unlikely with modern professional dredging operations. Furthermore, oil spill contingencies are available at RNZ (Marsden Point).

In terms of the changed pattern of oil deliveries that would occur as a result of the capital dredging programme, Bilderbeck and Oldham (2016), who assessed the risk of an oil spill as

a result of the Option 4.2 channel access improvements, concluded that the benefits of improved navigational safety and fewer tanker visits would significantly outweigh the countervailing effects of the proposed larger crude oil cargo sizes on the volume of oil released and subsequent environmental consequences in the unlikely event of a spill.

This is because tankers would clear Home Point with a greater safety margin after the channel realignment and that there would be a reduction of tanker movements to the RNZ oil terminal per annum.

4.4 Relocation of, Additions to, Navigation Aids adjacent to the Realigned Access Channel

The proposed aids to navigation (AtoN) are shown on Royal HaskoningDHV, 2016C Drawing PA1028-MA-1121 Revision M (see Figure 3).

The existing channel demarcation is provided by a safe water mark (also referred to as the fairway buoy) and eighteen (18) channel markers consisting of nine (9) starboard buoys and nine (9) port buoys.

Eight of the existing buoys will need to be relocated to accommodate the reconfigured channel alignment. These are buoys 2, 3, 5, 8, 11, 12, 14 and 18.

Two additional channel marker buoys (being one starboard buoy and one port buoy) will be installed at -17.7m depth and the existing fairway buoy will be moved to be aligned with the starboard channel markers and installed at -25.0 m depth to accommodate a lengthened entrance channel.

Other AtoN improvements proposed (Royal HaskoningDHV, 2016C) involve an improved Port Entry Light, modification of the (rear) lead light marking the offshore approach channel and installation of a set of lead lights in Taurikura Bay to assist with the night time navigation of arriving Suezmax Tankers and other vessels.

The construction of these navigational aids includes both the initial effects of installing the aid (e.g. anchors, blocks, poles or rock / boulder pins) and routine maintenance visits to service the structures (e.g. lights, marks). The expected effects associated with the removal, installation and maintenance of navigational aids will be localised and temporary.

Further, the navigation aids are expected to have positive effects in that they will reduce the likelihood of ships stranding or colliding with the shoreline, they will reduce the likelihood of accidents and potential hydrocarbon spillages. Accordingly, in my view, the ecological effects associated with the installation, modification and removal of navigational aids will be less than minor.

In addition, it is noted that approval to install, alter or remove aids to navigation aids in the Coastal Marine Area is required from the Director of Maritime New Zealand and there are industry best management practices for such activities.

Due to the rock outcrop, and therefore potential navigational hazard in the vicinity of Home Point, it is proposed that a West Cardinal Beacon or buoy be installed 175 m north of Buoy No. 7 at a relative depth of 15.8 metres. This is the only AtoN that will be constructed within habitats covered by Policy 11a of the NZCPS (Department of Conservation, 2010) and it is noted that the construction methodology for the beacon would involves a tripod base utilising two MT blocks on each leg to hold in position to avoid a requirement to fix too or drill into the reef. Alternatively, the buoy would involve three separate mooring blocks and chain. It is considered that these construction strategies and the limited footprint of reef involved would avoid adverse effects on reef habitat at that site.

4.5 Summary of Environmental Effects of Proposed Disturbance Activities

An adverse effect of the capital dredging proposal would be a localised and temporary reduced food supply for animals such as finfish and rays that feed in the entrance channel and the nominated sites that are used for the disposal of dredged material.

Seafloor sediments within the proposed dredging footprint are not contaminated and their relocation to the nominated offshore disposal areas is not expected to be associated with water column issues such as toxicity.

Given the low organic matter content of the sands to be relocated, no water quality issues such as dissolved oxygen sags are expected to be associated with sediment plumes that are associated with winning and disposing of dredged material.

The deepening of the access channel and the placement of dredged material at nominated disposal sites is expected to have a minor or less than minor effect on tides, currents, and/or wave heights within the study area (Met Ocean Solutions, 2016). No adverse marine ecology effects are expected as a result of such changes.

Existing soft-bottomed communities are adapted to naturally occurring sediment transport and there are no ecological issues associated with proposed disturbance activities at these sites. However, when these soft-bottom communities are instantaneously buried by a layer of sediment that is too deep for them to migrate up through to reach the new seabed surface, they are smothered and a conservative approach is to assume complete mortality of pre-exiting benthos. It is expected that such areas will be recolonised by like communities within a relatively short time-frame (i.e. 6 - 24 months after disposal is compete, Coffey, 2017A).

The habitat of indigenous fauna that would be disturbed by proposed dredging activities and buried by the placement of dredged material in proposed Disposal Area 1.2 and 3.2 is not of national or regional significance. No benthic taxa in these predominantly sandy sites are considered to be endangered or at risk (West and Don, 2016A).

However, surrounding some of these soft-bottom areas that will be disturbed are hard-bottom reef communities of high intrinsic, conservation and recreational value. These communities are of regional and national significance and it is proposed that potential adverse effects on these areas are to be avoided by monitoring and responding to real time telemetering of turbidity meters on the boundary between disturbance activities and these sensitive habitats (Bryan et. al., 2014).

The effect of the proposed disturbance activities on fish migration is expected to be minor with the most notable effect being a temporary proportional reduction in food availability for those taxa that feed on benthos in the entrance channel and disposal grounds for dredged material.

The proposed new alignment for the entrance channel and a reduced number of tanker visits per year will reduce the likelihood of significant oil spill from oil tankers within the study area (Bilderbeck and Oldham, 2016).

The ecological effects associated with the relocation and / or modification of existing, and / or the establishment of new navigation aids adjacent to the realigned channel entrance are expected to be less than minor.

While the winning and placement of the dredged material will result in the loss of benthic biomass at disturbed sites, the expected re-colonisation of disturbed areas should ensure that such effects are short-term, and overall, the effects are expected to be minor to moderate. There will be a progressive reduction in the level of these effects over time, and it is expected that the dredge and disposal areas will support an ecologically constructive area 6 - 24 months following disturbance.

In terms of the dredging footprint at Marsden Point, the fine sand habitat was the most common, most diverse, and dominated by smaller biota such as polychaete worms and

amphipods (see Figure 3.14 of West and Don 2016). Benthic recovery in this habitat type is expected to be relatively rapid (c. six months).

It is anticipated that the fine sand habitat will also dominate the dredging footprint following capital dredging works.

The coarse sand habitat (see Figure 3.14 of West and Don 2016) was dominated by the bivalve Tawera spissa and the primitive chordate, Epigonichthys hectori. Inside the harbour mouth the coarse sand habitat was dominated by the community defining bivalve Venerupis largillierti and juvenile gastropods. These communities would be expected to take two years to recover (in terms of longer lived bivalves) but ecologically constructive benthic communities (in terms of providing feeding grounds for fish) would be expected to recover within 12 months.

The shell gravel habitat (see Figure 3.14 of West and Don 2016) had a higher proportion of larger species than the sandy habitats. The species composition was different from the sandy habitats with 36 taxa only found in the shell gravel habitat. The community defining bivalve Tucetona laticostata and the primitive chordate, *Epigonichthys hectori* were abundant in the shell gravel seaward of Home Point, but almost absent inside the harbour mouth. Inside the harbour mouth the shell gravel had greater numbers of bivalves *Corbula zelandica* and *Venerupis largillierti* and juvenile gastropods.

Maldanid polychaetes that are indicative of stable rather than disturbed benthic communities were more common in the outer section of the proposed dredging footprint.

In terms of proposed disposal grounds for dredged material, Disposal Area 1.2 was a more disturbed site than Disposal Area 3.2 (in terms of Maldanid polychaetes and longer-lived bivalves) and recolonisation would be expected to be more rapid (c. 6 months) within Disposal Area 1.2 than within Disposal Areas 3.2 (c. 1 – 2 years). Again however, ecologically constructive benthic communities (in terms of providing feeding grounds for fish) would be expected to recover within 12 months within Disposal Area 3.2.

5.0 Avoidance, Remediation or Compensation Measures for Disturbance Activities

5.1 Short term loss of soft-bottom benthic productivity in the northern sector of Bream Bay

There will be a short-term loss of benthic productivity within the dredge and disposal areas. This area totals 4.37 km^2 or 437 hectares.

As an offset / compensation measure for this effect, it is recommended that RNZ consider supporting / collaborating with / making a financial contribution to, a Regional Council or Department of Conservation catchment management initiative that would improve the overall health of the Whangarei Harbour (Coffey and Stewart, 2017). Failing that, the recommended approach would be for RNZ to collaborate with the Regional Council, the Department of Conservation and Tangata Whenua to establish and support a Stream Care Group for Blacksmith's Creek and Estuary, or initiate / contribute to a planting programme to enhance the current recovery of seagrass beds in the downstream reaches of Whangarei Harbour.

NIWA and the Regional Council (Cummings and Hatton, 2003; Cummings, 2006; Lundquist and Broekhuizen, 2012; Reed et. al, 2004, NIWA, 2005) have already pioneered initiatives in Whangarei Harbour to understand and to re-dress the demise of pipi populations and seagrass beds in Whangarei Harbour.

5.2 Avoiding adverse sedimentation effects within sensitive hard bottom communities adjacent to the dredging footprint.

Given the regional and national significance of kelp beds and sponge gardens that are on the boundary of (but not within) the proposed dredging footprint and the Motukaroro Island marine

reserve and Home Point, then to be consistent with Policy 11(a) of the NZCPS (Department of Conservation, 2010), adverse sedimentation effects within these areas need to be avoided.

In addition, there are other specified receiving environments which also require significant adverse sedimentation effects to be avoided, and other effects to be avoided, remedied of mitigated. These include Calliope Bank, Mair Bank, and Bream Bay including Three Mile Reef.

Whilst there is less concern with potential sedimentation effects in soft-bottom communities that are on the boundary of the proposed dredging footprint (as they are less sensitive to sedimentation effects) the intention is to confine adverse ecological effects to the specific footprint of proposed disturbance activities wherever possible.

The usual approach is to establish background sedimentation rates to which surrounding communities are subject and to assume they are tolerant of these background conditions. Provided these worst-case concentrations of suspended solids are not exceeded as a result of proposed disturbance activities (and it has been established the sediment suspended by the dredging activities is not contaminated), it can be concluded the surrounding communities are not expected to be adversely affected if these thresholds are not exceeded.

Monitoring of turbidity levels at the boundary of each of the above sensitive receiving environments is proposed in Section 7 below.

Based on this monitoring, responses in terms of concurrent operational controls on dredging / dredged spoil disposal activities are summarised in Table 8 and Section 4.1.2d above and are expected to be effective in protecting adjacent community to adverse sedimentation effects arising from proposed disturbance activities.

5.3 Summary

With proposed avoidance, remediation and compensation measures in place, any adverse ecological effects within the footprints of the dredging and disposal activities are expected to be localised and short term (6 - 24 months) and further compensated for by proposed contributions to projects such as enhancing the overall health of the harbour / seagrass habitats (Coffey and Stewart, 2017).

Similarly, given the very conservative approach that is proposed in close proximity of ecologically significant areas (Motukaroro Island Whangarei Marine Reserve and kelp beds and sponge communities at Home Point), any adverse effects on the adjacent communities and environs is expected to be avoided.

In terms of Policy 11 of the New Zealand Coastal Policy Statement, the proposed activities would be conducted in accordance with the direction it sets. Adverse effects on matters listed in 11(a) will be avoided; and significant effects on matters listed in 11(b) will be avoided, and other effects avoided, remedied or mitigated.

6.0 Planning Matters (Resource Management Act 1991[8])

Some relevant matters that are set out in the Resource Management Act (1991) are now addressed.

6.1 Section 6(c)

The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna is a matter of national importance under section 6(c) of the Resource Management Act 1991 (the Act) and are expected to be achieved if more than minor sedimentation effects can be avoided in sponge garden and kelp bed habitats adjacent to proposed disturbance activities.

The proposed monitoring regime details a threshold limit for turbidity, and establishes real time monitoring at the boundary of the sensitive Motukaroro Island Whangarei Marine Reserve and Home Point, with hand-held monitoring at the boundary of other receiving environments as set out in Table 8. That regime specifically considers the potential effect on significant vegetation and habitats, to ensure that adverse sedimentation effects will be avoided in these sensitive habitats adjacent to proposed disturbance activities. Therefore, in my view the proposal is consistent with section 6(c) of the Act.

6.2 Section 7

The area of soft-bottom seabed that would be directly affected by the proposed disturbance activities is the most abundant and widespread habitat type within the coastal marine area of Northland. On this basis, the intrinsic value of that ecosystem will be maintained due to the localised footprint of the ecosystem that would be affected and because full recovery of the disturbed area is expected in the short term.

Kaitiakitanga and the ethic of stewardship for ecological values within the study area is demonstrated by Patuharakeke Te Iwi Trust Board Inc. (2014).

Maintenance and enhancement of the quality of the environment (as set out in Section s7 (f) of the Act) would be satisfied in terms of proposed works reducing the likelihood of a significant crude oil spill within the study area, and as a consequence of the considerable efforts that have been made to avoid the areas of significance, and to develop and advance robust, conservatively cast, measures to protect those areas. Minimising the adverse effects on all other marine species and environments also will ensure that quality of the marine environment will be at least maintained in the medium to long term.

The sea run salmon fishery is confined to the South Island and these applications will have no effect on that fishery (which is a relevant matter for consideration under Section 7[h] of the Act).

In terms of trout, brown trout do migrate in the sea from river mouth to river mouth around the New Zealand coastline but they are not generally present north of the Coromandel Peninsula because of warmer water temperatures (McDowall, 1990). Rainbow trout are not common in Northland and do not venture into salt water.

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[8] Under the Resource Management (Marine Pollution) Regulations 1998 (reprint as of 28 August 2014) the dumping of dredge material in the Coastal Marine Area is included as a discretionary activity in any regional coastal plan or proposed regional coastal plan and an application for such an activity must identify the sources of contamination and waste prevention strategies that may be used to control that contamination. However, it is considered that these matters have been adequately dealt with under the following sections of the Resource Management Act (1991) and elsewhere in this Assessment of Effects.

As a consequence, the activities proposed by Refining NZ are not expected to impact on that aspect of Section 7(h).

In terms of Section 7(i), based on the latest climate projections for New Zealand (mfe.govt.nz), by the end of this century we are likely to experience:

- higher temperatures – greater increases in the North Island than the South, with the greatest warming in the northeast (although the amount of warming in New Zealand is likely to be lower than the global average),
- rising sea levels,
- more frequent extreme weather events – such as droughts (especially in the east of New Zealand) and floods,
- a change in rainfall patterns – with increased summer rainfall in the north and east of the North Island and increased winter rainfall in many parts of the South Island.

No measureable effects of global warming are expected during the capital dredging programme as it would involve a 6-period within an 80-year projected impact time frame mfe.govt.nz).

However, the term of consent sought for maintenance dredging is 35 years and some subtle changes in terms of rising temperatures, rising sea level, drought / flood frequency and increased summer rainfall might be expected within this time frame. However, any such subtle changes are not expected to have a measureable effect on the effects of the maintenance dredging activities proposed by Refining New Zealand.

6.3 Section 8

It is recognised that the Act requires development of the type proposed to account for the Principles of the Treaty of Waitangi and in this case taonga species such as pipi and flounder.

6.4 Section 15B

Section 15B relates to the discharge of harmful substances (or contaminants) from ships and offshore installations. In terms of ecological matters, sediment plumes created by proposed dredging activities are not expected to contravene matters set out in 15B1(b) (i), (ii) and (iii) of the Act after reasonable mixing.

However, in the case of Section 15B (1) (b) (iv) of the Act, there will be an adverse effect on aquatic life in that surface dwelling benthos and infauna within the dredging footprint will be sacrificed for the project and surface dwelling benthos and infauna at the nominated disposal grounds (1.2 and 3.2) will be buried.

However, the effect is expected to be localised, short term and re-colonisation of disturbed areas is expected to be relatively rapid (6 – 24 months) and compensation measures are proposed to offset these effects (also see Section 2.5.1).

Therefore, this is not expected to constitute a significant adverse effect.

Accordingly, it is considered that the requirements of Section 15B will be met and that this section should not prohibit the grant of resource consents for the project.

6.5 Section 105

(a) The nature of the discharge and the sensitivity of the receiving environment to adverse effects.

These applications involve the placement of clean (uncontaminated) sand and shell with < 6% silt onto similar sediment that occurs within Disposal Areas 1.2 and 3.2 (Tonkin & Taylor 2016C). Benthic communities that are present within the nominated disposal sites can tolerate sediment transport and sediment resuspension that occurs naturally in these habitats in relation to water currents and wave action.

However, they cannot tolerate burial by a significant depth of sediment (> 20 cm) as is proposed during the disposal of dredged sediment in this instance. Re-colonisation of dredged sediment placed in disposal areas is expected to occur relatively quickly so that the effect of displacing benthic communities within these areas will be short term (6 – 24 months, see Coffey 2017A).

Each maintenance dredging event will again displace benthic communities from the footprint of the disposal areas where dredged sediment is placed and the re-colonisation sequence will need to begin again.

(b) The applicant's reasons for the proposed choice.

A combination of project efficiency (addressed by other experts) and sediment supply to nourish Mair Bank that has been described by Tonkin & Taylor (2016D).

(c) Any possible alternative methods of discharge, including discharge into any other receiving environment.

Whilst the stated preference in the RCP is "*to promote land-based disposal of dredging spoil from both capital and maintenance dredging of the coastal marine area, where this better meets the purpose of the Act*" (Policy 22.4 No. 7), benthic communities are expected to re-establish in and on dredged material placed in these areas within a reasonable time frame (6 to 24 months).

Refining N.Z. have sought to identify land-based disposal options where there is a market for dredged material and parties wishing to receive dredged material have the necessary authorisations (Tonkin and Taylor, 2016C).

6.6 Section 107

Section 107 is addressed within the Assessment of Environmental Effects report that is being lodged in support of the Refining NZ's proposal. In summary, however, Section 107 requires that consent for discharges to the CMA shall only be granted where certain water quality and ecology outcomes (as set out in subsections 107(1)(c) to (g) of the Act) are met. The water quality and ecology outcomes (that apply after reasonable mixing in receiving waters) are discussed briefly in the following comments.

Management measures will be required to meet Section 107 (c) requirements in terms of suspended materials and the risk of oil or grease contamination from machinery used to win and dispose of dredged materials. These can be managed by conditions of consent.

In terms of Section 107 (d) a conspicuous change in colour and visual clarity should be confined to a reasonable mixing zone and again can be managed by conditions of consent.

Section 107 (e) is not expected to be an issue due to the low organic matters content of dredged material to be won and disposed of and Section 107 (f) is not applicable in this instance.

There will be an adverse effect on aquatic life (Section 107[g]) in that surface dwelling benthos and infauna within the dredging footprint will be sacrificed for the project and surface dwelling

benthos and infauna at the nominated disposal grounds (1.2 and 3.2) will be buried. However, the effect is expected to be, localised, short-term and re-colonisation of disturbed areas is expected to be relatively rapid (6 – 24 months) and compensation measures are proposed to offset these effects. Therefore, this is not expected to constitute a significant adverse effect.

Accordingly, it is considered that the requirements of S107 will be met and that this section should not prohibit the grant of resource consents for the project.

7.0 Recommended Monitoring

The baseline description of pre-impact community structure by Bioresearches, Kerr and Associates and the Cawthron Institute, within and adjacent to areas that would be disturbed by the proposed dredging programme is considered to be robust. Post-dredging monitoring is required to document any actual changes and effects of the proposed activities.

The situation in terms of potential impacts is less complicated now it has been established that seabed sediments that would be disturbed by proposed works are not contaminated and have a low organic matter content.

The remaining matters that warrant on-going monitoring are:

- a localised, short-term loss of benthic productivity,
- measures to ensure that sediment plumes and associated sedimentation effects from dredging operations do not extend into sensitive communities adjacent to the proposed dredging footprint,
- a benchmark description of seagrass and shellfish communities that are in a current state of flux and need to be described separately from the effects of the proposed RNZ dredging programme, and
- monitoring to identify possible re-colonisation by adventive marine pest species.

7.1 Immediately Prior to Dredging and Disposal

Monitoring would involve a benchmark description of seagrass beds (footprint description and photoquadrats for % cover, health and vigour) and shellfish communities on Mair Bank (as per Pawley (2016). It is appropriate to undertake this immediately prior to commencement of dredging operations because they are known to be in a state of flux and subject to short term change in the absence of proposed disturbance activities.

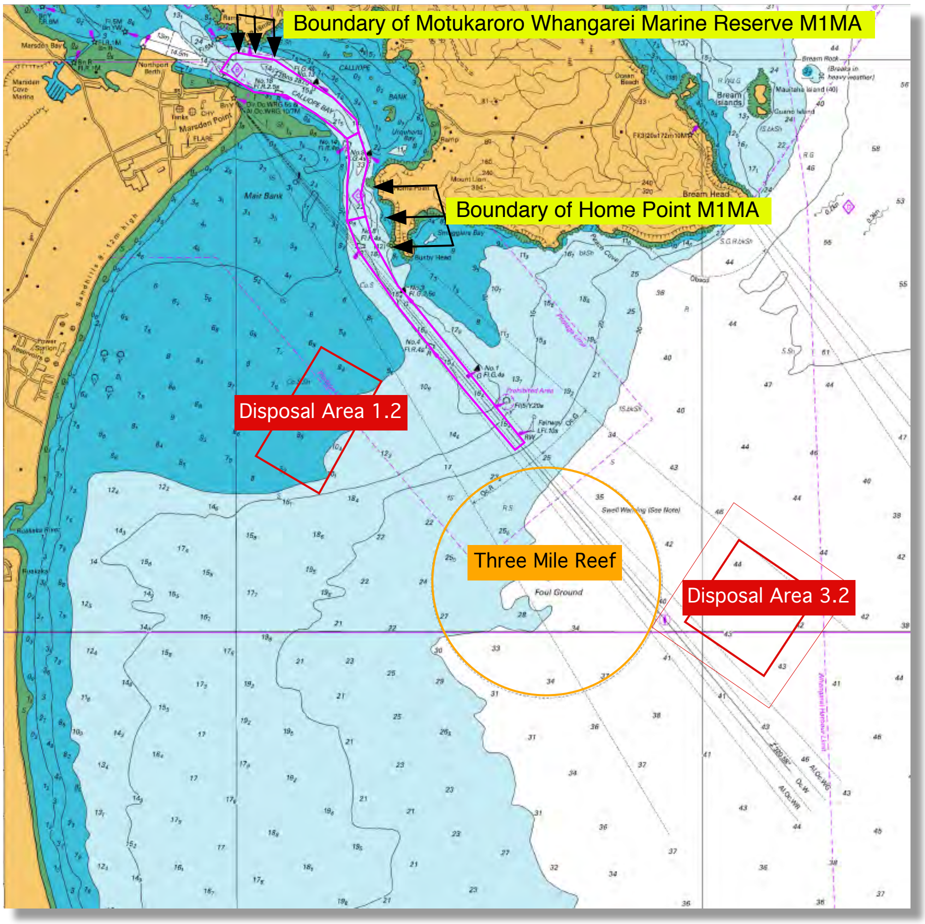
7.2 During Dredging and Disposal

Monitoring would involve the deployment of continuous recording, data transmitting, turbidity meters on the boundary of adjacent reef habitats abeam of where the dredge(s) would be winning dredged material (see Figure 16).

Three would be deployed on the southern boundary of the Motukaroro Marine Reserve and three would be deployed on the western boundary of the Home Point Marine 1 Management Area).

Real time data would be sent to the dredging vessel and a running 6-hour average NTU value (or revisions thereof – see Table 8) would be used to modify (if necessary) engineering and operational measures to meet NTU guidelines for those receiving environments.

Figure 16: Proposed deployment of six fixed, real time, transmitting turbidity metres adjacent to sensitive hard-short receiving environments. Other adjacent receiving environments are to be monitored with hand-held turbidity metres outside a 100m mixing zone at high tide on a daily basis when the dredger is operational.



Turbidity limits / thresholds have been derived that require the following responses in terms of concurrent operational controls on dredging / dredged spoil disposal activities.

- Level 1: the reason for elevated suspended solids concentrations down-current of the operational dredge need to be investigated,
- Level 2: operational changes are required by the dredge to reduce down-current suspended solids concentrations, and
- Level 3: suspended solids concentrations down-current of the operational dredge result in dredge activities being stopped.

In this instance, it is proposed that if a six-hour average turbidity of 20 NTU (average of 360, one-minute real-time records) is exceeded on the boundary of the Motukaroro Island Whangarei Marine Reserve or Home Point due to dredging activities, then dredging activities shall to be modified to ensure the a six-hour average turbidity is reduced to less than 20 NTU (or revisions thereof – see Table 8).

If the one-hour average turbidity of 25 NTU is exceeded on the boundary of the Motukaroro Island Whangarei Marine Reserve or Home Point due to dredging activities, then dredging activities shall stop.

These limits (see Table 8) apply to the boundary of the Motukaroro Island Whangarei Marine Reserve and Home Point. This strategy requires that real time data from turbidity meters on the boundary of the Motukaroro Island Whangarei Marine Reserve or Home Point are

transmitted to the operational dredge and that there are agreed protocols to follow to reduce sediment plumes generated by the dredge if required (for example stop the discharge of decant water, or move away from the boundary of the Motukaroro Island Whangarei Marine Reserve or Home Point).

With regard to other soft-bottomed adjacent communities (see Figure 16), compliance with turbidity thresholds listed in Table 8 (or revisions thereof) would be established with hand-held turbidity meter readings.

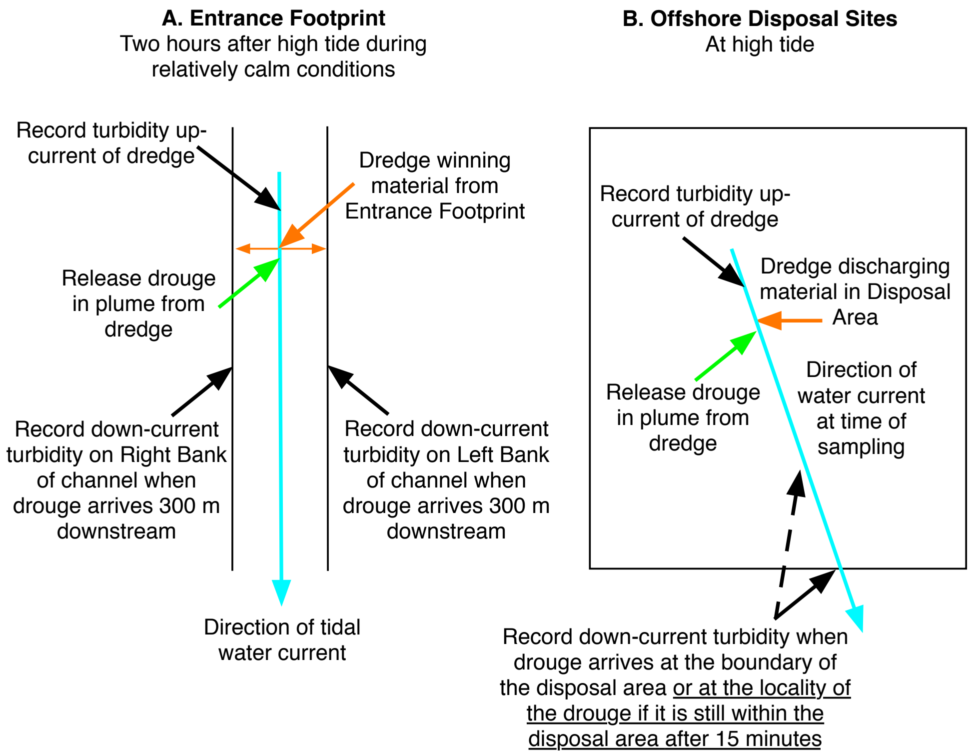
There would two strategies employed with the hand-held turbidity meters.

The first would apply to dredging activities in the entrance channel (see Figure 17A). The second would apply to the disposal areas 1.2 and 3.2 in Bream Bay (see Figure 17B). A drogue (e.g. Dan Bouy) would be used to track the downstream movement of the plume and down-current readings would be taken at the position of the drogue as per Figure 17.

The up-current readings will be used to determine natural background levels of turbidity and the down-current readings will be used to described turbidity increases due to the operation of the dredge (as per Byran et. al., 2014). Turbidity records would be made at a depth of one metre.

It is recommended the readings within the entrance channel are standardised (2 hours into ebb tide during relatively calm conditions) and a mixing zone of 300 m is used to describe turbidity on either bank of the entrance channel as shown in Figure 17A. In the event the drogue enters the boundaries of either of Mair Bank or Calliope Bank, a hand-held turbidity reading would be taken on that boundary (plus records of time and GPS co-ordinates).

Figure 17: Use of hand-held turbidity metre to measure up-current / down-current turbidity when dredge is operating adjacent to soft bottomed habitats (see Figure 16).



In the case of the disposal areas (see Figure 17B), it is recommended sampling is undertaken at high tide and that the down-current reading is taken when the plume (as indicated by the drogue) crosses the boundary of the disposal area (together with records of time and GPS co-ordinates). In the event that the drogue is still within the boundary of the disposal area after

15 minutes, a turbidity reading would be at the position of the drogue (together with records of time and GPS co-ordinates).

Values in Table 8 (or revisions thereof) would be used to assess compliance of dredging activities with turbidity thresholds in soft-bottomed receiving environments and it is envisaged 4 days of data would be used to established compliance / non-compliance on a monthly basis.

The highest turbidity (equivalent to Total Suspended Solids concentration) adopted in Table 8 is 100 NTU for disposal area 1.2 in Bream Bay. This is because Tonkin & Taylor (2016D) have calculated that this depth average concentration of Total Suspended Solids is experienced within disposal area 1.2 for some 10% of the year when waves are 1.5 m high. Clearly therefore, resident benthos present in disposal area 1.2 can tolerate short to medium term exposure to Total Suspended Solids concentration of 100 grams per cubic metre. Similarly, data currently being generated by Elliot (2107), whilst subject to on-going review, has used to inform other changes in Table 8 relative to thresholds originally proposed by Coffey (2016D).

7.3 Post Dredging and Disposal

Benthic ecological surveys post dredging and disposal would involve a repeat of the following.

- The benchmark description of seagrass beds (footprint description and photoquadrats for % cover, health and vigour) and shellfish communities on Mair Bank (as per Pawley (2016) immediately prior to dredging and disposal activities.
- Aspects of the baseline surveys conducted for the AEE immediately after the disturbance events.

These annual repeat (post-dredging and disposal) surveys will be designed to provide ecological information on:

- the recovery of disturbed benthic communities within the dredging footprint,
- the recovery of any affected communities in the immediate surrounds of the dredging footprint (if any adverse effects are described outside of the dredging footprint in the immediate post dredging and disposal monitoring survey),
- the recovery of disturbed benthic communities within the disposal areas,
- the recovery of any affected communities in the immediate surrounds of the spoil disposal footprints (if any adverse effects are described outside of disposal footprints in the immediate post dredging and disposal monitoring survey),

If it is determined that disturbance effects have successfully been limited to the footprint of disturbance activities (on the basis of the immediate post dredging and disposal monitoring survey), then subsequent benthic ecological surveys can be limited to same season follow up surveys for up to three years, or until it has been determined that the affected habitats have recovered. Any longer monitoring period beyond three years will be influenced by anticipated maintenance dredging and disposal disturbances.

However, if the results of the post-dredging and disposal survey find ecological areas adjacent to the dredging footprint have changed as a result of the dredging programme and / or the disposal of dredged material, then a contingency post capital dredging monitoring programme would involve a more detailed control-impact design with both seasonal and temporal components.

In this regard, reference sites have been described for the disposal areas 1.2 and 3.2 (i.e. reference areas 1.2A and 1.2B, and reference areas 3.2A and 3.2B -see Figures 10 and 11) relative to which recovery of soft-bottomed disturbed areas can be gauged. The reef / hard-bottomed areas have necessarily been sampled non-destructively with photoquadrats as they

include a marine reserve and there are ample hard-bottomed photoquadrats logged by Kerr and Associates (2016A) and Kerr and Grace (2016A) relative to which recovery of hard-bottomed disturbed areas can be gauged.

It would also involve a review of ongoing maintenance dredging activities to ensure subsequent dredging activities are confined to disturbance footprints.

8.0 Overall Conclusion

It is confidently expected that dredging activities proposed by Refining NZ can be managed to ensure they have only minor to moderate, localised and short-term effects on benthic communities and water quality at the entrance to Whangarei Harbour.

The material to be removed from the dredging footprint is not contaminated relative to guidelines provided by the Maritime Safety Authority of New Zealand (1999) and contains a low proportion of fines and organic matter (Tonkin & Taylor, 2016D).

Soft-bottomed benthic communities that will be directly disturbed by the proposed dredging programme, will be removed from the proposed dredging footprint and will be effectively buried at offshore disposal sites for dredged materials. There will therefore be a short-term loss of benthic productivity within the dredging and disposal footprints shown in Figure 2.

Soft-bottomed benthic communities adjacent to the dredging and disposal footprints are routinely subject to high turbidity / suspended solids concentrations during high energy wave events (MetOcean Solutions, 2017) and are considered relatively tolerant to sediment plumes that will be generated when winning and disposing of dredged material.

Conversely, there are hard-bottomed reef / rock / boulder communities immediately adjacent to the dredging footprint at the Motukaroro Island Whangarei Marine Reserve and Home Point that are of regional and national significance and that are afforded protection under Policy 11a of the New Zealand Coastal Policy Statement. Adverse sedimentation effects on kelp beds and sponge gardens within these habitats must be avoided rather than remedied or mitigated.

To this end, turbidity limits / thresholds have been derived / are being reviewed (see Table 8) for the boundaries of receiving environments that require the following responses in terms of concurrent operational controls on dredging / dredged spoil disposal activities.

- Level 1: the reason for elevated suspended solids concentrations down-current of the operational dredge need to be investigated,
- Level 2: operational changes are required by the dredge to reduce down-current suspended solids concentrations, and
- Level 3: suspended solids concentrations down-current of the operational dredge result in dredge activities being stopped.

These turbidity thresholds are to be monitored by fixed turbidity meters that telemeter results to the operational barge so it can respond to real time data in the case of sensitive hard-bottomed communities adjacent to the dredging footprint (the Motukaroro Island Whangarei Marine Reserve and at Home Point) in particular.

In the case of the turbidity limits / thresholds that have been derived for the boundaries of the less sensitive soft-bottomed receiving environments adjacent to the dredging and disposal footprints, compliance will be assessed with hand held turbidity meters down-current of the barge on an outgoing (ebb) tide.

Given there is expected to be a localised and short-term loss of benthic productivity within the dredge and disposal areas that amounts to some 4.37 km^2 or 437 hectares, some compensation measures are considered appropriate.

As a compensation measure for this effect, it is recommended that RNZ consider supporting / collaborating with / making a financial contribution to, projects that would enhance the overall health of the harbour or seagrass habitats for example (Coffey and Stewart, 2017).

A monitoring programme is recommended to describe the effects of the dredging programme separately from other temporal ecological changes that are occurring within the study area. The baseline description of pre-impact community structure by Bioresearches, Kerr and Associates and the Cawthron Institute (within and adjacent to areas that would be disturbed by the proposed dredging programme) is considered to be robust in terms of providing a comparison with post impact surveys of the same areas. However, a benchmark description of seagrass and shellfish communities (that are in a current state of flux) needs to be undertaken immediately prior to capital dredging activities.

In summary, it is considered that adverse sedimentation effects can be avoided in sponge garden and kelp bed habitats adjacent to proposed disturbance activities, and should be appropriately avoided, remedied or mitigated in all other adjacent habitats.

Acknowledgements

Much of this report is based on the work of Kerr (2016A), Kerr (2016B), Kerr and Grace (2016A), Kerr and Grace (2016B), Kerr and Grace (2016C), Kerr and Grace (2016D), Kerr and Grace (2016E), West and Don (2015), West and Don (2016A) and West and Don (2016B). I have reviewed the data they have generated and in my opinion, the conclusions they have reached are scientifically defensible and robust.

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Appendix A1: Synthesised Data for Cawthron Institute ID and Counts for diver cores collected by Kerr and Associates in Disposal Area 1.2 and Reference Areas 1.2A and 1.2B.

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institute in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B.

Appendix B: Particle Size and Chemistry for Disposal Area 3.2 (11, 12, 13, 14, 15, 16) Reference Areas 3.2A (23, 24, 24, 25, 26, 27, 28) and 3.2B (29, 30, 31, 32, 33, 34).

Appendix C1: Summary Chemical database for sectioned vibrocore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories.

Appendix C2 Amended Laboratory Report, including elutriate testing for Vibrocore sample V19.

Appendix C3 Amended Laboratory Report, including elutriate testing for Vibrocore sample V20.

Appendix A1: Synthesised Data for Cawthron Institute ID and Counts for diver cores collected by Kerr and Associates in Disposal Area 1.2 and Reference Areas 1.2A and 1.2B

															1.2															
Taxa	**KER2016INF-47-1**	**KER2016INF-47-2**	**KER2016INF-47-3**	**KER2016INF-47-4**	**KER2016INF-47-5**	**KER2016INF-48-1**	**KER2016INF-48-2**	**KER2016INF-48-3**	**KER2016INF-48-4**	**KER2016INF-48-5**	**KER2016INF-49-1**	**KER2016INF-49-2**	**KER2016INF-49-3**	**KER2016INF-49-4**	**KER2016INF-49-5**	**KER2016INF-50-1**	**KER2016INF-50-2**	**KER2016INF-50-3**	**KER2016INF-50-4**	**KER2016INF-50-5**	**KER2016INF-51-1**	**KER2016INF-51-2**	**KER2016INF-51-3**	**KER2016INF-51-4**	**KER2016INF-51-5**	**KER2016INF-52-1**	**KER2016INF-52-2**	**KER2016INF-52-3**	**KER2016INF-52-4**	**KER2016INF-52-5**
Aglaophamus sp.					1	1	2			1												1					2	1		
Alpheus socialis			1	2																										
Amalda australis	1				1										1															
Amphipoda			2				5		1				1	1			3								1	5	5	7	1	6
Anthozoa																														
Anthuridea							1			3						1														
Anthuridea																														
Armandia maculata									1																					
Asteroidea																														
Barantolla lepte																														
Bivalvia Unid. (juv)				1																										
Bryozoa (encrusting)				1		1	1	2	2	1																				
Caecum digitulum																														
Chaetognatha																								1						
Cirratulidae	1		2				6	1	1	3											5	6	4	14	6	1		2		
Cominella adspersa		1					1																							
Cominella adspersa																														
Cominella glandiformis																														
Copepoda			1			1		2	2		1			2		1	1	1	1		4	5		4	1			1		
Corophiidae																1		1												
Cumacea		1	3	2	1		1	1	1	3		4	2	4				1	2		2	5	3		1					
Cylichna thetidis																														
Decapoda (larvae unid.)																														
Decapoda ident.																	1													
Diasterope grisea																														
Diplodonta zelandica																									1					

Appendix A1: Synthesised Data for Cawthron Institute ID and Counts for diver cores collected by Kerr and Associates in Disposal Area 1.2 and Reference Areas 1.2A and 1.2B

Divalucina cumingi											1		1																	1
Divariscintilla maoria				2		3		1						9								3								
Dorvilleidae																														
Dosinia sp.																	1	1												
Dosinia sp. (Juvenile)			2																											
Dosinia subrosea	1		1				2	3	3	1		2	1								1		1				1	1	1	
Echinocardium cordatum																							1							
Echinoidea	2	1	4	2	1	4	4	19	3	7	13	16	8	2	51	3		1	2	1	21	16	11	3	12	4	6	13	3	2
Edwardsia sp.						1											1													
Epigonichthys hectori																		2	2	1										
Euchone sp.						1			1									2											2	
Eurydice sp.	3	1	1	2		1	5	5			1			2							1		1		1	3	2			
Eurydice sp.																														
Euterebra tristis																				1										
Exosphaeroma chilensis																1														
Exosphaeroma chilensis																														
Exosphaeroma sp.	2	2	4		1	3	1	11	2		3	1	1	8	4						6	6	5	10	4	11	4	11	4	
Exosphaeroma sp.																														
Exosphaeroma sp.																														
Fellaster zelandiae															1			1												
Gastropoda (micro snails)																		1												
Gastropoda Unid. Juv.																														
Goniadidae			2					1	3									3												
Goniadidae																														
Haustoriidae	12	9	6	10	6	14	17	11	15	7	1	1	2					1				2	1							
Hesionidae									1												1									
Hydroides norvegicus																														
Hydrozoa		1	1				1										1					3								
Limnichthys polyactis																														
Lumbrineridae																														
Lysianassidae	3		3	1		1	1	2		1					1	1														
Magelona sp.	1		1		2	5	1	2	2	10			1		1															

Appendix A1: Synthesised Data for Cawthron Institute ID and Counts for diver cores collected by Kerr and Associates in Disposal Area 1.2 and Reference Areas 1.2A and 1.2B

Maldanidae																														
Munna neozelanica																													1	
Munna neozelanica																														
Myadora antipodum																														
Myllitella vivens vivens						6	1		1	1																				
Mysidacea											1										1	1		1				1		
Natatolana sp.		1					1	1	1		2	2		1				1			1	11	4	4	1	4	3	3	3	2
Nematoda		3	1				1	1	3	3						30		7	3	1	1	1	2	1	7			8	1	
Nemertea	1					1				2							2				2		1		3					
Neoguraleus sp.										1																				
Nereididae sp. A																														
Nucula nitidula																														
Oenonidae																														
Oligochaeta								2										1	1											
Ophiuroidea																														
Ostracoda	1		3	2	1	2	3	1	3	6			1					1			1	2	1	1				1		
Oweniidae																														
Paguridae													6								1									
Paraonidae	2				2	1	1	1	1	1	2	1	1	1	1		1				30	79	56	54	41	5		7	1	3
Phoronida										2																				
Phoxocephalidae	1	1					1	1	1	1											2	3	3	4	3	7	4	7	4	11
Phyllodocidae																1				1										
Polynoidae									1																					
Prionospio sp.	2						1				1																			
Propeamussiidae																														
Pycnogonida																	1													
Sabellidae																1				1										
Serpula sp.																														
Serpulidae																														
Sigalionidae		1			1					1		1										1	1		1					
Sigapatella tenuis																	3	1												
Soletellina nitida																														

Appendix A1: Synthesised Data for Cawthron Institute ID and Counts for diver cores collected by Kerr and Associates in Disposal Area 1.2 and Reference Areas 1.2A and 1.2B

	KER2016INF-47-1	KER2016INF-47-2	KER2016INF-47-3	KER2016INF-47-4	KER2016INF-47-5	KER2016INF-48-1	KER2016INF-48-2	KER2016INF-48-3	KER2016INF-48-4	KER2016INF-48-5	KER2016INF-49-1	KER2016INF-49-2	KER2016INF-49-3	KER2016INF-49-4	KER2016INF-49-5	KER2016INF-50-1	KER2016INF-50-2	KER2016INF-50-3	KER2016INF-50-4	KER2016INF-50-5	KER2016INF-51-1	KER2016INF-51-2	KER2016INF-51-3	KER2016INF-51-4	KER2016INF-51-5	KER2016INF-52-1	KER2016INF-52-2	KER2016INF-52-3	KER2016INF-52-4	KER2016INF-52-5
Sphaeromatidae												2	1				1													
Sphaeromatidae																														
Sphaerosyllis sp.																6			5	5										
Syllidae	2						4	2	1					1		3	3	4	1	1	3	10	4	11	20	2		1		
Tanaidacea								1																						
Tawera spissa						1							1					1		1										1
Travisia sp.			2	2	1		1				2	2									1		2	1						
Waitangi brevirostris											1					1	1	1	4								2	1		
# taxa	15	11	18	11	11	17	24	21	22	19	11	11	12	11	7	12	13	19	9	9	18	17	17	13	15	9	9	15	10	7
# individuals	35	22	40	27	18	47	63	71	50	55	28	33	26	32	60	50	20	32	21	13	84	155	101	109	103	42	29	65	21	26

average per site	47	48	49	50	51	52
# taxa	13	21	10	12	16	10
# individuals	28	57	36	27	110	37

average per area	Disposal Area 1.2
# taxa	14
# individuals	49

Appendix A1: Synthesised Data for Cawthron Institute ID and Counts for diver cores collected by Kerr and Associates in Disposal Area 1.2 and Reference Areas 1.2A and 1.2B

	1.2A																													
Taxa	**KER2016INF-53-1**	**KER2016INF-53-2**	**KER2016INF-53-3**	**KER2016INF-53-4**	**KER2016INF-53-5**	**KER2016INF-54-1**	**KER2016INF-54-2**	**KER2016INF-54-3**	**KER2016INF-54-4**	**KER2016INF-54-5**	**KER2016INF-55-1**	**KER2016INF-55-2**	**KER2016INF-55-3**	**KER2016INF-55-4**	**KER2016INF-55-5**	**KER2016INF-56-1**	**KER2016INF-56-2**	**KER2016INF-56-3**	**KER2016INF-56-4**	**KER2016INF-56-5**	**KER2016INF-57-1**	**KER2016INF-57-2**	**KER2016INF-57-3**	**KER2016INF-57-4**	**KER2016INF-57-5**	**KER2016INF-58-1**	**KER2016INF-58-2**	**KER2016INF-58-3**	**KER2016INF-58-4**	**KER2016INF-58-5**
Aglaophamus sp.												1			1	1		1												
Alpheus socialis																														
Amalda australis										1																		1		
Amphipoda	1	2	10	13		3	22	1		20		4	4	10			2				1						1	1		
Anthozoa																		1												
Anthuridea																														
Anthuridea																														
Armandia maculata																									1		1			
Asteroidea					2													1												
Barantolla lepte																														
Bivalvia Unid. (juv)																														
Bryozoa (encrusting)				1																										
Caecum digitulum																														
Chaetognatha																						1								
Cirratulidae	3	3	3	1		2	1			1	3	7	2	2	5		1			1	1		2	2		6	5		5	1
Cominella adspersa																														
Cominella adspersa																	2													
Cominella glandiformis																1														
Copepoda										1																				
Corophiidae																														
Cumacea							1					1							1		1	6			1		4	2		2
Cylichna thetidis																												1		
Decapoda (larvae unid.)					1																									
Decapoda ident.																														
Diasterope grisea																											3	6		1
Diplodonta zelandica																														

Appendix A1: Synthesised Data for Cawthron Institute ID and Counts for diver cores collected by Kerr and Associates in Disposal Area 1.2 and Reference Areas 1.2A and 1.2B

Divalucina cumingi																														
Divariscintilla maoria																						2								
Dorvilleidae																	1													
Dosinia sp.																														
Dosinia sp. (Juvenile)																														
Dosinia subrosea	2				1	1			3	1				1		1						1		1		1		4	2	
Echinocardium cordatum																												1		
Echinoidea	5	10	14	3	14	17	2	1	3	4	11	3	4	2	5	3	4	6		4		6	1				11	9	4	1
Edwardsia sp.									1		2						3													
Epigonichthys hectori	1														1	3	4	4	2	1										
Euchone sp.	2	17	10	1	29	5		3	4	7	2	12	5	1	64	36	85	10	34	12										
Eurydice sp.			1		1						2						1					2			6	1	2	6	1	3
Eurydice sp.																														
Euterebra tristis																														
Exosphaeroma chilensis							1											1		2							2			
Exosphaeroma chilensis																														
Exosphaeroma sp.																														
Exosphaeroma sp.				1							1			1								2	1	5	3	3	3	2	3	7
Exosphaeroma sp.																														
Fellaster zelandiae																														
Gastropoda (micro snails)															2		2													
Gastropoda Unid. Juv.					2																									
Goniadidae																														
Goniadidae	1					1											3		2	1				1						
Haustoriidae																					2	3		2		3	4	4	8	9
Hesionidae																														
Hydroides norvegicus																														
Hydrozoa																														
Limnichthys polyactis								1		1										1										
Lumbrineridae			1														2			3										
Lysianassidae	2																				3	1	2				1			
Magelona sp.													1								1						1			

Appendix A1: Synthesised Data for Cawthron Institute ID and Counts for diver cores collected by Kerr and Associates in Disposal Area 1.2 and Reference Areas 1.2A and 1.2B

Maldanidae															2		1													
Munna neozelanica																														
Munna neozelanica																														
Myadora antipodum																							1							
Myllitella vivens vivens																														
Mysidacea							2								1															
Natatolana sp.	1							1	1	1	1		2	2									2	3			1	1	2	1
Nematoda	5	8	2	2	15	3	3	2	2	1	12	5	26	6	14	3	19	11	14	18				6	4	1			3	
Nemertea	2	1							1							1	1	1	1	1									1	
Neoguraleus sp.																														
Nereididae sp. A																2	8	4	12	2										
Nucula nitidula																														
Oenonidae																	2	1												
Oligochaeta																	1	1												
Ophiuroidea																														
Ostracoda		1	1				1				1			1	1	1	1		2		1	2	1		3	5	1	1	5	7
Oweniidae																														
Paguridae						2						1	1	1				1												
Paraonidae	3	3	3	4	7		1				3	6	5	7	6	8	2	1		4	3	12	5	16	8	3	6	14	1	
Phoronida																														
Phoxocephalidae	9	5	10	4	5	2	2		5	4	6	4	4	12	4	2		2	2	3	3	1	3	2	6	2	8	3	14	7
Phyllodocidae															1			1	1											
Polynoidae																														
Prionospio sp.																						1				1			1	
Propeamussiidae																														
Pycnogonida																														
Sabellidae								2			1		2		9	2	3			1										
Serpula sp.								1									1													
Serpulidae													1																	
Sigalionidae	1												1	1												1		1		
Sigapatella tenuis								1				1							1											
Soletellina nitida																						1				1				

Appendix A1: Synthesised Data for Cawthron Institute ID and Counts for diver cores collected by Kerr and Associates in Disposal Area 1.2 and Reference Areas 1.2A and 1.2B

	KER2016INF-53-1	KER2016INF-53-2	KER2016INF-53-3	KER2016INF-53-4	KER2016INF-53-5	KER2016INF-54-1	KER2016INF-54-2	KER2016INF-54-3	KER2016INF-54-4	KER2016INF-54-5	KER2016INF-55-1	KER2016INF-55-2	KER2016INF-55-3	KER2016INF-55-4	KER2016INF-55-5	KER2016INF-56-1	KER2016INF-56-2	KER2016INF-56-3	KER2016INF-56-4	KER2016INF-56-5	KER2016INF-57-1	KER2016INF-57-2	KER2016INF-57-3	KER2016INF-57-4	KER2016INF-57-5	KER2016INF-58-1	KER2016INF-58-2	KER2016INF-58-3	KER2016INF-58-4	KER2016INF-58-5
Sphaeromatidae																														
Sphaeromatidae																														
Sphaerosyllis sp.					4		6	3			1	1	1	12	4	1	4	1	2	1										
Syllidae	13		6	6	1	9	2	6	2	8	14	5	29	10	4	14	13	15	14	10	1	1	3	2	4		2	2		
Tanaidacea																														
Tawera spissa							1											1												
Travisia sp.															1												1			
Waitangi brevirostris			1			1							2						2	1						4				
# taxa	15	9	12	10	12	11	13	11	9	12	14	13	16	15	17	15	24	19	14	17	10	15	10	10	9	13	18	17	13	10
# individuals	51	50	62	36	82	46	45	22	22	50	60	51	90	69	125	79	166	64	90	66	17	42	21	40	36	32	57	59	50	39

average per site	53	54	55	56	57	58
# taxa	12	11	15	18	11	14
# individuals	56	37	79	93	31	47

average per area	Reference Area 1.2A
# taxa	13
# individuals	57

Appendix A1: Synthesised Data for Cawthron Institute ID and Counts for diver cores
collected by Kerr and Associates in Disposal Area 1.2 and Reference Areas 1.2A and 1.2B

1.2B

Taxa	**KER2016INF-59-1**	**KER2016INF-59-2**	**KER2016INF-59-3**	**KER2016INF-59-4**	**KER2016INF-59-5**	**KER2016INF-60-1**	**KER2016INF-60-2**	**KER2016INF-60-3**	**KER2016INF-60-4**	**KER2016INF-60-5**	**KER2016INF-61-1**	**KER2016INF-61-2**	**KER2016INF-61-3**	**KER2016INF-61-4**	**KER2016INF-61-5**	**KER2016INF-62-1**	**KER2016INF-62-2**	**KER2016INF-62-3**	**KER2016INF-62-4**	**KER2016INF-62-5**	**KER2016INF-63-1**	**KER2016INF-63-2**	**KER2016INF-63-3**	**KER2016INF-63-4**	**KER2016INF-63-5**	**KER2016INF-64-1**	**KER2016INF-64-2**	**KER2016INF-64-3**	**KER2016INF-64-4**	**KER2016INF-64-5**
Aglaophamus sp.				1									1			1				1					1	1				
Alpheus socialis																				1										
Amalda australis																													1	
Amphipoda		2	1			4	4	2	5	3	1		1	1		1		4	1	2		8	1	2	2	2			1	
Anthozoa																					1									
Anthuridea																														
Anthuridea																														
Armandia maculata																														
Asteroidea						1			1				1																	
Barantolla lepte		2																												
Bivalvia Unid. (juv)																					4									
Bryozoa (encrusting)																														
Caecum digitulum					1																									
Chaetognatha																														1
Cirratulidae		1			6			1			6	7	3	1	6	1		1			2	1	2	6	5	7	6	2	1	3
Cominella adspersa																														
Cominella adspersa																														
Cominella glandiformis																														
Copepoda																						1	2					1		2
Corophiidae																														
Cumacea	1					9	2	2	3	9	2	6	2	1	1		2				2	9	2	2	3	4	4	7	3	8
Cylichna thetidis																														
Decapoda (larvae unid.)																														
Decapoda ident.																														
Diasterope grisea												3	1																1	
Diplodonta zelandica																														

Appendix A1: Synthesised Data for Cawthron Institute ID and Counts for diver cores collected by Kerr and Associates in Disposal Area 1.2 and Reference Areas 1.2A and 1.2B

Divalucina cumingi																31	1		11	1										
Divariscintilla maoria														3		1	2									4				
Dorvilleidae				1																										
Dosinia sp.																														
Dosinia sp. (Juvenile)																														
Dosinia subrosea		1					1			1					1	1	1	1	1	1	4	5	2			3	2	2	4	2
Echinocardium cordatum																									1		1			
Echinoidea	2	6	6		1	8	1	9	3	10	5	42	12	15	3	13	8	3	6	2	3	25	52	1	19	38	20	39	12	35
Edwardsia sp.																						2								
Epigonichthys hectori				1						1																				
Euchone sp.	10	4	1	7	6	2			3		1	2	2		1	2			1											
Eurydice sp.				1						1		1	2	3	3	1					3	14	2	2	1	2	1	4	5	8
Eurydice sp.																														
Euterebra tristis																														
Exosphaeroma chilensis	1	1		3	1				2							31	2		1											
Exosphaeroma chilensis																														
Exosphaeroma sp.																														
Exosphaeroma sp.						2	6	3	3	10	11	19	8	4	3						5	14	11	3	11	10	2	7	2	10
Exosphaeroma sp.																														
Fellaster zelandiae																		1												
Gastropoda (micro snails)												1				1	1													
Gastropoda Unid. Juv.																														
Goniadidae																														
Goniadidae				1												3	3	2	2					2	1	1	1	1	2	
Haustoriidae												1									1		4		1		2		9	1
Hesionidae																														
Hydroides norvegicus													1	1																
Hydrozoa																														
Limnichthys polyactis	1	1																												
Lumbrineridae		1		1													3			1										
Lysianassidae											1										5	4	14	3	2	4	4	2	5	3
Magelona sp.																								2	2	1	1			

Appendix A1: Synthesised Data for Cawthron Institute ID and Counts for diver cores collected by Kerr and Associates in Disposal Area 1.2 and Reference Areas 1.2A and 1.2B

Maldanidae				8	1											3	1								1					
Munna neozelanica																														
Munna neozelanica																														
Myadora antipodum																														
Myllitella vivens vivens																					1									
Mysidacea												1	2	1													2			
Natatolana sp.							3	1	2	1	3		2	2	1					1						5		1		
Nematoda	4	3	3	10	10	19	1	8	4	1	1	3	1	4	2	18	9		1	1	2	2	5	2	3	2	5	2	2	5
Nemertea											1										2				2					
Neoguraleus sp.																														
Nereididae sp. A				1												2														
Nucula nitidula																2												1		
Oenonidae			1																											
Oligochaeta																		1												
Ophiuroidea																						1	1			1		1		
Ostracoda												1									1	5	1	1	8	1	3		1	4
Oweniidae				1																										
Paguridae																														
Paraonidae			4		4	6	3	11	3	9	6	11	8	5	10						1	3	1	1	5	2	1	2		
Phoronida																														
Phoxocephalidae	5	2	2	1	3	1		2	3	3	1	2	1	4	4			4		1	2	2	3	6	4	2	5	4	2	1
Phyllodocidae																1		1	2											
Polynoidae																														
Prionospio sp.																								1				1	1	
Propeamussiidae				1																										
Pycnogonida																														
Sabellidae	4	7		4	4		5	3	1		1	1	2	1			2			1										
Serpula sp.																														
Serpulidae																														
Sigalionidae								1			1		1						1							1				1
Sigapatella tenuis				2												2														
Soletellina nitida																														

Appendix A1: Synthesised Data for Cawthron Institute ID and Counts for diver cores collected by Kerr and Associates in Disposal Area 1.2 and Reference Areas 1.2A and 1.2B

	KER2016INF-59-1	KER2016INF-59-2	KER2016INF-59-3	KER2016INF-59-4	KER2016INF-59-5	KER2016INF-60-1	KER2016INF-60-2	KER2016INF-60-3	KER2016INF-60-4	KER2016INF-60-5	KER2016INF-61-1	KER2016INF-61-2	KER2016INF-61-3	KER2016INF-61-4	KER2016INF-61-5	KER2016INF-62-1	KER2016INF-62-2	KER2016INF-62-3	KER2016INF-62-4	KER2016INF-62-5	KER2016INF-63-1	KER2016INF-63-2	KER2016INF-63-3	KER2016INF-63-4	KER2016INF-63-5	KER2016INF-64-1	KER2016INF-64-2	KER2016INF-64-3	KER2016INF-64-4	KER2016INF-64-5
Sphaeromatidae																														
Sphaeromatidae																														
Sphaerosyllis sp.	12	11	2	16	5	3	4	1	1								2													
Syllidae	7	5	6	8	3	3		2		5	3	2	5	6	2	23	10	8	7	3		1	1	1						1
Tanaidacea																														
Tawera spissa																														
Travisia sp.											1				1														1	1
Waitangi brevirostris	3	3			1			1						1			1		1											
# taxa	11	15	9	18	13	11	10	14	13	12	16	16	19	16	13	19	15	10	12	12	16	16	16	15	18	19	16	16	17	16
# individuals	50	50	26	68	46	58	30	47	34	54	45	103	56	53	38	138	48	26	35	16	39	97	104	35	72	91	60	77	53	86

average per site	59	60	61	62	63	64
# taxa	13	12	16	14	16	17
# individuals	48	45	59	53	69	73

average per area	Reference Area 1.2B
# taxa	15
# individuals	58

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

	3.2																													
Taxa	11_3_2_ RNZ2016INF001	11_3_2_ RNZ2016INF002	11_3_2_ RNZ2016INF003	11_3_2_ RNZ2016INF004	11_3_2_ RNZ2016INF005	12_3_2_ RNZ2016INF006	12_3_2_ RNZ2016INF007	12_3_2_ RNZ2016INF008	12_3_2_ RNZ2016INF009	12_3_2_ RNZ2016INF010	13_3_2_ RNZ2016INF011	13_3_2_ RNZ2016INF012	13_3_2_ RNZ2016INF013	13_3_2_ RNZ2016INF014	13_3_2_ RNZ2016INF015	14_3_2_ RNZ2016INF016	14_3_2_ RNZ2016INF017	14_3_2_ RNZ2016INF018	14_3_2_ RNZ2016INF019	14_3_2_ RNZ2016INF020	15_3_2_ RNZ2016INF021	15_3_2_ RNZ2016INF022	15_3_2_ RNZ2016INF023	15_3_2_ RNZ2016INF024	15_3_2_ RNZ2016INF025	16_3_2_ RNZ2016INF026	16_3_2_ RNZ2016INF027	16_3_2_ RNZ2016INF028	16_3_2_ RNZ2016INF029	16_3_2_ RNZ2016INF030
Acarina																														
Aglaophamus sp.		1	5	2		1	2	3	1	3	1																			1
Alpheus sp.																														
Amalda northlandica																														
Ampelisca sp.									1																					
Ampharetidae		3		3	1	1					1			1				1			1									
Amphinomidae																														
Amphipoda	5	4	3	2	7	2	1	1	2	2	1	1		2	4	5	5	2		2	1		3	3				2		
Annelida indet.																														
Anthozoa	1																													
Anthuridea	5	2	4	1	2	1			1			1				3	4	3	2	2			1	1						
Aonides trifida																														
Arachnanthus sp.																				1										
Aricidea sp.			2																											
Armandia maculata																														
Ascidiacea																														
Ascidian (orange colonial)																														
Asellota	1		2			1	3												1											
Asteroidea																														
Austrofusus glans					1																									
Austrovenus stutchburyi					1	1																								
Barantolla lepte																														
Bathytoma murdochi																														
Bivalvia Unid.															2															

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Bivalvia Unid. (juv)		1	1	1		3				1																				
Brachyura (juv.)																														
Bryozoa (bushy)																														
Bryozoa (Conical Discoidal)																		1	2	1										
Bryozoa (encrusting)												1	1	1					1			1	1				1			
Callianassidae																														
Capitella sp.											1																			
Capitellidae			1																											
Caprellidae										1							2													
Chaetognatha		1																												
Chrysopetalidae			1																											
Cirolanidae														1																
Cirratulidae	1	3	4	4	2	2	1			2	1				1	1				2	1	1	2	4	2	3		1	1	
Cominella quoyana																														
Copepoda									2							1		1							2					
Corallina (Encrusting Pink)																														
Coralline Paint																														
Corophiidae																	1													
Cossura consimilis	5		2	1	4	2	2	4		3																				
Ctenophora																														
Cumacea	3	4		3		3	1	1		6							1					1								
Cylichna thetidis																														
Cylichnina striata																														
Cypridinodes reticulata									1																					
Diasterope grisea																														
Diplodonta sp.																														
Diplodonta striatula																														
Dorvilleidae			1		1			2			10	1	1	1	1	5		2	4	2		1			5			2	2	1
Ebalia laevis		1								1																				
Echinocardium cordatum								1																						
Echinoidea																														
Edwardsia sp.							1	1							1															

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Ennucula strangei						1																								
Epigonichthys hectori						1	1								1	1	2		1						1					
Euchone sp.				1	1			2	2	1																				
Eunicidae																														
Euphilomedes sp.	4	1	3	2	1				1	3							2	1			1			1	2					
Eurydice sp.																														
Flabelligeridae			1								1		1																	
Gastropoda (rissoid like)																														
Gastropoda (micro snails)																														
Gastrotricha																														
Glyceridae	1	1			1						1	1																		
Goniadidae	1			1		2	2	1	5				1			1	2				5						1		3	
Gonimyrtea concinna																														
Haustoriidae	1		3	5			1							1										1						
Hemichordata						1															2						1	1	1	
Hemichordata (zooids)																												1		
Hesionidae					3				3	1				4						1	1			2					1	
Heteromastus filiformis																						1								
Hiatella arctica																		1												
Hunkydora novozelandica																														
Hydrozoa		1		1																										
Leitoscoloplos kerguelensis																														
Leptochiton inquinatus																														
Leuroleberis zealandica															1															
Limaria orientalis														1																
Liocarcinus corrugatus																														
Lumbrineridae		1				1		1		1												2								
Lysianassidae	9	1	2	1					2	3				4				7						3		2	1		1	
Magelona dakini																														
Magelona sp.				2							1																			
Maldanidae	27	24	21	30	10	7	2	4	12	11	1	1		2	1	7	1	3		3	1	3								
Munnidae						1																								

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Myadora subrostrata																														
Mysidacea																														
Natantia unid.																														
Natatolana sp.								1																						
Neanthes cricognatha																		1												
Nebaliacea	1						2											1						1						
Nematoda	6	4	3	7	9	10	10	3	12	26	6		1	9	17	4	28	18	5	4	14	6	1	24	7	2		3	5	6
Nematoda sp. A																														
Nemertea	5	3	3	5		6	9	5	2	13	2	1	1	7	1	8	22	3		7	5	4	3	2	4		2	3	2	1
Nereididae																														
Nereididae sp. A											4	3			12	3	6	3	2						3					
Notocallista multistriata							1																							
Notomastus sp.				1					1			1		1		4	1			3		2			2	1	1	1	1	
Nucula nitidula																														
Oligochaeta					1	2	1		1	1	4	2		2		1	6	7	1	2	9	15	21	34	5	8	2	1	2	1
Onuphis aucklandensis	4	9	1			1		1	1		1	1		1		2	3	7	3	2	6	4	2	3	2				2	
Ophichthidae																														
Ophiuroidea	7	3	8	4	2	5	3	4	3	7	1	2			1								1							
Orbiniidae																										1				
Orbiniidae juv.																														
Ostracoda	1			4		2		1	1						1			1			2	1	3	4						
Owenia petersenae	2																													
Oweniidae						8				1												1								
Paguridae																				3										
Paphies australis																														
Paraonidae	6	4	7	6	7	37	25	4	29	24	2		1			3	1	1		1	1	3	1		1				1	2
Paraprionospio sp.	1	1							1																					
Parasterope quadrata																												1		
Pectinaria australis																														
Pennatulacea																														
Philine sp.			1																											
Phoronida		3		1																										

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Phoxocephalidae	2	1	6	2			1	1		1	1			1		1	2			3	3	3	1	3	2		1	1		
Phyllodocidae	1	2				1			1													1		6						
Pilargidae										1																				
Platyhelminthes																														
Pleuromeris zelandica																														
Poecilochaetidae																														
Polydorid		5				1																								
Polynoidae	3	1	2		1	3	4	5	1	6			2							1		1								
Porifera																				1										
Porifera (orange encrusting)																														
Pratulum pulchellum					1																							1		
Prionospio sp.		1	2	1	2	3		1			2		3	9	2	5	10	1	2	14	2			2	2		2	1	2	
Prionospio yuriel	3		2	3		1	2	9	1	1				1	4															
Processa moana												1																		
Pupa affinis																														
Pupa kirki			1				1																							
Retusidae																														
Ruditapes largillierti																														
Rutiderma sp.							1			1										1										
Sabellidae	2	5	1	2		4	1	3	2			1				2	1					2								
Saccella bellula																														
Saccella maxwelli	1				1				1																					
Scalibregmatidae																					1									
Scoloplos cylindrifer								1																						
Scoloplos sp.				1						1	1	1			1									1						
Serpula sp.																														
Serpulidae																				1										
Sigalionidae																	1									1			1	
Sigapatella tenuis																														
Sipuncula																														
Solariella tryphenensis																														
Solemya parkinsoni									1	1																				

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Taxa	11.1	11.2	11.3	11.4	11.5	12.1	12.2	12.3	12.4	12.5	13.1	13.2	13.3	13.4	13.5	14.1	14.2	14.3	14.4	14.5	15.1	15.2	15.3	15.4	15.5	16.1	16.2	16.3	16.4	16.5
Sphaeromatidae																														
Sphaerosyllis sp.	5	2	2			7	2	3	5	7	3	2		2	1	6	7			4	2		1	3	2	1	1		1	
Spionidae				1																										
Spiophanes kroyeri	14	19	3	7	8	1	2	6	1	3																				
Spiophanes modestus	24	25	19	58	29	42	9	19	21	8			3			6	8				4	1	5	8	1			1	1	
Spirorbidae																				2										
Syllidae	2	1	10	2	1	13	5	8	3	1	2	3		4		5	3			1	4	4	1	4	1	2	4	2	2	5
Tanaidacea	2	1	2	1	1		1		1		1			1			1		2		1		5	2	4	1				1
Terebellidae	6	1	4	2			2					1		2				1			2	1		2	1			1		
Terebellides stroemii										1						1			1											
Terebra circumcincta																														
Thyasiridae	1																													
Travisia olens																								1						
Ungulinidae	1																													
Upogebia sp.															1															
Xenophora neozelanica																		1												
Zeacolpus pagoda pagoda																														
# taxa	36	34	34	34	25	35	30	28	32	32	23	18	10	22	18	22	24	22	13	24	22	22	16	23	19	10	11	16	17	8
# individuals	164	140	133	168	98	178	99	96	122	143	49	25	15	58	53	75	120	67	27	64	69	59	52	115	49	22	17	23	29	18

average per site	11	12	13	14	15	16
# taxa	33	31	18	21	20	12
# individuals	141	128	40	71	69	22

average per area	Disposal Area 3.2
# taxa	23
# individuals	78

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

	3.2A																													
Taxa	23_3_2A_ RNZ2016INF036	23_3_2A_ RNZ2016INF037	23_3_2A_ RNZ2016INF038	23_3_2A_ RNZ2016INF039	23_3_2A_ RNZ2016INF040	24_3_2A_ RNZ2016INF041	24_3_2A_ RNZ2016INF042	24_3_2A_ RNZ2016INF043	24_3_2A_ RNZ2016INF044	24_3_2A_ RNZ2016INF045	25_3_2A_ RNZ2016INF046	25_3_2A_ RNZ2016INF047	25_3_2A_ RNZ2016INF048	25_3_2A_ RNZ2016INF049	25_3_2A_ RNZ2016INF050	26_3_2A_ RNZ2016INF051	26_3_2A_ RNZ2016INF052	26_3_2A_ RNZ2016INF053	26_3_2A_ RNZ2016INF054	26_3_2A_ RNZ2016INF055	27_3_2A_ RNZ2016INF056	27_3_2A_ RNZ2016INF057	27_3_2A_ RNZ2016INF058	27_3_2A_ RNZ2016INF059	27_3_2A_ RNZ2016INF060	28_3_2A_ RNZ2016INF061	28_3_2A_ RNZ2016INF062	28_3_2A_ RNZ2016INF063	28_3_2A_ RNZ2016INF064	28_3_2A_ RNZ2016INF065
Acarina															1															
Aglaophamus sp.																												1		
Alpheus sp.																														
Amalda northlandica																														
Ampelisca sp.																														
Ampharetidae	1	2	1		2							1	1				2	1			1	4	1		2		2	1		
Amphinomidae																						1								1
Amphipoda	1		2	1				1	1	12	5		3	1	6	14	8	1	3	1		2	3	4		1	3	7	1	3
Annelida indet.																						3				1	2	2		
Anthozoa																														
Anthuridea	1	1	1		1		1						2	1	1		1					1	1				2	1	1	
Aonides trifida																			2									1		
Arachnanthus sp.																														
Aricidea sp.			3			2	2	1		1		2							1			1								
Armandia maculata																														
Ascidiacea																														
Ascidian (orange colonial)																												1		
Asellota																2												1		
Asteroidea																														
Austrofusus glans																														
Austrovenus stutchburyi								1																						
Barantolla lepte					1																									
Bathytoma murdochi																														
Bivalvia Unid.																														

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Bivalvia Unid. (juv)																1														
Brachyura (juv.)																														
Bryozoa (bushy)																1														
Bryozoa (Conical Discoida	9	3	3	2	4	2	2	12	6	9	2	10	3	5	14	1						1								
Bryozoa (encrusting)															1	1	1			1	1					1				
Callianassidae																														
Capitella sp.																														
Capitellidae																														
Caprellidae										3																				
Chaetognatha																														
Chrysopetalidae																														
Cirolanidae	1				1																									
Cirratulidae			1			1	4	2	4		4	1		1	5	2						5	1		2		2	1		4
Cominella quoyana																														
Copepoda								1		1			1	1	2	1	3	1	1	1				1	3		1	1		
Corallina (Encrusting Pink)																												1		
Coralline Paint																													1	
Corophiidae																														
Cossura consimilis																														
Ctenophora									7			1		1					1		2	1	1	1				2	1	
Cumacea			2	1												3	3	1	1		1				1			1	1	
Cylichna thetidis																														
Cylichnina striata																														
Cypridinodes reticulata																												1		
Diasterope grisea										1																				
Diplodonta sp.																														
Diplodonta striatula																														
Dorvilleidae					1						1	1			1							1	5		1					
Ebalia laevis																			1											
Echinocardium cordatum																														
Echinoidea																											1			
Edwardsia sp.																														

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Ennucula strangei														1																
Epigonichthys hectori	1														1	1		1								1				
Euchone sp.																									1					
Eunicidae																														
Euphilomedes sp.			1		1								1		1		1													
Eurydice sp.									1								1	2	1			1			2			1		
Flabelligeridae			1													1	3	1				1					1			
Gastropoda (rissoid like)																			1											
Gastropoda (micro snails)																												1		
Gastrotricha																														
Glyceridae																								2				1		
Goniadidae	1		2	4	1			1													1						1			
Gonimyrtea concinna																														
Haustoriidae				1										1	1	1			3											
Hemichordata		1	9		2					1			1												1					
Hemichordata (zooids)	1																							1			3	4	1	
Hesionidae			1					1								1	1		1		1			1	1		2			
Heteromastus filiformis	1		1																											
Hiatella arctica																														
Hunkydora novozelandica																														
Hydrozoa																														
Leitoscoloplos kerguelensis																														
Leptochiton inquinatus																	1								1			2		
Leuroleberis zealandica																														
Limaria orientalis																												2		
Liocarcinus corrugatus																														
Lumbrineridae									1			1					1	1									1			
Lysianassidae			2						4						2							1		1				1		
Magelona dakini																														
Magelona sp.						1							1										1							
Maldanidae	9				5	1		4		3	2	3	6	1	2		4	1	1		1	2			1		1	1		3
Munnidae										1																				

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Myadora subrostrata																														
Mysidacea																														
Natantia unid.																														
Natatolana sp.																														
Neanthes cricognatha																														
Nebaliacea																														
Nematoda	3	9	5		10	3	1	1	6	4	2	8	6	22	19	6	19	14	12	39	18	25	10	19	37		20	27	20	14
Nematoda sp. A				1				2			2			3	1	1	1	3		1										
Nemertea	3	2	1	1	4			1			6	4	3	4	1	1	10		1		2	1	5		3			1		2
Nereididae																							4				16		19	
Nereididae sp. A		1	1	6	1		1		2					1	1	7	13	5	8	12	2	6						12		5
Notocallista multistriata																														
Notomastus sp.	1				2				1				2	2		1			1		1	5	1		2		2			1
Nucula nitidula	1																													1
Oligochaeta	1	7	1	1	5			1	4	1	1	3	2	2		2		14	3		2	3	1	2	2			1		1
Onuphis aucklandensis		1			4							2						1			1	1	1							
Ophichthidae			1																											
Ophiuroidea					2			2		2							3				2						1		1	
Orbiniidae																												1		
Orbiniidae juv.																														
Ostracoda	1							1	2		1	1		1		1					1	1						2		
Owenia petersenae																														1
Oweniidae	1				1							1					2													
Paguridae			1																1											
Paphies australis																			1											
Paraonidae	1		5		3		1	1	2	3	1	3		1								1	1							
Paraprionospio sp.																														
Parasterope quadrata					1									1														1		1
Pectinaria australis																														
Pennatulacea																														
Philine sp.													1		1												1			
Phoronida																														

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Phoxocephalidae		1		1					1						1		1	1	3				1							1
Phyllodocidae												1			1		1											1		
Pilargidae																														
Platyhelminthes																														
Pleuromeris zelandica																														
Poecilochaetidae																												1		
Polydorid																									1					
Polynoidae																2		1				1				1				
Porifera																	1													
Porifera (orange encrusting)																												1		1
Pratulum pulchellum																								1	1					
Prionospio sp.	2	4	7	8	1	1	2	1		1		2	2	1	6	4	1	2	2			7		1	5		4	5		4
Prionospio yuriel																														
Processa moana						1		1									1										1			1
Pupa affinis																														
Pupa kirki																														
Retusidae																														
Ruditapes largillierti																														
Rutiderma sp.																														
Sabellidae		1	1						1	1												1								
Saccella bellula																														
Saccella maxwelli																														
Scalibregmatidae																														
Scoloplos cylindrifer																														
Scoloplos sp.				1											2	1	1	1			1	1				1	1			
Serpula sp.																														
Serpulidae																														
Sigalionidae									1																		1		1	
Sigapatella tenuis																												1		
Sipuncula																						1								
Solariella tryphenensis																														
Solemya parkinsoni																														

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Taxa	23.1	23.2	23.3	23.4	23.5	24.1	24.2	24.3	24.4	24.5	25.1	25.2	25.3	25.4	25.5	26.1	26.2	26.3	26.4	26.5	27.1	27.2	27.3	27.4	27.5	28.1	28.2	28.3	28.4	28.5
Sphaeromatidae				1																		1			1					
Sphaerosyllis sp.	2	1	9	19	4		1		1		3		4	8	5	4	7	8	4			4	2	6	6		10	13		6
Spionidae																														
Spiophanes kroyeri																														
Spiophanes modestus				1								1																		
Spirorbidae																														
Syllidae		4	3	4	7	1	1	4	5	3	4	7	1	2	3	1	1	1				9		1	4		2	3		6
Tanaidacea		1			3					1	1		1	8	4	1	3	3	4	2	1	1		1	1			3		1
Terebellidae	1	2		1				1	1	1	3						2	1				2						1		1
Terebellides stroemii																														
Terebra circumcincta																														
Thyasiridae																														
Travisia olens																														
Ungulinidae																														
Upogebia sp.																														
Xenophora neozelanica																														
Zeacolpus pagoda pagoda										1		1																		

Taxa	23.1	23.2	23.3	23.4	23.5	24.1	24.2	24.3	24.4	24.5	25.1	25.2	25.3	25.4	25.5	26.1	26.2	26.3	26.4	26.5	27.1	27.2	27.3	27.4	27.5	28.1	28.2	28.3	28.4	28.5
# taxa	21	16	25	17	24	9	10	20	19	19	15	20	18	22	25	26	29	22	23	7	17	32	16	14	22	6	24	38	10	20
# individuals	43	41	65	54	67	13	16	40	51	50	38	54	41	69	83	62	97	65	57	57	39	96	39	42	79	6	81	109	47	58

average per site	23	24	25	26	27	28
# taxa	21	15	20	21	20	20
# individuals	54	34	57	68	59	60

average per area	Reference Area 3.2A
# taxa	20
# individuals	55

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

3.2B

Taxa	29_3_2B_ RNZ2016INF066	29_3_2B_ RNZ2016INF067	29_3_2B_ RNZ2016INF068	29_3_2B_ RNZ2016INF069	29_3_2B_ RNZ2016INF070	30_3_2B_ RNZ2016INF071	30_3_2B_ RNZ2016INF072	30_3_2B_ RNZ2016INF073	30_3_2B_ RNZ2016INF074	30_3_2B_ RNZ2016INF075	31_3_2B_ RNZ2016INF076	31_3_2B_ RNZ2016INF077	31_3_2B_ RNZ2016INF078	31_3_2B_ RNZ2016INF079	31_3_2B_ RNZ2016INF080	32_3_2B_ RNZ2016INF081	32_3_2B_ RNZ2016INF082	32_3_2B_ RNZ2016INF083	32_3_2B_ RNZ2016INF084	32_3_2B_ RNZ2016INF085	33_3_2B_ RNZ2016INF086	33_3_2B_ RNZ2016INF087	33_3_2B_ RNZ2016INF088	33_3_2B_ RNZ2016INF089	33_3_2B_ RNZ2016INF090	34_3_2B_ RNZ2016INF091	34_3_2B_ RNZ2016INF092	34_3_2B_ RNZ2016INF093	34_3_2B_ RNZ2016INF094	34_3_2B_ RNZ2016INF095
Acarina		1																												
Aglaophamus sp.	2				1	3					2				2	1	1		1								1			1
Alpheus sp.																			1	1										
Amalda northlandica																								1	1			1	1	
Ampelisca sp.					1													1			1		1		1		1			1
Ampharetidae	1		1			2	2	1	1		1										1		2	2	1	2	1		3	3
Amphinomidae						1																								
Amphipoda	4	1	4	6		1	14	13	7	6	10	1	1	8	3		2	1	2	1		8	2		1	3		2	2	3
Annelida indet.								1	2																					
Anthozoa																														
Anthuridea	2	1	3			2	6	2	2	1	2			1	1	1	2	2	1	4	1	1		1	2	1		2		
Aonides trifida																														
Arachnanthus sp.							1																							
Aricidea sp.	1		2	2		1					1							2								1				
Armandia maculata																														
Ascidiacea							2			2																				
Ascidian (orange colonial)																														
Asellota										1																				
Asteroidea				1										1																
Austrofusus glans						1					1								1											
Austrovenus stutchburyi																														
Barantolla lepte																	1													
Bathytoma murdochi																													1	
Bivalvia Unid.																														

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Bivalvia Unid. (juv)									2				1			1									1					
Brachyura (juv.)											1																			
Bryozoa (bushy)																														
Bryozoa (Conical Discoidal)		1											1																	
Bryozoa (encrusting)										1							1		1			1						1		
Callianassidae				1																										
Capitella sp.																														
Capitellidae							1																1		2					
Caprellidae																														
Chaetognatha																														
Chrysopetalidae																														
Cirolanidae																														
Cirratulidae		1	4	2	1		4	2	2	2	2	2		3	1			2						1			3			1
Cominella quoyana																									1					
Copepoda																2	1	1	2	8										
Corallina (Encrusting Pink)																														
Coralline Paint										1																				
Corophiidae																														
Cossura consimilis						4																								
Ctenophora					1						1		1							1										10
Cumacea	1		1			2	3		1		3		1		2		1	3			2	3			1	1		1		1
Cylichna thetidis																											1			
Cylichnina striata																								1	1					
Cypridinodes reticulata		1											1																	
Diasterope grisea									1			1								1	1			1	1					1
Diplodonta sp.				2								1						1				1	5				1	1		
Diplodonta striatula			1		1																									
Dorvilleidae		1			1		6	2	2	8		1								1										
Ebalia laevis																														
Echinocardium cordatum																														
Echinoidea	1																													
Edwardsia sp.		1							1		1	1			2															

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Ennucula strangei																														
Epigonichthys hectori		1			1		1		3											1										
Euchone sp.						1															1				1					
Eunicidae	1					1	1																							
Euphilomedes sp.						2						1		3		2		1										3		2
Eurydice sp.																														
Flabelligeridae						1	1				1										1	1								
Gastropoda (rissoid like)						1																								
Gastropoda (micro snails)																														
Gastrotricha																				1										
Glyceridae					1																									
Goniadidae			1				1	1	4		2			1	1	2		1				2	1	1	1	1	1	1	1	
Gonimyrtea concinna		1	1																					1						
Haustoriidae		1			1	1		2	2				2			3		2		3	3		3			3		1		
Hemichordata		1								1		1									1									
Hemichordata (zooids)																														
Hesionidae			1									1			1							1			1					
Heteromastus filiformis																														
Hiatella arctica																														
Hunkydora novozelandica																											1			
Hydrozoa		1																												
Leitoscoloplos kerguelensis														1						1										
Leptochiton inquinatus							1													1										
Leuroleberis zealandica																														
Limaria orientalis																				1										
Liocarcinus corrugatus																														
Lumbrineridae			1																		1				1	1				
Lysianassidae		4	1		1	1			1				3			2		3		1			5	5	9	8	4	14	1	9
Magelona dakini																		1												
Magelona sp.									1				1		1															
Maldanidae	75	18	85	52	7	40	3	1		3	25	3	4	2	26	33	33	67	18	1	45	2	5		2	5	1	3	3	3
Munnidae							1	1									1													1

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Myadora subrostrata																					1									
Mysidacea					2																									
Natantia unid.						2										1														
Natatolana sp.																														
Neanthes cricognatha					1																									
Nebaliacea						1																			1	1				
Nematoda	5	8	7	1	4	4	4	16	15	1		28	1		3				1	11		1	7	4	8	1	2	2	1	3
Nematoda sp. A																														
Nemertea	9	6	1	1		6	9	3	2	9	1	9		1	1		1	1	1	3	1		1		1				1	1
Nereididae																1														
Nereididae sp. A																														
Notocallista multistriata	1																			1										
Notomastus sp.							2	1	2	3	1												1						1	
Nucula nitidula	1				2	2										3	1		1					5		1	1			
Oligochaeta	1				1			3	3																					
Onuphis aucklandensis	21	4	9	3	2	8	1	2	9	1	4			2	2	5	3	2	1	1	5	2	2	7	1	2	3	4	4	1
Ophichthidae																														
Ophiuroidea						3	2									1		1	2		1									
Orbiniidae	3														2				1											
Orbiniidae juv.																										2				
Ostracoda		1		4	2			1	7		3		3			2						2	4	21	21	24	31	15	33	1
Owenia petersenae	1				4	3	1	1	1														1							
Oweniidae																														
Paguridae						2																								
Paphies australis																														
Paraonidae				2	4	3	2	1	3	1	1			3			1	1	1	1		3	2		1		1	1	1	
Paraprionospio sp.						1							1						1		1									
Parasterope quadrata																														
Pectinaria australis	1											1					1	1												
Pennatulacea																								1						
Philine sp.				1				1											1											
Phoronida	4			9				1	3			1		1	10			3	10	1	7	1		1	1	2		7	3	1

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Phoxocephalidae	4	2	14	5	8	5	3	2	7	1	1		13	7	1	8	5	5	4	10	4	5	7	13	28	6	1	4	8	9
Phyllodocidae	3			2	1			1	5			1		1				1		1			2	1			2		2	1
Pilargidae																														
Platyhelminthes	1														1															
Pleuromeris zelandica		1																				1		1						
Poecilochaetidae																														
Polydorid	2		3	2																1		1								
Polynoidae																		1	1											
Porifera																														
Porifera (orange encrusting)																														
Pratulum pulchellum			1				1																							
Prionospio sp.	1	2	4	1	4	3	3	12	4	4	2		8	7				1	9	11		2	4	4	3	2	1		1	2
Prionospio yuriel						1																								
Processa moana																1														
Pupa affinis																		1	1		1									
Pupa kirki																														
Retusidae																														
Ruditapes largillierti							1																							
Rutiderma sp.								1								1														
Sabellidae		2		5	1	5	10	1	2	5	1	2	1			2	1	1	1	1	6	1	1		2	1	1	3		1
Saccella bellula																				1										
Saccella maxwelli				1																										
Scalibregmatidae																														
Scoloplos cylindrifer																														
Scoloplos sp.				1	4						1		2	1																
Serpula sp.				1			1			3														1						
Serpulidae																														
Sigalionidae					1			1																						
Sigapatella tenuis																														
Sipuncula																														
Solariella tryphenensis									1																					
Solemya parkinsoni																	1													

Appendix A2: Synthesised Data for Cawthron Institute ID and Counts for grab samples collected Cawthron Institue in Disposal Area 3.2 and Reference Areas 3.2A and 3.2B

Taxa	29.1	29.2	29.3	29.4	29.5	30.1	30.2	30.3	30.4	30.5	31.1	31.2	31.3	31.4	31.5	32.1	32.2	32.3	32.4	32.5	33.1	33.2	33.3	33.4	33.5	34.1	34.2	34.3	34.4	34.5
Sphaeromatidae																														
Sphaerosyllis sp.	3	1		1	1	2	1	10	2	2		2	2				1	1	1			1	2						2	
Spionidae																														
Spiophanes kroyeri	5		1	4	3	8							1	1			3				1				1					
Spiophanes modestus	32	1	9	29	26	28	4	2	62	1	11	31		78	16	1	1	27	5	5	3	9	16		38	5	3	6	13	8
Spirorbidae							1																							
Syllidae	5	4	3			4	6	5	5	18	3						3	1			2	1	2	1		3	1	1		
Tanaidacea				2	3	2	5	2		1	1				1	1	2		1	3				1		1	1	2	5	7
Terebellidae	1	2	2	1	2	1	1	1	1	1	1	1	1						1			4		6	3	8	2	4	4	3
Terebellides stroemii			1				1		1												1					2			4	
Terebra circumcincta											1																			
Thyasiridae																														
Travisia olens																					1	1								
Ungulinidae																														
Upogebia sp.																														
Xenophora neozelanica																														
Zeacolpus pagoda pagod	1						1																		1					
# taxa	30	27	25	27	31	38	37	31	34	24	28	19	20	18	19	21	22	29	27	29	24	25	23	23	31	25	23	22	22	24
# individuals	193	69	161	142	93	159	108	94	167	77	85	89	49	122	77	74	67	136	71	78	92	56	77	81	138	87	65	79	95	74

average per site	29	30	31	32	33	34
# taxa	28	33	21	26	25	23
# individuals	132	121	84	85	89	80

average per area	Reference Area 3.2B
# taxa	26
# individuals	99

APPENDIX B: Particle Size and Chemistry for Disposal Area 3.2 (11, 12, 13, 14, 15, 16) Reference Areas 3.2A (23, 24, 24, 25, 26, 27, 28) and 3.2B (29, 30, 31, 32, 33, 34).

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ANALYSIS REPORT

Client:	Cawthron Institute (Nelson)	**Lab No:**	1578823	SPv2
Contact:	Deanna Elvines	**Date Registered:**	05-May-2016	
	C/- Cawthron Institute (Nelson)	**Date Reported:**	02-Jun-2016	
	Private Bag 2	**Quote No:**	76487	
	Nelson Mail Centre	**Order No:**		
	Nelson 7042	**Client Reference:**	Sediment Analyses	
		Add. Client Ref:	RNZ	
		Submitted By:	Olivia Johnston	

Amended Report

This report replaces an earlier report issued on the 20 May 2016 at 2:18 pm
At the client's request, organic analyses have been added to four samples.

Sample Type: Sediment

Sample Name:		RNZ2016SED001 11_3.2	RNZ2016SED002 12_3.2	RNZ2016SED003 13_3.2	RNZ2016SED004 14_3.2	RNZ2016SED005 15_3.2
Lab Number:		1578823.1	1578823.2	1578823.3	1578823.4	1578823.5
Individual Tests						
Particle size analysis*		See attached report	See attached report	See attached report	See attached report	See attached report
Total Recoverable Silver	mg/kg dry wt	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	3.3	4	6	6.3	4.9
Total Recoverable Cadmium	mg/kg dry wt	0.032	0.038	0.012	< 0.010	< 0.010
Total Recoverable Chromium	mg/kg dry wt	14.5	15.0	6.7	6.4	5.7
Total Recoverable Copper	mg/kg dry wt	1.4	1.8	0.8	0.6	0.5
Total Recoverable Lead	mg/kg dry wt	2.7	2.8	1.32	1.23	1.05
Total Recoverable Mercury	mg/kg dry wt	0.013	0.016	< 0.010	< 0.010	< 0.010
Total Recoverable Nickel	mg/kg dry wt	5.6	7.5	4.8	3.3	4.0
Total Recoverable Zinc	mg/kg dry wt	14.7	15.5	8.1	7.0	6.4

Sample Name:		RNZ2016SED006 16_3.2	RNZ2016SED007 19_2.2	RNZ2016SED008 23_3.2A	RNZ2016SED009 24_3.2A	RNZ2016SED010 25_3.2A
Lab Number:		1578823.6	1578823.7	1578823.8	1578823.9	1578823.10
Individual Tests						
Particle size analysis*		See attached report	See attached report	See attached report	See attached report	See attached report
Total Recoverable Silver	mg/kg dry wt	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	4.5	3.5	7.2	5.0	6.8
Total Recoverable Cadmium	mg/kg dry wt	< 0.010	< 0.010	< 0.010	< 0.010	0.012
Total Recoverable Chromium	mg/kg dry wt	4.3	7.3	5.6	4.3	4.9
Total Recoverable Copper	mg/kg dry wt	0.5	0.4	0.7	0.4	0.6
Total Recoverable Lead	mg/kg dry wt	0.96	1.06	1.33	0.99	1.20
Total Recoverable Mercury	mg/kg dry wt	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Total Recoverable Nickel	mg/kg dry wt	3.4	2.0	4.2	3.9	5.0
Total Recoverable Zinc	mg/kg dry wt	5.2	8.9	6.4	5.2	6.8

Sample Name:		RNZ2016SED011 26_3.2A	RNZ2016SED012 27_3.2A	RNZ2016SED013 28_3.2A	RNZ2016SED014 29_3.2B	RNZ2016SED015 30_3.2B
Lab Number:		1578823.11	1578823.12	1578823.13	1578823.14	1578823.15

Sample Type: Sediment						
Sample Name:		RNZ2016SED011 26_3.2A	RNZ2016SED012 27_3.2A	RNZ2016SED013 28_3.2A	RNZ2016SED014 29_3.2B	RNZ2016SED015 30_3.2B
Lab Number:		1578823.11	1578823.12	1578823.13	1578823.14	1578823.15
Individual Tests						
Particle size analysis*		See attached report	See attached report	See attached report	See attached report	See attached report
Total Recoverable Silver	mg/kg dry wt	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	6.8	5.3	5	5.5	5.7
Total Recoverable Cadmium	mg/kg dry wt	0.010	< 0.010	0.012	0.018	0.013
Total Recoverable Chromium	mg/kg dry wt	5.6	4.7	4.4	16.6	7.9
Total Recoverable Copper	mg/kg dry wt	0.6	0.7	0.7	1.0	0.6
Total Recoverable Lead	mg/kg dry wt	1.36	1.24	1.47	2.1	1.36
Total Recoverable Mercury	mg/kg dry wt	< 0.010	0.013	< 0.010	< 0.010	< 0.010
Total Recoverable Nickel	mg/kg dry wt	4.8	5.1	5.9	5.2	4.5
Total Recoverable Zinc	mg/kg dry wt	6.0	6.4	5.8	13.4	7.1

Sample Name:		RNZ2016SED016 31_3.2B	RNZ2016SED017 32_3.2B	RNZ2016SED018 33_3.2B	RNZ2016SED019 34_3.2B	RNZ2016SED061 14_3.2
Lab Number:		1578823.16	1578823.17	1578823.18	1578823.19	1578823.23
Individual Tests						
Dry Matter	g/100g as rcvd	-	-	-	-	81
Particle size analysis*		See attached report	See attached report	See attached report	See attached report	-
Total Recoverable Silver	mg/kg dry wt	< 0.02	< 0.02	< 0.02	< 0.02	-
Total Organic Carbon*	g/100g dry wt	-	-	-	-	< 0.13
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	5.1	5	4.9	4.2	-
Total Recoverable Cadmium	mg/kg dry wt	0.015	0.030	< 0.010	0.010	-
Total Recoverable Chromium	mg/kg dry wt	13.9	21	10.0	9.1	-
Total Recoverable Copper	mg/kg dry wt	0.8	1.6	0.6	0.5	-
Total Recoverable Lead	mg/kg dry wt	2.2	3.3	1.49	1.33	-
Total Recoverable Mercury	mg/kg dry wt	< 0.010	< 0.010	< 0.010	< 0.010	-
Total Recoverable Nickel	mg/kg dry wt	4.4	8.0	4.0	3.8	-
Total Recoverable Zinc	mg/kg dry wt	12.3	18.9	8.4	8.0	-
Organochlorine Pesticides Trace in Soil						
Aldrin	mg/kg dry wt	-	-	-	-	< 0.0010
alpha-BHC	mg/kg dry wt	-	-	-	-	< 0.0010
beta-BHC	mg/kg dry wt	-	-	-	-	< 0.0010
delta-BHC	mg/kg dry wt	-	-	-	-	< 0.0010
gamma-BHC (Lindane)	mg/kg dry wt	-	-	-	-	< 0.0010
cis-Chlordane	mg/kg dry wt	-	-	-	-	< 0.0010
trans-Chlordane	mg/kg dry wt	-	-	-	-	< 0.0010
2,4'-DDD	mg/kg dry wt	-	-	-	-	< 0.0010
4,4'-DDD	mg/kg dry wt	-	-	-	-	< 0.0010
2,4'-DDE	mg/kg dry wt	-	-	-	-	< 0.0010
4,4'-DDE	mg/kg dry wt	-	-	-	-	< 0.0010
2,4'-DDT	mg/kg dry wt	-	-	-	-	< 0.0010
4,4'-DDT	mg/kg dry wt	-	-	-	-	< 0.0010
Total DDT Isomers	mg/kg dry wt	-	-	-	-	< 0.006
Dieldrin	mg/kg dry wt	-	-	-	-	< 0.0010
Endosulfan I	mg/kg dry wt	-	-	-	-	< 0.0010
Endosulfan II	mg/kg dry wt	-	-	-	-	< 0.0010
Endosulfan sulphate	mg/kg dry wt	-	-	-	-	< 0.0010
Endrin	mg/kg dry wt	-	-	-	-	< 0.0010
Endrin aldehyde	mg/kg dry wt	-	-	-	-	< 0.0010
Endrin ketone	mg/kg dry wt	-	-	-	-	< 0.0010
Heptachlor	mg/kg dry wt	-	-	-	-	< 0.0010
Heptachlor epoxide	mg/kg dry wt	-	-	-	-	< 0.0010
Hexachlorobenzene	mg/kg dry wt	-	-	-	-	< 0.0010

Sample Type: Sediment						
Sample Name:		RNZ2016SED016 31_3.2B	RNZ2016SED017 32_3.2B	RNZ2016SED018 33_3.2B	RNZ2016SED019 34_3.2B	RNZ2016SED061 14_3.2
Lab Number:		1578823.16	1578823.17	1578823.18	1578823.19	1578823.23
Organochlorine Pesticides Trace in Soil						
Methoxychlor	mg/kg dry wt	-	-	-	-	< 0.0010
Total Chlordane [(cis+trans)* 100/42]	mg/kg dry wt	-	-	-	-	< 0.002
Polycyclic Aromatic Hydrocarbons Trace in Soil						
Acenaphthene	mg/kg dry wt	-	-	-	-	< 0.002
Acenaphthylene	mg/kg dry wt	-	-	-	-	< 0.002
Anthracene	mg/kg dry wt	-	-	-	-	< 0.002
Benzo[a]anthracene	mg/kg dry wt	-	-	-	-	< 0.002
Benzo[a]pyrene (BAP)	mg/kg dry wt	-	-	-	-	< 0.002
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	-	-	-	-	< 0.002
Benzo[g,h,i]perylene	mg/kg dry wt	-	-	-	-	< 0.002
Benzo[k]fluoranthene	mg/kg dry wt	-	-	-	-	< 0.002
Chrysene	mg/kg dry wt	-	-	-	-	< 0.002
Dibenzo[a,h]anthracene	mg/kg dry wt	-	-	-	-	< 0.002
Fluoranthene	mg/kg dry wt	-	-	-	-	< 0.002
Fluorene	mg/kg dry wt	-	-	-	-	< 0.002
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	-	-	-	-	< 0.002
Naphthalene	mg/kg dry wt	-	-	-	-	< 0.012
Phenanthrene	mg/kg dry wt	-	-	-	-	< 0.005
Pyrene	mg/kg dry wt	-	-	-	-	< 0.002
Polychlorinated Biphenyls Trace in Soil						
PCB-18	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-28	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-31	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-44	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-49	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-52	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-60	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-77	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-81	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-86	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-101	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-105	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-110	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-114	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-118	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-121	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-123	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-126	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-128	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-138	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-141	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-149	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-151	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-153	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-156	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-157	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-159	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-167	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-169	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-170	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-180	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-189	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-194	mg/kg dry wt	-	-	-	-	< 0.0010

Sample Type: Sediment						
Sample Name:		RNZ2016SED016 31_3.2B	RNZ2016SED017 32_3.2B	RNZ2016SED018 33_3.2B	RNZ2016SED019 34_3.2B	RNZ2016SED061 14_3.2
Lab Number:		1578823.16	1578823.17	1578823.18	1578823.19	1578823.23
Polychlorinated Biphenyls Trace in Soil						
PCB-206	mg/kg dry wt	-	-	-	-	< 0.0010
PCB-209	mg/kg dry wt	-	-	-	-	< 0.0010
Total PCB (Sum of 35 congeners)	mg/kg dry wt	-	-	-	-	< 0.04
Tributyl Tin Trace in Soil samples by GCMS						
Dibutyltin (as Sn)	mg/kg dry wt	-	-	-	-	< 0.005
Monobutyltin (as Sn)	mg/kg dry wt	-	-	-	-	< 0.007
Tributyltin (as Sn)	mg/kg dry wt	-	-	-	-	< 0.004
Triphenyltin (as Sn)	mg/kg dry wt	-	-	-	-	< 0.003
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	-	-	-	-	< 8
C10 - C14	mg/kg dry wt	-	-	-	-	< 20
C15 - C36	mg/kg dry wt	-	-	-	-	< 40
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	-	-	-	< 70

Sample Name:		RNZ2016SED062 15_3.2	RNZ2016SED066 24_3.2A	RNZ2016SED071 29_3.2B		
Lab Number:		1578823.24	1578823.28	1578823.33		
Individual Tests						
Dry Matter	g/100g as rcvd	80	80	76	-	-
Total Organic Carbon*	g/100g dry wt	< 0.13	< 0.13	0.16	-	-
Organochlorine Pesticides Trace in Soil						
Aldrin	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
alpha-BHC	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
beta-BHC	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
delta-BHC	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
gamma-BHC (Lindane)	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
cis-Chlordane	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
trans-Chlordane	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
2,4'-DDD	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
4,4'-DDD	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
2,4'-DDE	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
4,4'-DDE	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
2,4'-DDT	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
4,4'-DDT	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
Total DDT Isomers	mg/kg dry wt	< 0.006	< 0.006	< 0.006	-	-
Dieldrin	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
Endosulfan I	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
Endosulfan II	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
Endosulfan sulphate	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
Endrin	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
Endrin aldehyde	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
Endrin ketone	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
Heptachlor	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
Heptachlor epoxide	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
Hexachlorobenzene	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
Methoxychlor	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
Total Chlordane [(cis+trans)* 100/42]	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Polycyclic Aromatic Hydrocarbons Trace in Soil						
Acenaphthene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Acenaphthylene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Anthracene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-

Sample Type: Sediment						
	Sample Name:	RNZ2016SED062 15_3.2	RNZ2016SED066 24_3.2A	RNZ2016SED071 29_3.2B		
	Lab Number:	1578823.24	1578823.28	1578823.33		
Polycyclic Aromatic Hydrocarbons Trace in Soil						
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Chrysene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Fluoranthene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Fluorene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Naphthalene	mg/kg dry wt	< 0.012	< 0.012	< 0.013	-	-
Phenanthrene	mg/kg dry wt	< 0.005	< 0.006	< 0.006	-	-
Pyrene	mg/kg dry wt	< 0.002	< 0.002	< 0.002	-	-
Polychlorinated Biphenyls Trace in Soil						
PCB-18	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-28	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-31	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-44	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-49	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-52	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-60	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-77	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-81	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-86	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-101	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-105	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-110	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-114	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-118	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-121	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-123	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-126	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-128	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-138	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-141	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-149	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-151	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-153	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-156	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-157	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-159	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-167	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-169	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-170	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-180	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-189	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-194	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-206	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
PCB-209	mg/kg dry wt	< 0.0010	< 0.0010	< 0.0010	-	-
Total PCB (Sum of 35 congeners)	mg/kg dry wt	< 0.04	< 0.04	< 0.04	-	-
Tributyl Tin Trace in Soil samples by GCMS						
Dibutyltin (as Sn)	mg/kg dry wt	< 0.005	< 0.005	< 0.005	-	-
Monobutyltin (as Sn)	mg/kg dry wt	< 0.007	< 0.007	< 0.007	-	-
Tributyltin (as Sn)	mg/kg dry wt	< 0.004	< 0.004	< 0.004	-	-
Triphenyltin (as Sn)	mg/kg dry wt	< 0.003	< 0.003	< 0.003	-	-

Sample Type: Sediment						
Sample Name:		RNZ2016SED062 15_3.2	RNZ2016SED066 24_3.2A	RNZ2016SED071 29_3.2B		
Lab Number:		1578823.24	1578823.28	1578823.33		
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 9	< 9	< 9	-	-
C10 - C14	mg/kg dry wt	< 20	< 20	< 20	-	-
C15 - C36	mg/kg dry wt	< 40	< 40	< 40	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 70	< 70	< 70	-	-

Analyst's Comments

The detection limit for Naphthalene and Phenanthrene was raised due to an elevated blank level found during the analysis.

Appendix No.1 - Particle Size Report - 1578823

Appendix No.2 - Particle Size Report - 1578823

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%.	-	1-19, 23-24, 28, 33
Organochlorine/Polychlorinated biphenyls Trace in Soil	Sonication extraction, SPE cleanup, GC & GC-MS analysis. Tested on dried sample	0.0010 - 0.02 mg/kg dry wt	23-24, 28, 33
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	1-19
Polycyclic Aromatic Hydrocarbons Trace in Soil	Sonication extraction, SPE cleanup, GC-MS SIM analysis US EPA 8270C. Tested on as received sample [KBIs:5784,4273,2695]	0.002 - 0.010 mg/kg dry wt	23-24, 28, 33
Tributyl Tin Trace in Soil samples by GCMS	Solvent extraction, ethylation, SPE cleanup, GC-MS SIM analysis. Tested on dried sample	0.003 - 0.007 mg/kg dry wt	23-24, 28, 33
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample [KBIs:5786,2805,10734]	8 - 60 mg/kg dry wt	23-24, 28, 33
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	23-24, 28, 33
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-19
Particle size analysis*	Malvern Laser Sizer particle size analysis. Subcontracted to Earth Sciences Department, Waikato University, Hamilton.	-	1-19
Total Recoverable Silver	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, trace level. US EPA 200.2.	0.02 mg/kg dry wt	1-19
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	23-24, 28, 33

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.

Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental

Samples were sieved at 2mm and particles below 2mm were analysed using the Malvern Lasersizer.
Below are the proportions above and below 2mm

Sample No	% > 2mm	%< 2mm
1578823.3	22.5	77.5
1578823.4	3.1	96.9
1578823.5	4.6	95.4
1578823.6	10.7	89.3
1578823.7	1.1	98.9
1578823.8	7.2	92.8
1578823.1	8.6	91.4
1578823.11	20.9	79.1
1578823.12	23.5	76.5
1578823.13	24.0	76.0
1578823.15	12.7	87.3

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MASTERSIZER 2000

Result Analysis Report

Sample Name:
1578823.1

SOP Name:
Sediment

Measured:
Wednesday, 18 May 2016 2:44:32 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Wednesday, 18 May 2016 2:44:34 p.m.

Sample bulk lot ref:
2016084/1

Result Source:
Measurement

Particle Name:
Sediment

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Enhanced

Particle RI:
1.500

Absorption:
0.2

Size range:
0.020 to 2000.000 um

Obscuration:
25.51 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.536 %

Result Emulation:
Off

Concentration:
0.1097 %Vol

Span :
2.127

Uniformity:
0.684

Result units:
Volume

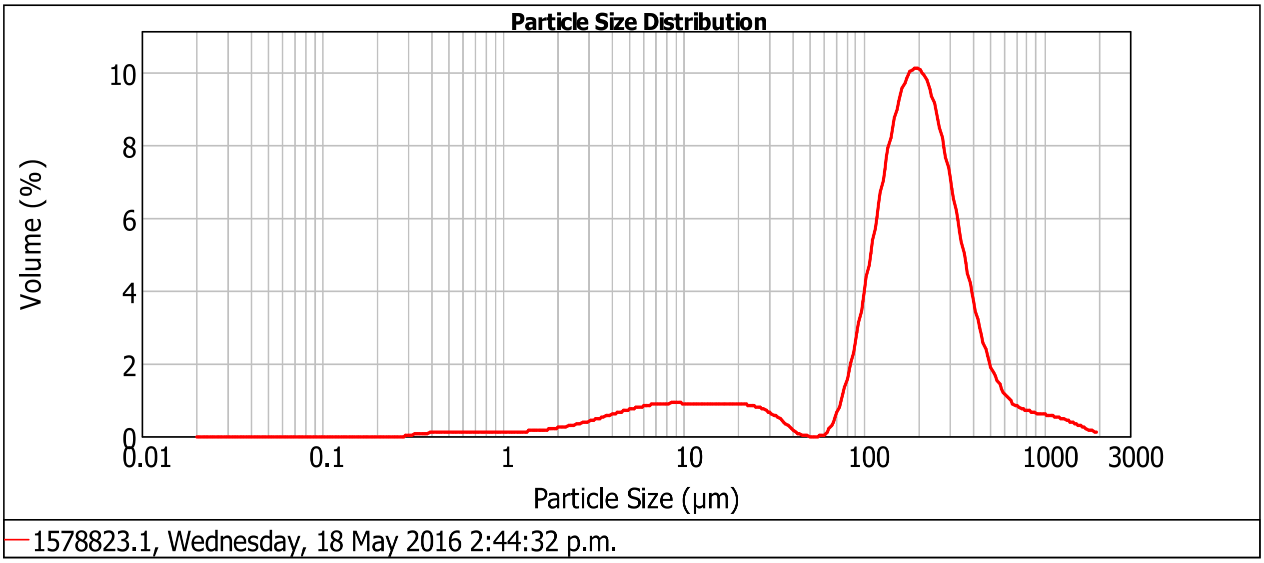
Specific Surface Area:
0.253 m²/g

Surface Weighted Mean D[3,2]:
23.720 um

Vol. Weighted Mean D[4,3]:
224.507 um

Standard Deviation
212.633 um

d(0.1): 13.723 um **d(0.5): 184.500 um** **d(0.9): 406.138 um**



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	1.53	44.000	15.25	149.000	36.62	500.000	93.83	1680.000	99.82
0.060	0.00	3.900	3.18	53.000	15.26	177.000	47.27	590.000	95.56	2000.000	100.00
0.120	0.00	7.800	6.67	63.000	15.28	210.000	58.58	710.000	96.77		
0.240	0.00	10.000	8.14	74.000	15.71	250.000	69.57	840.000	97.58		
0.490	0.27	15.600	10.74	88.000	17.43	300.000	79.29	1000.000	98.30		
0.700	0.56	31.000	14.48	105.000	21.28	350.000	85.61	1190.000	98.94		
0.980	0.83	37.000	15.05	125.000	27.64	420.000	90.78	1410.000	99.45		

Operator notes:

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MALVERN INSTRUMENTS

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Result Analysis Report

Sample Name:
1578823.2

SOP Name:
Sediment

Measured:
Wednesday, 18 May 2016 2:49:47 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Wednesday, 18 May 2016 2:49:49 p.m.

Sample bulk lot ref:
2016084/2

Result Source:
Measurement

Particle Name:
Sediment

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Enhanced

Particle RI:
1.500

Absorption:
0.2

Size range:
0.020 to 2000.000 um

Obscuration:
18.76 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.558 %

Result Emulation:
Off

Concentration:
0.0451 %Vol

Span :
3.043

Uniformity:
0.966

Result units:
Volume

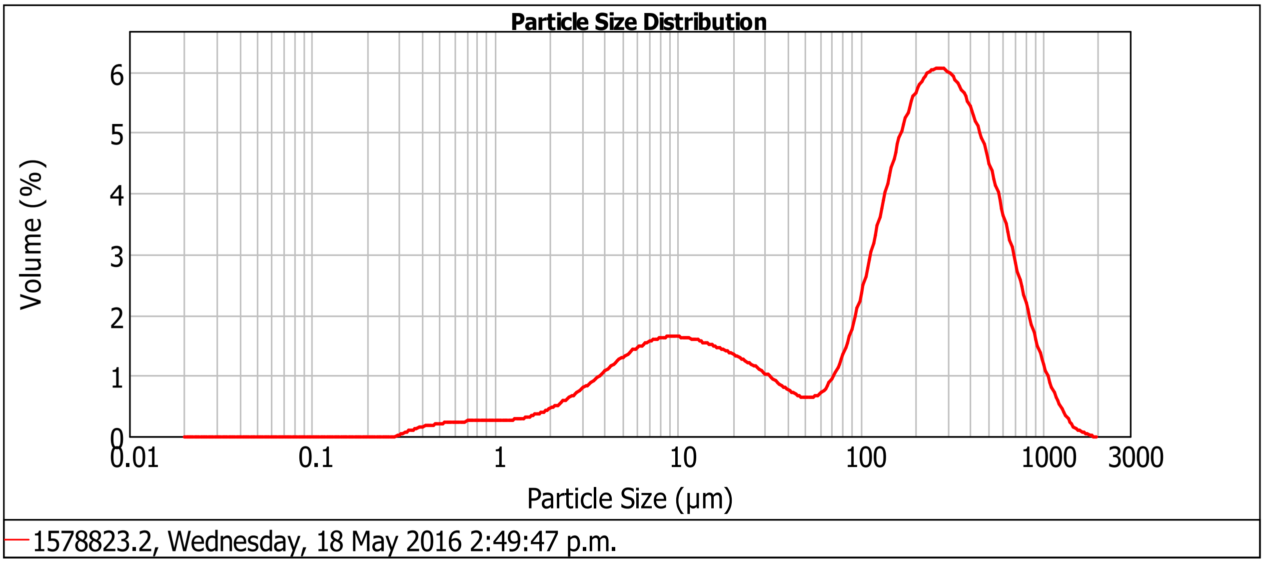
Specific Surface Area:
0.43 m²/g

Surface Weighted Mean D[3,2]:
13.938 um

Vol. Weighted Mean D[4,3]:
252.039 um

Standard Deviation
252.12 um

d(0.1): 6.232 um **d(0.5): 192.796 um** **d(0.9): 592.985 um**



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.050	0.00	2.000	2.94	44.000	27.20	149.000	41.54	500.000	85.33	1680.000	99.98
0.060	0.00	3.900	6.09	53.000	28.00	177.000	46.99	590.000	89.87	2000.000	100.00
0.120	0.00	7.800	12.27	63.000	28.75	210.000	53.16	710.000	93.90		
0.240	0.00	10.000	14.92	74.000	29.68	250.000	59.92	840.000	96.55		
0.490	0.41	15.600	19.52	88.000	31.20	300.000	67.14	1000.000	98.37		
0.700	0.95	31.000	25.27	105.000	33.58	350.000	73.10	1190.000	99.38		
0.980	1.49	37.000	26.34	125.000	36.99	420.000	79.70	1410.000	99.85		

Operator notes:

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Result Analysis Report

Sample Name:
1578823.3

SOP Name:

Measured:
Wednesday, 18 May 2016 3:06:08 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Wednesday, 18 May 2016 3:06:09 p.m.

Sample bulk lot ref:
2016084/3

Result Source:
Measurement

Particle Name:
Sediment

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.500

Absorption:
0.2

Size range:
0.050 to 2000.000 um

Obscuration:
9.15 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.700 %

Result Emulation:
Off

Concentration:
0.1008 %Vol

Span :
1.863

Uniformity:
0.5

Result units:
Volume

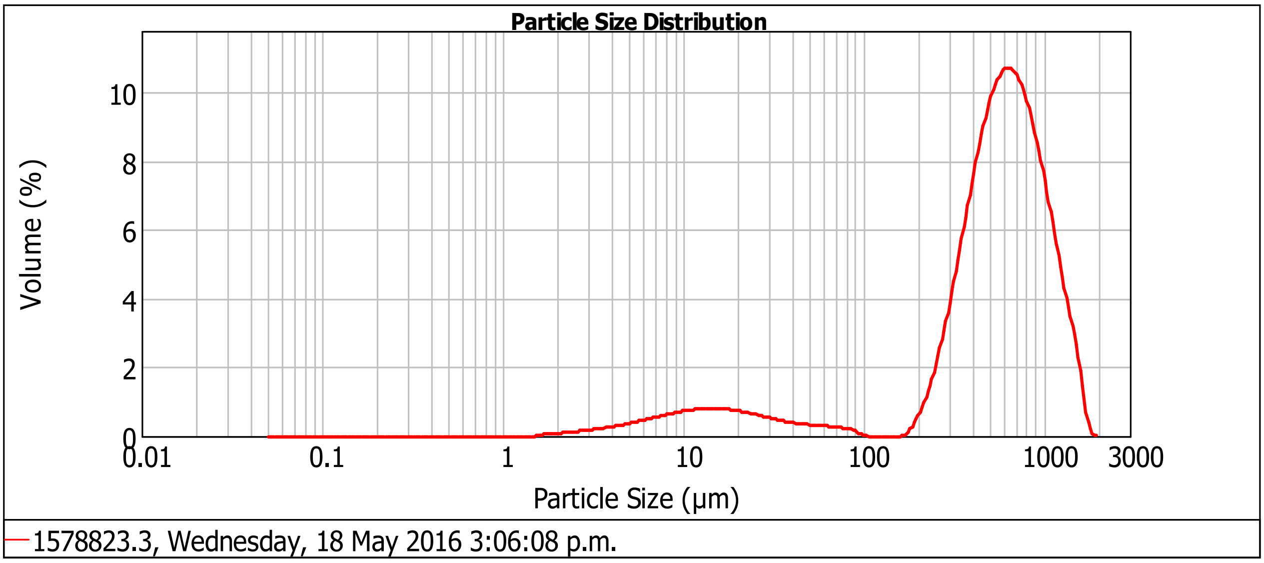
Specific Surface Area:
0.0775 m²/g

Surface Weighted Mean D[3,2]:
77.374 um

Vol. Weighted Mean D[4,3]:
617.198 um

Standard Deviation
369.036 um

d(0.1): 41.755 um **d(0.5): 580.502 um** **d(0.9): 1123.321 um**



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	0.10	44.000	10.13	149.000	11.51	500.000	40.02	1680.000	99.82
0.060	0.00	3.900	0.80	53.000	10.54	177.000	11.51	590.000	51.13	2000.000	100.00
0.120	0.00	7.800	2.71	63.000	10.89	210.000	11.98	710.000	64.05		
0.240	0.00	10.000	3.79	74.000	11.18	250.000	13.49	840.000	75.07		
0.490	0.00	15.600	6.06	88.000	11.43	300.000	16.89	1000.000	84.78		
0.700	0.00	31.000	9.13	105.000	11.51	350.000	21.67	1190.000	92.19		
0.980	0.00	37.000	9.68	125.000	11.51	420.000	29.86	1410.000	97.05		

Operator notes:

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MASTERSIZER 2000

Result Analysis Report

Sample Name:
1578823.4

SOP Name:

Measured:
Wednesday, 18 May 2016 3:56:54 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Wednesday, 18 May 2016 3:56:56 p.m.

Sample bulk lot ref:
2016084/4

Result Source:
Measurement

Particle Name:
Sediment

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.500

Absorption:
0.2

Size range:
0.050 to 2000.000 um

Obscuration:
13.11 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.894 %

Result Emulation:
Off

Concentration:
0.6562 %Vol

Span :
1.260

Uniformity:
0.387

Result units:
Volume

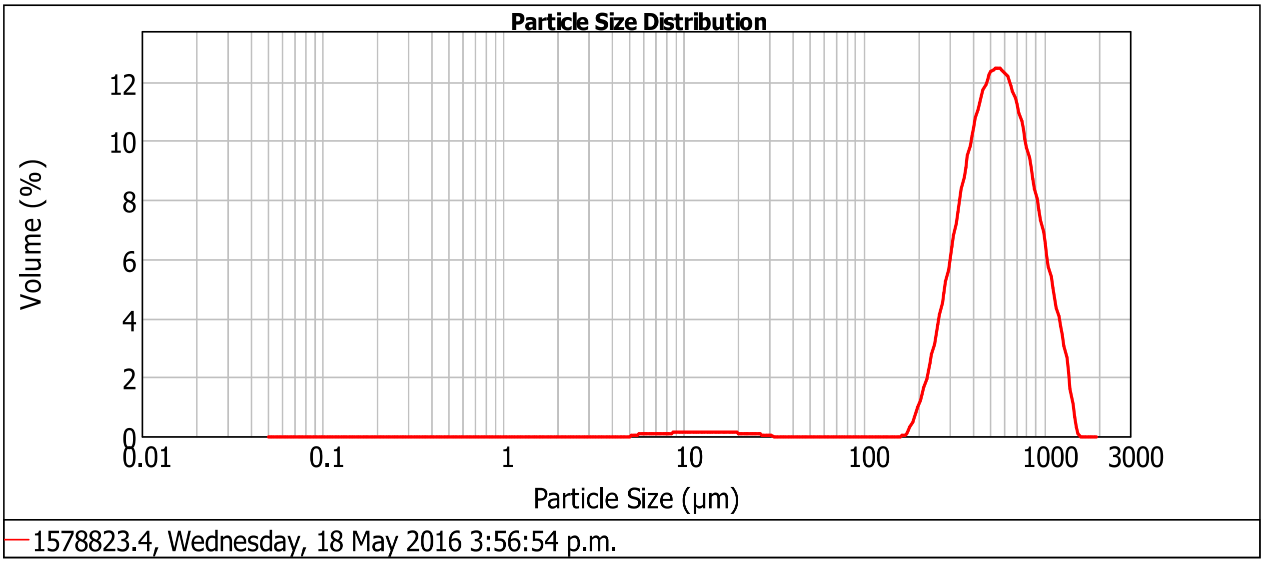
Specific Surface Area:
0.018 m²/g

Surface Weighted Mean D[3,2]:
333.807 um

Vol. Weighted Mean D[4,3]:
603.367 um

Standard Deviation
274.189 um

d(0.1): 300.504 um **d(0.5):** 552.885 um **d(0.9):** 997.288 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	0.00	44.000	1.20	149.000	1.20	500.000	41.85	1680.000	100.00
0.060	0.00	3.900	0.00	53.000	1.20	177.000	1.20	590.000	55.30	2000.000	100.00
0.120	0.00	7.800	0.19	63.000	1.20	210.000	1.97	710.000	69.74		
0.240	0.00	10.000	0.38	74.000	1.20	250.000	4.52	840.000	81.03		
0.490	0.00	15.600	0.79	88.000	1.20	300.000	9.94	1000.000	90.12		
0.700	0.00	31.000	1.20	105.000	1.20	350.000	17.12	1190.000	96.25		
0.980	0.00	37.000	1.20	125.000	1.20	420.000	28.60	1410.000	99.71		

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
1578823.5

SOP Name:

Measured:
Wednesday, 18 May 2016 4:02:53 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Wednesday, 18 May 2016 4:02:55 p.m.

Sample bulk lot ref:
2016084/5

Result Source:
Measurement

Particle Name:
Sediment

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.500

Absorption:
0.2

Size range:
0.050 to 2000.000 um

Obscuration:
19.07 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.304 %

Result Emulation:
Off

Concentration:
0.3821 %Vol

Span :
1.456

Uniformity:
0.461

Result units:
Volume

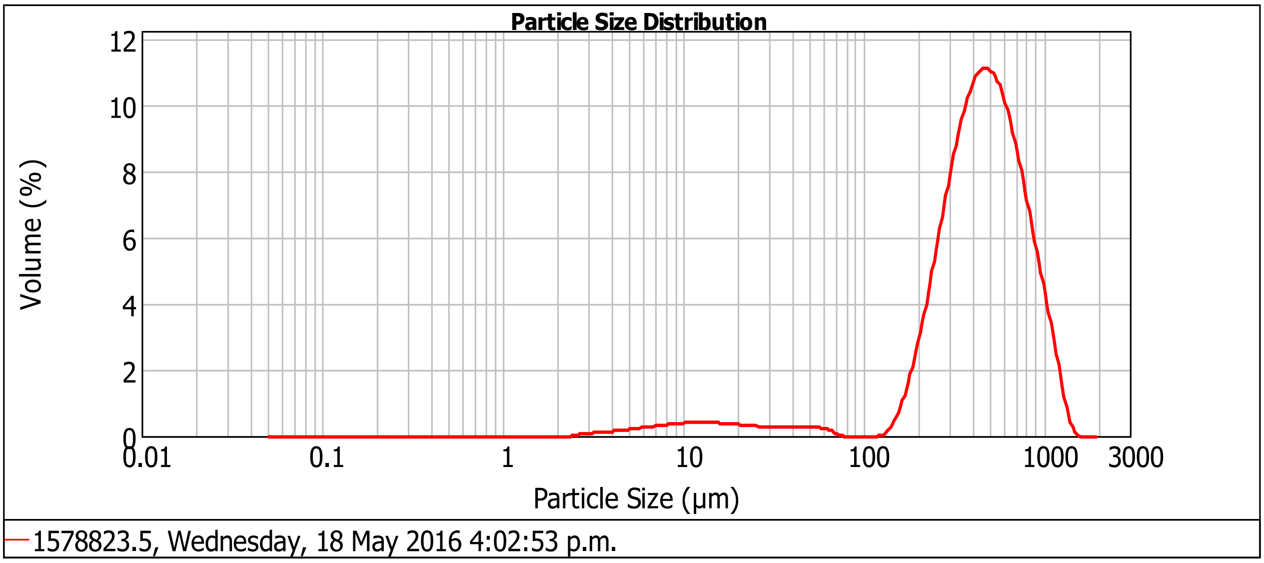
Specific Surface Area:
0.0456 m²/g

Surface Weighted Mean D[3,2]:
131.618 um

Vol. Weighted Mean D[4,3]:
497.639 um

Standard Deviation
270.118 um

d(0.1): **209.672** **um** **d(0.5):** **456.274** **um** **d(0.9):** **874.222** **um**



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	0.00	44.000	5.29	149.000	6.25	500.000	56.67	1680.000	100.00
0.060	0.00	3.900	0.27	53.000	5.65	177.000	7.35	590.000	68.36	2000.000	100.00
0.120	0.00	7.800	1.33	63.000	5.93	210.000	10.03	710.000	79.94		
0.240	0.00	10.000	1.93	74.000	6.07	250.000	14.99	840.000	88.34		
0.490	0.00	15.600	3.13	88.000	6.07	300.000	22.92	1000.000	94.65		
0.700	0.00	31.000	4.63	105.000	6.07	350.000	31.74	1190.000	98.55		
0.980	0.00	37.000	4.96	125.000	6.07	420.000	44.03	1410.000	99.95		

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
1578823.6

SOP Name:

Measured:
Wednesday, 18 May 2016 4:07:50 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Wednesday, 18 May 2016 4:07:52 p.m.

Sample bulk lot ref:
2016084/6

Result Source:
Measurement

Particle Name:
Sediment

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.500

Absorption:
0.2

Size range:
0.050 to 2000.000 um

Obscuration:
14.78 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.509 %

Result Emulation:
Off

Concentration:
0.5627 %Vol

Span :
1.197

Uniformity:
0.378

Result units:
Volume

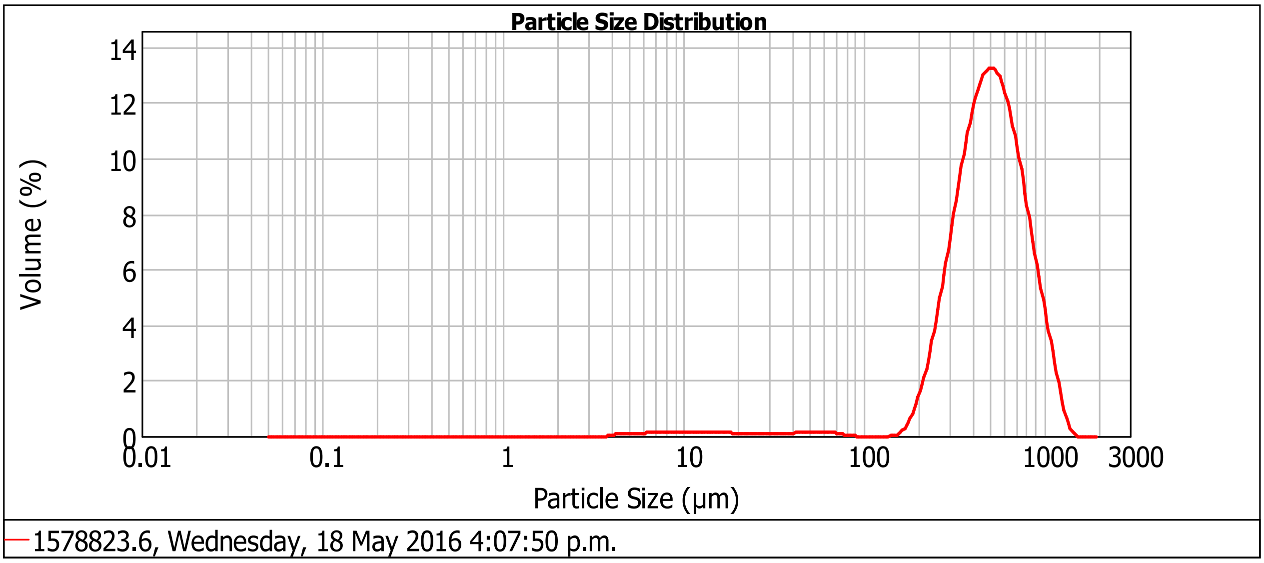
Specific Surface Area:
0.0237 m²/g

Surface Weighted Mean D[3,2]:
252.960 um

Vol. Weighted Mean D[4,3]:
539.538 um

Standard Deviation
242.384 um

d(0.1): **276.201** **um** **d(0.5):** **501.305** **um** **d(0.9):** **876.095** **um**



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.050	0.00	2.000	0.00	44.000	1.84	149.000	2.40	500.000	49.77	1680.000	100.00
0.060	0.00	3.900	0.00	53.000	2.03	177.000	2.58	590.000	63.96	2000.000	100.00
0.120	0.00	7.800	0.46	63.000	2.22	210.000	3.74	710.000	78.09		
0.240	0.00	10.000	0.72	74.000	2.36	250.000	6.91	840.000	88.01		
0.490	0.00	15.600	1.20	88.000	2.40	300.000	13.40	1000.000	94.98		
0.700	0.00	31.000	1.63	105.000	2.40	350.000	21.85	1190.000	98.87		
0.980	0.00	37.000	1.71	125.000	2.40	420.000	35.06	1410.000	99.98		

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name: 1578823.7

SOP Name:

Measured: Wednesday, 18 May 2016 4:17:06 p.m.

Sample Source & type:

Measured by: rodgers

Analysed: Wednesday, 18 May 2016 4:17:08 p.m.

Sample bulk lot ref: 2016084/7

Result Source: Measurement

Particle Name: Sediment

Accessory Name: Hydro 2000G (A)

Analysis model: General purpose

Sensitivity: Normal

Particle RI: 1.500

Absorption: 0.2

Size range: 0.050 to 2000.000 um

Obscuration: 14.37 %

Dispersant Name: Water

Dispersant RI: 1.330

Weighted Residual: 1.697 %

Result Emulation: Off

Concentration: 0.8625 %Vol

Span : 1.322

Uniformity: 0.406

Result units: Volume

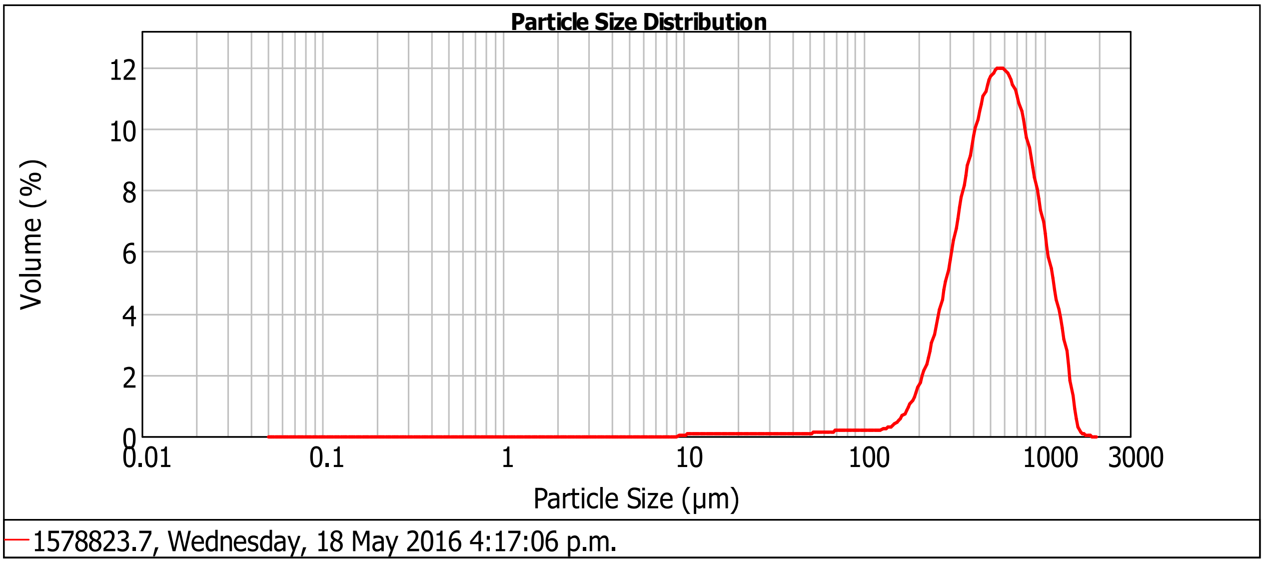
Specific Surface Area: 0.0152 m²/g

Surface Weighted Mean D[3,2]: 393.714 um

Vol. Weighted Mean D[4,3]: 599.922 um

Standard Deviation 286.183 um

d(0.1): 278.011 um **d(0.5):** 551.799 um **d(0.9):** 1007.495 um



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.050	0.00	2.000	0.00	44.000	0.74	149.000	2.08	500.000	42.39	1680.000	99.99
0.060	0.00	3.900	0.00	53.000	0.86	177.000	2.77	590.000	55.25	2000.000	100.00
0.120	0.00	7.800	0.00	63.000	1.01	210.000	4.26	710.000	69.34		
0.240	0.00	10.000	0.00	74.000	1.17	250.000	7.21	840.000	80.55		
0.490	0.00	15.600	0.23	88.000	1.37	300.000	12.55	1000.000	89.67		
0.700	0.00	31.000	0.59	105.000	1.56	350.000	19.28	1190.000	95.91		
0.980	0.00	37.000	0.66	125.000	1.76	420.000	29.95	1410.000	99.48		

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
1578823.8

SOP Name:

Measured:
Wednesday, 18 May 2016 4:21:49 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Wednesday, 18 May 2016 4:21:51 p.m.

Sample bulk lot ref:
2016084/8

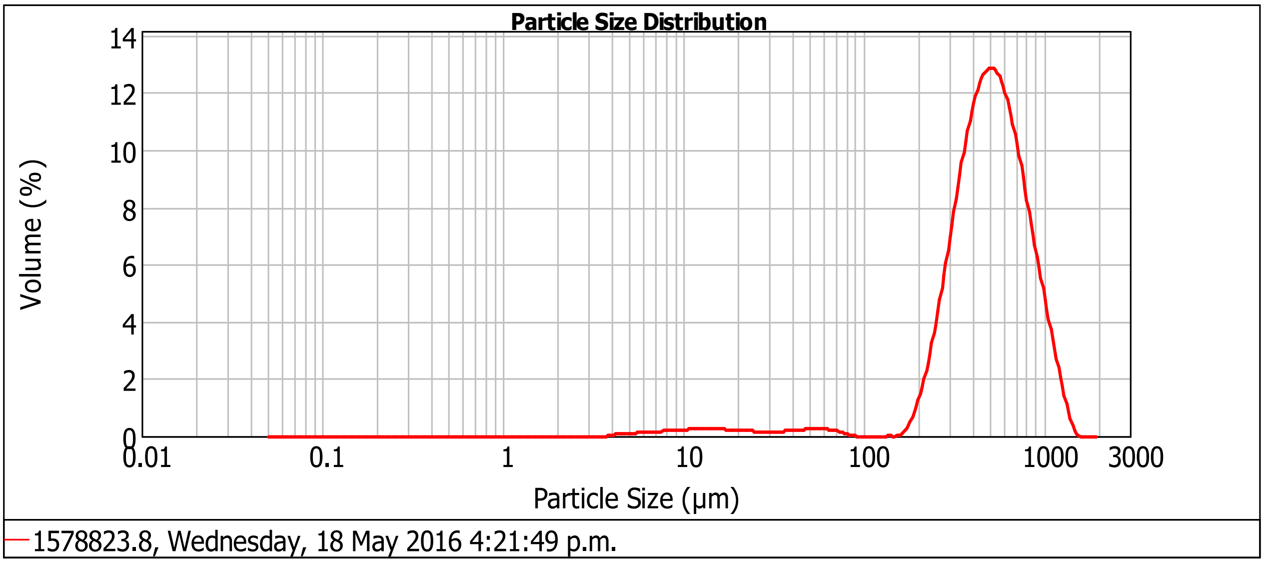
Result Source:
Measurement

Particle Name: Sediment	**Accessory Name:** Hydro 2000G (A)	**Analysis model:** General purpose	**Sensitivity:** Normal
Particle RI: 1.500	**Absorption:** 0.2	**Size range:** 0.050 to 2000.000 um	**Obscuration:** 16.54 %
Dispersant Name: Water	**Dispersant RI:** 1.330	**Weighted Residual:** 1.464 %	**Result Emulation:** Off

---

Concentration: 0.5503 %Vol	**Span :** 1.251	**Uniformity:** 0.398	**Result units:** Volume
Specific Surface Area: 0.0273 m²/g	**Surface Weighted Mean D[3,2]:** 219.393 um	**Vol. Weighted Mean D[4,3]:** 542.916 um	**Standard Deviation** 257.675 um

d(0.1): 270.110 um   **d(0.5):** 502.601 um   **d(0.9):** 898.772 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	0.00	44.000	2.82	149.000	3.68	500.000	49.56	1680.000	100.00
0.060	0.00	3.900	0.00	53.000	3.11	177.000	3.78	590.000	63.33	2000.000	100.00
0.120	0.00	7.800	0.53	63.000	3.39	210.000	4.79	710.000	77.08		
0.240	0.00	10.000	0.85	74.000	3.60	250.000	7.77	840.000	86.88		
0.490	0.00	15.600	1.55	88.000	3.68	300.000	14.07	1000.000	94.00		
0.700	0.00	31.000	2.41	105.000	3.68	350.000	22.33	1190.000	98.24		
0.980	0.00	37.000	2.60	125.000	3.68	420.000	35.24	1410.000	99.91		

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
1578823.9

SOP Name:

Measured:
Wednesday, 18 May 2016 4:26:31 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Wednesday, 18 May 2016 4:26:33 p.m.

Sample bulk lot ref:
2016084/9

Result Source:
Measurement

Particle Name:
Sediment

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.500

Absorption:
0.2

Size range:
0.050 to 2000.000 um

Obscuration:
9.42 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.565 %

Result Emulation:
Off

Concentration:
0.6571 %Vol

Span :
1.087

Uniformity:
0.337

Result units:
Volume

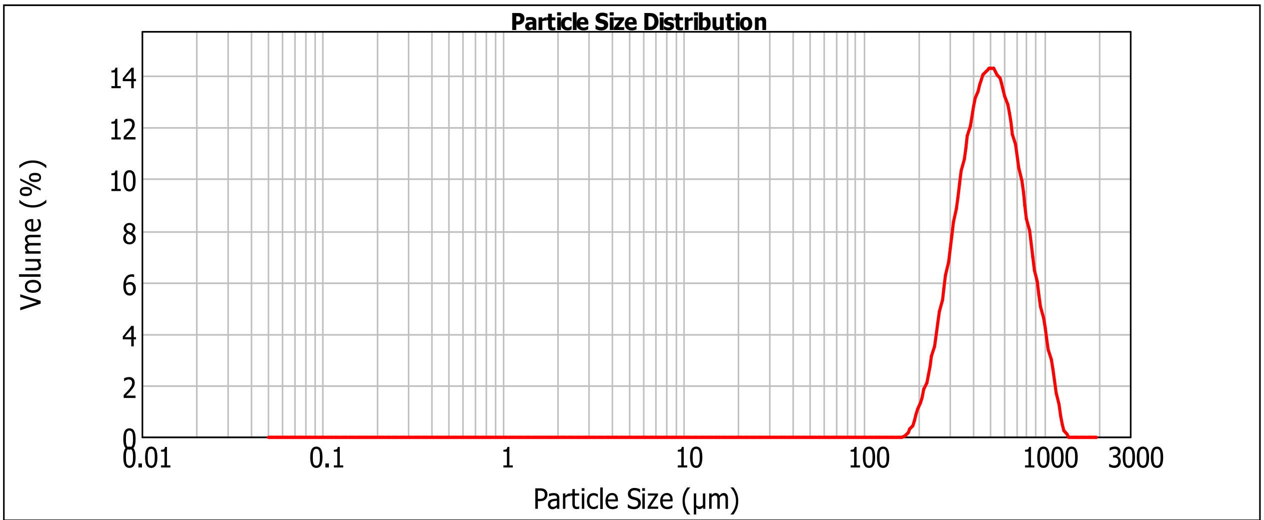
Specific Surface Area:
0.0128 m²/g

Surface Weighted Mean D[3,2]:
467.557 um

Vol. Weighted Mean D[4,3]:
544.858 um

Standard Deviation
214.469 um

d(0.1): **299.850** **um** **d(0.5):** **506.214** **um** **d(0.9):** **850.290** **um**



—1578823.9, Wednesday, 18 May 2016 4:26:31 p.m.

Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.050	0.00	2.000	0.00	44.000	0.00	149.000	0.00	500.000	48.84	1680.000	100.00
0.060	0.00	3.900	0.00	53.000	0.00	177.000	0.00	590.000	64.14	2000.000	100.00
0.120	0.00	7.800	0.00	63.000	0.00	210.000	0.78	710.000	79.15		
0.240	0.00	10.000	0.00	74.000	0.00	250.000	3.60	840.000	89.39		
0.490	0.00	15.600	0.00	88.000	0.00	300.000	10.02	1000.000	96.19		
0.700	0.00	31.000	0.00	105.000	0.00	350.000	18.82	1190.000	99.62		
0.980	0.00	37.000	0.00	125.000	0.00	420.000	32.94	1410.000	100.00		

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
1578823.10

SOP Name:

Measured:
Wednesday, 18 May 2016 4:30:56 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Wednesday, 18 May 2016 4:30:57 p.m.

Sample bulk lot ref:
2016084/10

Result Source:
Measurement

Particle Name:
Sediment

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.500

Absorption:
0.2

Size range:
0.050 to 2000.000 um

Obscuration:
10.97 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.738 %

Result Emulation:
Off

Concentration:
0.7666 %Vol

Span :
1.284

Uniformity:
0.395

Result units:
Volume

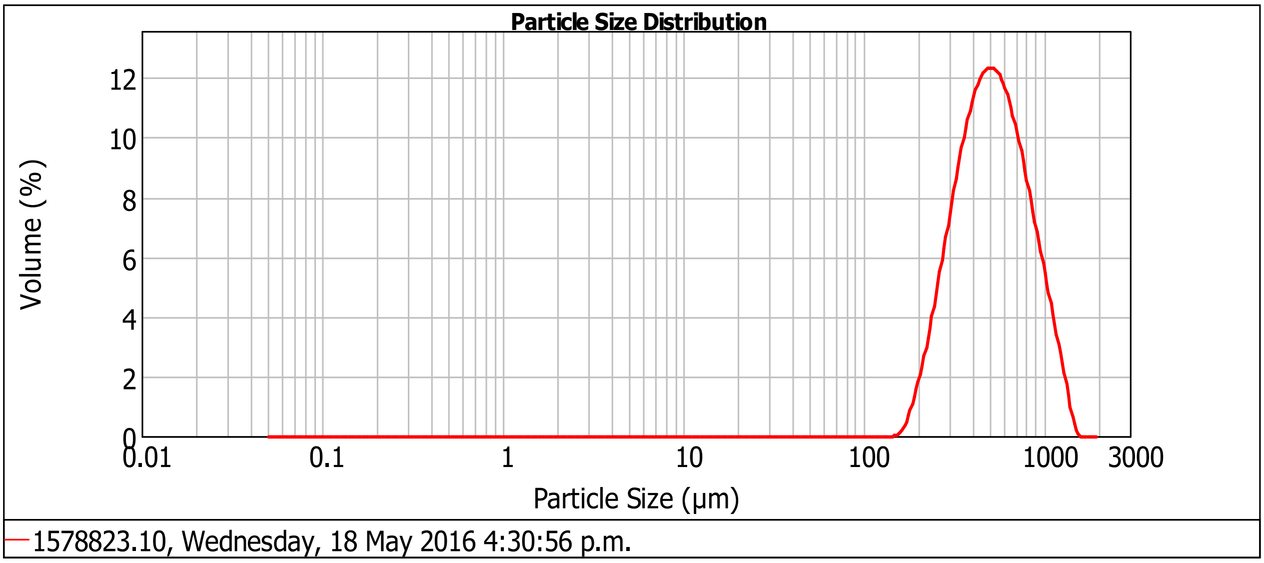
Specific Surface Area:
0.0129 m²/g

Surface Weighted Mean D[3,2]:
464.788 um

Vol. Weighted Mean D[4,3]:
568.054 um

Standard Deviation
258.201 um

d(0.1): **282.648** **um** **d(0.5):** **513.233** **um** **d(0.9):** **941.694** **um**



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	0.00	44.000	0.00	149.000	0.00	500.000	47.89	1680.000	100.00
0.060	0.00	3.900	0.00	53.000	0.00	177.000	0.21	590.000	61.11	2000.000	100.00
0.120	0.00	7.800	0.00	63.000	0.00	210.000	1.76	710.000	74.58		
0.240	0.00	10.000	0.00	74.000	0.00	250.000	5.58	840.000	84.61		
0.490	0.00	15.600	0.00	88.000	0.00	300.000	12.70	1000.000	92.37		
0.700	0.00	31.000	0.00	105.000	0.00	350.000	21.31	1190.000	97.42		
0.980	0.00	37.000	0.00	125.000	0.00	420.000	34.10	1410.000	99.83		

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
1578823.11

SOP Name:
Sediment

Measured:
Thursday, 19 May 2016 10:54:50 a.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Thursday, 19 May 2016 10:54:52 a.m.

Sample bulk lot ref:
2016084/11

Result Source:
Measurement

Particle Name:
Sediment

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Enhanced

Particle RI:
1.500

Absorption:
0.2

Size range:
0.020 to 2000.000 um

Obscuration:
13.15 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.566 %

Result Emulation:
Off

Concentration:
0.4583 %Vol

Span :
1.336

Uniformity:
0.418

Result units:
Volume

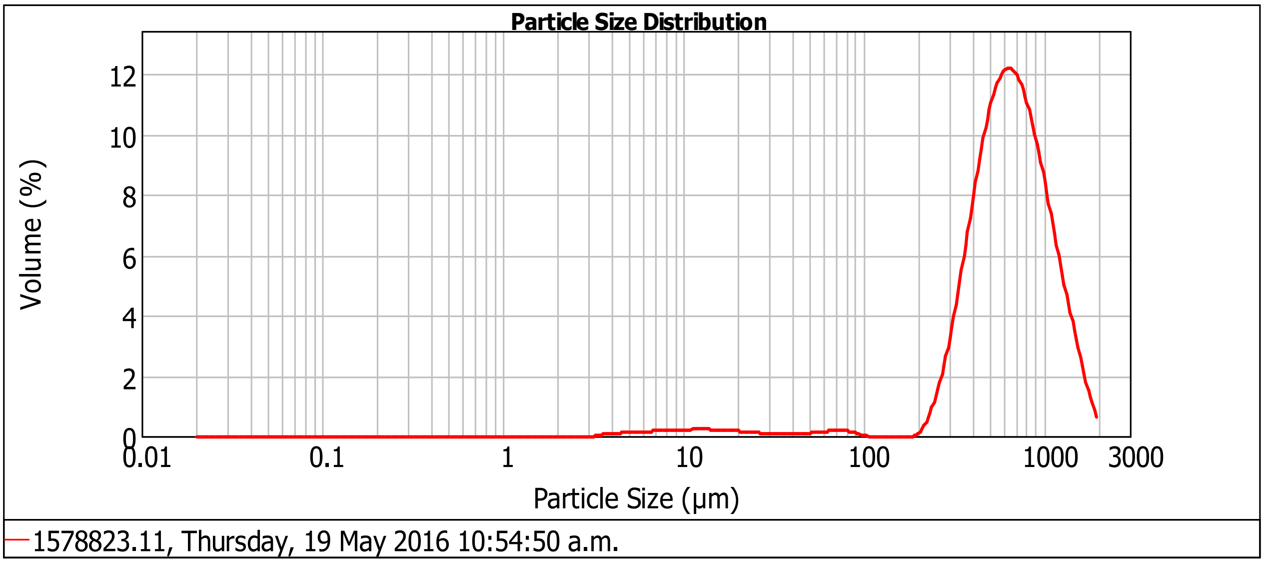
Specific Surface Area:
0.0255 m²/g

Surface Weighted Mean D[3,2]:
235.629 um

Vol. Weighted Mean D[4,3]:
711.266 um

Standard Deviation
354.533 um

d(0.1): 341.801 um **d(0.5): 645.893 um** **d(0.9): 1204.965 um**



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	0.00	44.000	2.46	149.000	3.18	500.000	30.24	1680.000	98.61
0.060	0.00	3.900	0.06	53.000	2.58	177.000	3.18	590.000	42.78	2000.000	100.00
0.120	0.00	7.800	0.68	63.000	2.74	210.000	3.20	710.000	57.52		
0.240	0.00	10.000	1.01	74.000	2.92	250.000	3.95	840.000	70.07		
0.490	0.00	15.600	1.64	88.000	3.12	300.000	6.49	1000.000	81.09		
0.700	0.00	31.000	2.31	105.000	3.18	350.000	10.82	1190.000	89.50		
0.980	0.00	37.000	2.39	125.000	3.18	420.000	19.15	1410.000	95.14		

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name: 1578823.12

SOP Name:

Measured: Thursday, 19 May 2016 11:05:42 a.m.

Sample Source & type:

Measured by: rodgers

Analysed: Thursday, 19 May 2016 11:05:43 a.m.

Sample bulk lot ref: 2016084/12

Result Source: Measurement

Particle Name: Sediment

Accessory Name: Hydro 2000G (A)

Analysis model: General purpose

Sensitivity: Normal

Particle RI: 1.500

Absorption: 0.2

Size range: 0.050 to 2000.000 um

Obscuration: 12.82 %

Dispersant Name: Water

Dispersant RI: 1.330

Weighted Residual: 0.547 %

Result Emulation: Off

Concentration: 0.8829 %Vol

Span : 1.371

Uniformity: 0.424

Result units: Volume

Specific Surface Area: 0.0131 m²/g

Surface Weighted Mean D[3,2]: 456.590 um

Vol. Weighted Mean D[4,3]: 703.268 um

Standard Deviation 347.045 um

d(0.1): 336.765 um **d(0.5):** 627.155 um **d(0.9):** 1196.701 um

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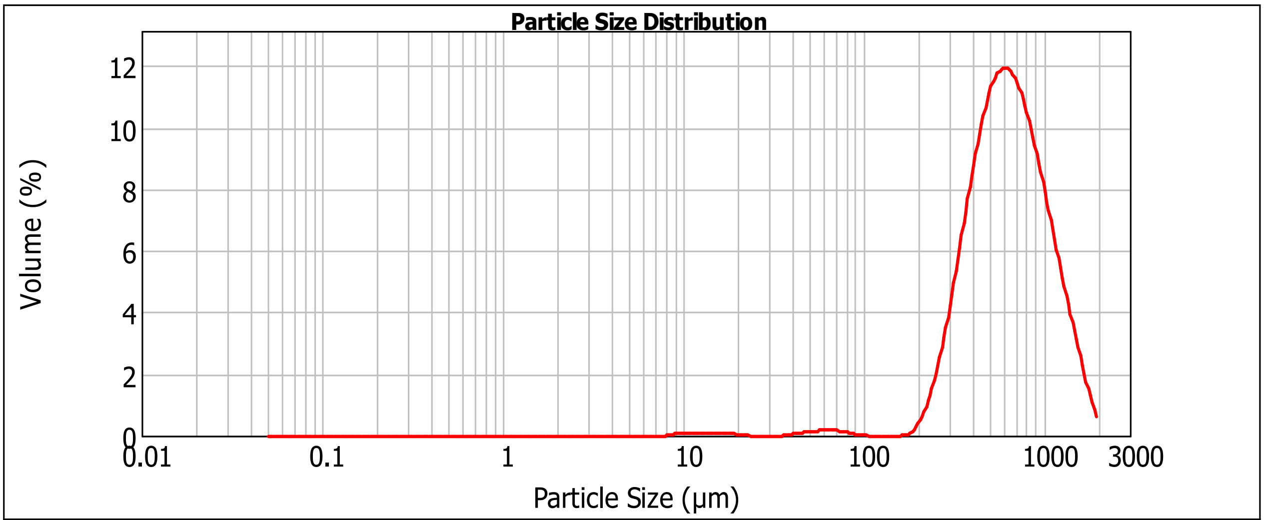

Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	0.00	44.000	0.49	149.000	1.15	500.000	32.61	1680.000	98.61
0.060	0.00	3.900	0.00	53.000	0.63	177.000	1.15	590.000	45.22	2000.000	100.00
0.120	0.00	7.800	0.00	63.000	0.82	210.000	1.41	710.000	59.55		
0.240	0.00	10.000	0.08	74.000	1.00	250.000	2.74	840.000	71.47		
0.490	0.00	15.600	0.31	88.000	1.12	300.000	6.24	1000.000	81.84		
0.700	0.00	31.000	0.44	105.000	1.15	350.000	11.55	1190.000	89.78		
0.980	0.00	37.000	0.44	125.000	1.15	420.000	20.92	1410.000	95.21		

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
1578823.13

SOP Name:

Measured:
Thursday, 19 May 2016 11:10:11 a.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Thursday, 19 May 2016 11:10:13 a.m.

Sample bulk lot ref:
2016084/13

Result Source:
Measurement

Particle Name:
Sediment

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.500

Absorption:
0.2

Size range:
0.050 to 2000.000 um

Obscuration:
13.52 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.478 %

Result Emulation:
Off

Concentration:
0.7557 %Vol

Span :
1.330

Uniformity:
0.416

Result units:
Volume

Specific Surface Area:
0.0162 m²/g

Surface Weighted Mean D[3,2]:
370.921 um

Vol. Weighted Mean D[4,3]:
669.388 um

Standard Deviation
325.739 um

d(0.1): 325.265 um **d(0.5):** 603.555 um **d(0.9):** 1128.137 um

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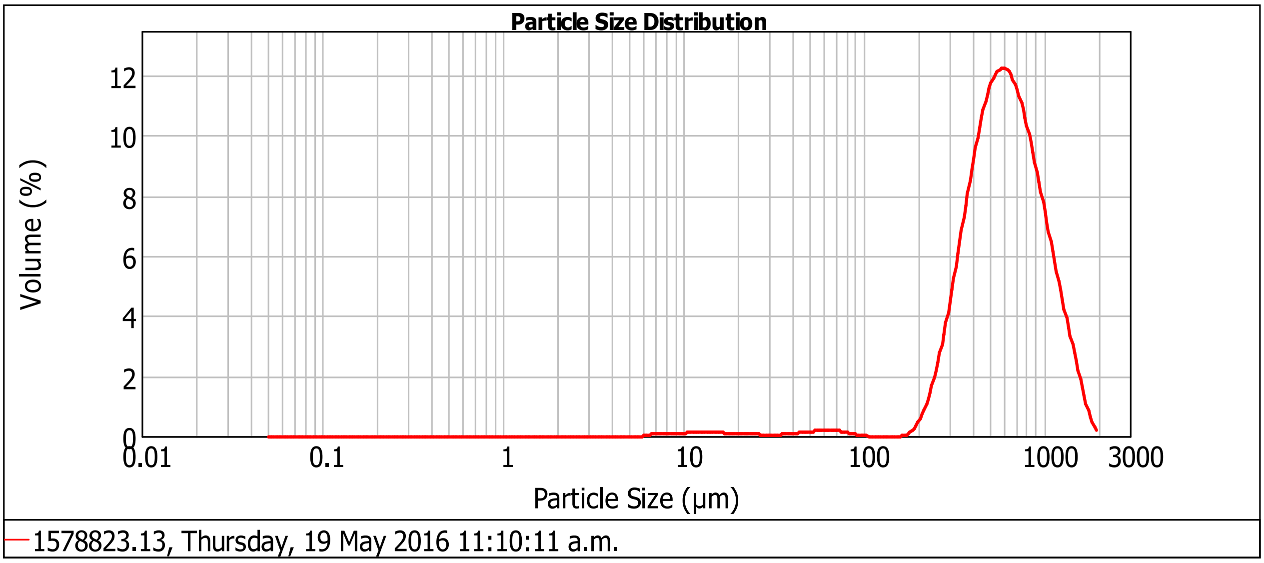

Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	0.00	44.000	1.09	149.000	1.82	500.000	35.11	1680.000	99.38
0.060	0.00	3.900	0.00	53.000	1.26	177.000	1.82	590.000	48.17	2000.000	100.00
0.120	0.00	7.800	0.11	63.000	1.46	210.000	2.14	710.000	62.77		
0.240	0.00	10.000	0.27	74.000	1.65	250.000	3.60	840.000	74.63		
0.490	0.00	15.600	0.61	88.000	1.79	300.000	7.36	1000.000	84.62		
0.700	0.00	31.000	0.93	105.000	1.82	350.000	12.99	1190.000	91.98		
0.980	0.00	37.000	0.98	125.000	1.82	420.000	22.88	1410.000	96.75		

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
1578823.14

SOP Name:

Measured:
Thursday, 19 May 2016 11:14:36 a.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Thursday, 19 May 2016 11:14:38 a.m.

Sample bulk lot ref:
2016084/14

Result Source:
Measurement

Particle Name:
Sediment

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.500

Absorption:
0.2

Size range:
0.050 to 2000.000 um

Obscuration:
17.73 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.358 %

Result Emulation:
Off

Concentration:
0.1548 %Vol

Span :
1.767

Uniformity:
0.484

Result units:
Volume

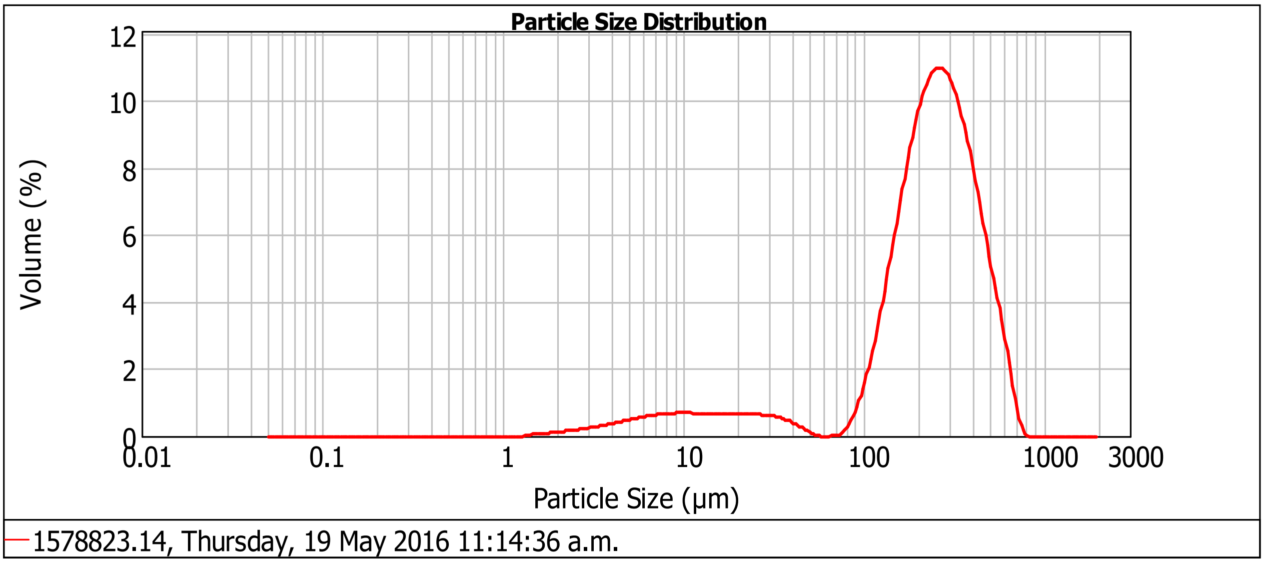
Specific Surface Area:
0.103 m²/g

Surface Weighted Mean D[3,2]:
58.320 um

Vol. Weighted Mean D[4,3]:
260.070 um

Standard Deviation
150.393 um

d(0.1): 35.054 um **d(0.5):** 244.077 um **d(0.9):** 466.285 um



Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %	Size (µm)	Vol Under %
0.050	0.00	2.000	0.21	44.000	10.65	149.000	21.21	500.000	92.64	1680.000	100.00
0.060	0.00	3.900	1.18	53.000	10.86	177.000	29.30	590.000	97.30	2000.000	100.00
0.120	0.00	7.800	3.57	63.000	10.86	210.000	39.63	710.000	99.84		
0.240	0.00	10.000	4.68	74.000	10.87	250.000	51.71	840.000	100.00		
0.490	0.00	15.600	6.65	88.000	11.16	300.000	64.74	1000.000	100.00		
0.700	0.00	31.000	9.54	105.000	12.51	350.000	75.02	1190.000	100.00		
0.980	0.00	37.000	10.18	125.000	15.63	420.000	85.29	1410.000	100.00		

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name: 1578823.15
SOP Name:
Measured: Thursday, 19 May 2016 11:19:06 a.m.

Sample Source & type:
Measured by: rodgers
Analysed: Thursday, 19 May 2016 11:19:08 a.m.

Sample bulk lot ref: 2016084/15
Result Source: Measurement

Particle Name: Sediment
Accessory Name: Hydro 2000G (A)
Analysis model: General purpose
Sensitivity: Normal

Particle RI: 1.500
Absorption: 0.2
Size range: 0.050 to 2000.000 um
Obscuration: 12.24 %

Dispersant Name: Water
Dispersant RI: 1.330
Weighted Residual: 0.579 %
Result Emulation: Off

Concentration: 0.5384 %Vol
Span : 1.338
Uniformity: 0.43
Result units: Volume

Specific Surface Area: 0.0204 m²/g
Surface Weighted Mean D[3,2]: 293.653 um
Vol. Weighted Mean D[4,3]: 495.997 um
Standard Deviation 261.343 um

d(0.1): 241.464 um **d(0.5):** 438.561 um **d(0.9):** 828.058 um

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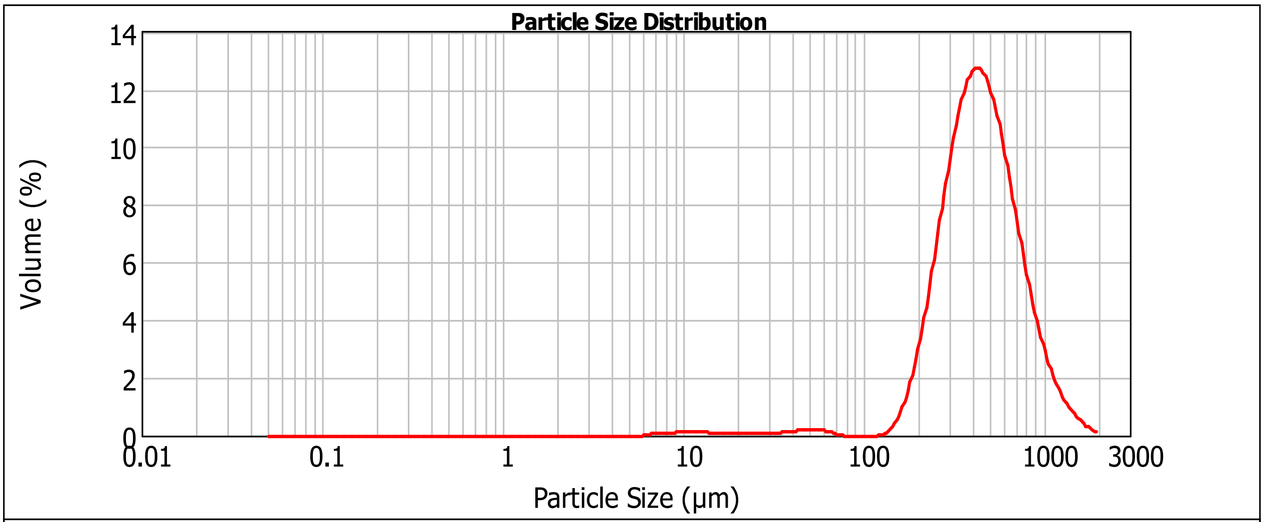

Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	0.00	44.000	1.29	149.000	2.00	500.000	60.75	1680.000	99.74
0.060	0.00	3.900	0.00	53.000	1.53	177.000	3.02	590.000	72.95	2000.000	100.00
0.120	0.00	7.800	0.12	63.000	1.74	210.000	5.78	710.000	83.68		
0.240	0.00	10.000	0.30	74.000	1.84	250.000	11.38	840.000	90.47		
0.490	0.00	15.600	0.64	88.000	1.84	300.000	20.87	1000.000	94.98		
0.700	0.00	31.000	0.99	105.000	1.84	350.000	31.62	1190.000	97.61		
0.980	0.00	37.000	1.12	125.000	1.84	420.000	46.38	1410.000	99.01		

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
1578823.16

SOP Name:

Measured:
Thursday, 19 May 2016 11:23:36 a.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Thursday, 19 May 2016 11:23:38 a.m.

Sample bulk lot ref:
2016084/16

Result Source:
Measurement

Particle Name:
Sediment

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.500

Absorption:
0.2

Size range:
0.050 to 2000.000 um

Obscuration:
16.54 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.324 %

Result Emulation:
Off

Concentration:
0.1483 %Vol

Span :
1.820

Uniformity:
0.504

Result units:
Volume

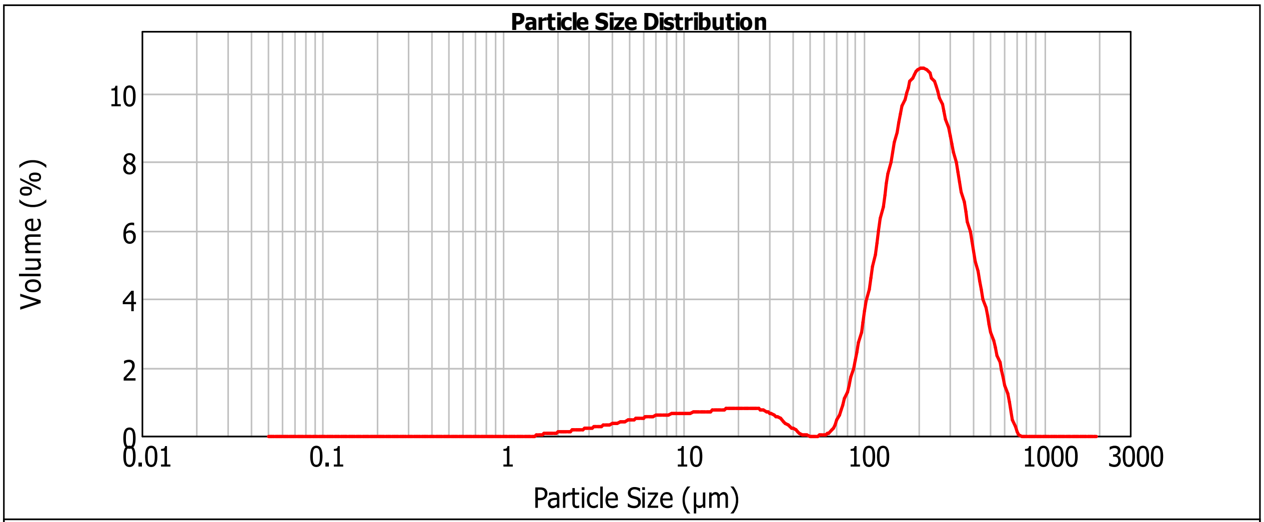
Specific Surface Area:
0.0998 m²/g

Surface Weighted Mean D[3,2]:
60.102 um

Vol. Weighted Mean D[4,3]:
220.858 um

Standard Deviation
132.261 um

d(0.1): 33.480 um **d(0.5): 202.248 um** **d(0.9): 401.599 um**



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	0.10	44.000	10.56	149.000	30.17	500.000	96.22	1680.000	100.00
0.060	0.00	3.900	0.97	53.000	10.57	177.000	40.83	590.000	98.92	2000.000	100.00
0.120	0.00	7.800	3.16	63.000	10.58	210.000	52.65	710.000	100.00		
0.240	0.00	10.000	4.19	74.000	10.84	250.000	64.75	840.000	100.00		
0.490	0.00	15.600	6.22	88.000	12.23	300.000	76.23	1000.000	100.00		
0.700	0.00	31.000	9.70	105.000	15.63	350.000	84.30	1190.000	100.00		
0.980	0.00	37.000	10.31	125.000	21.52	420.000	91.55	1410.000	100.00		

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
1578823.17

SOP Name:

Measured:
Thursday, 19 May 2016 11:28:16 a.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Thursday, 19 May 2016 11:28:18 a.m.

Sample bulk lot ref:
2016084/17

Result Source:
Measurement

Particle Name:
Sediment

Accessory Name:
Hydro 2000G (A)

Analysis model:
General purpose

Sensitivity:
Normal

Particle RI:
1.500

Absorption:
0.2

Size range:
0.050 to 2000.000 um

Obscuration:
17.91 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.322 %

Result Emulation:
Off

Concentration:
0.0998 %Vol

Span :
2.766

Uniformity:
0.831

Result units:
Volume

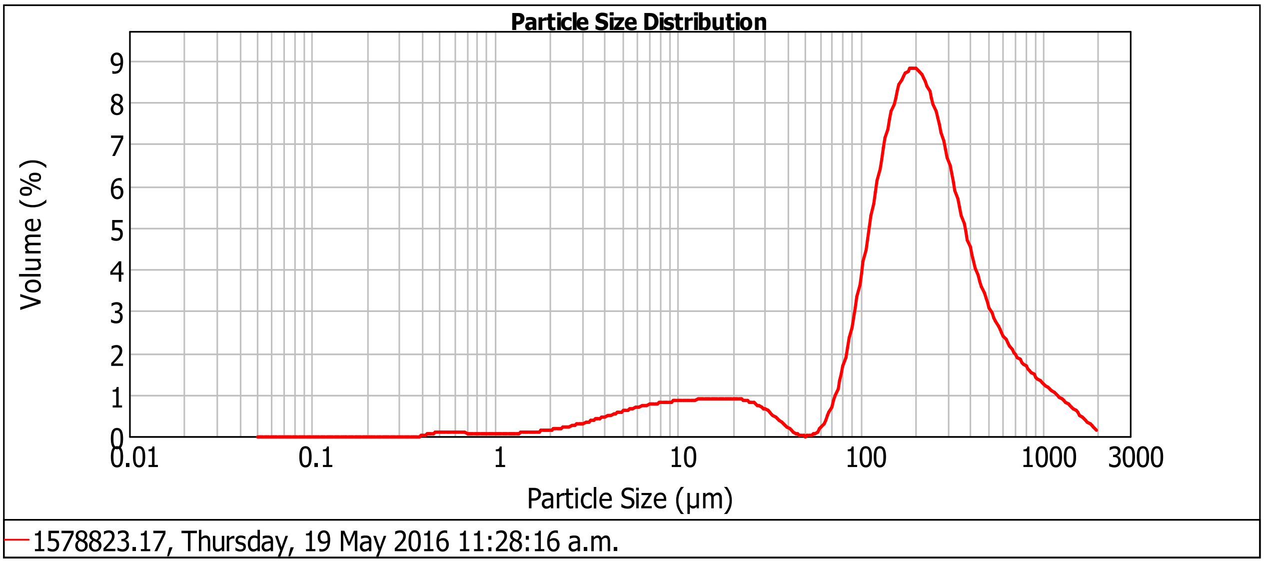
Specific Surface Area:
0.175 m²/g

Surface Weighted Mean D[3,2]:
34.326 um

Vol. Weighted Mean D[4,3]:
272.203 um

Standard Deviation
269.3 um

d(0.1): **19.024** **um** **d(0.5):** **199.216** **um** **d(0.9):** **570.033** **um**



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	0.85	44.000	13.41	149.000	33.81	500.000	87.53	1680.000	99.68
0.060	0.00	3.900	2.08	53.000	13.43	177.000	43.19	590.000	90.58	2000.000	100.00
0.120	0.00	7.800	4.97	63.000	13.54	210.000	53.04	710.000	93.25		
0.240	0.00	10.000	6.30	74.000	14.17	250.000	62.68	840.000	95.19		
0.490	0.08	15.600	8.83	88.000	16.04	300.000	71.51	1000.000	96.81		
0.700	0.27	31.000	12.60	105.000	19.81	350.000	77.66	1190.000	98.09		
0.980	0.43	37.000	13.17	125.000	25.74	420.000	83.38	1410.000	99.03		

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MASTERSIZER 2000

Result Analysis Report

Sample Name: 1578823.18

SOP Name:

Measured: Thursday, 19 May 2016 11:33:13 a.m.

Sample Source & type:

Measured by: rodgers

Analysed: Thursday, 19 May 2016 11:33:15 a.m.

Sample bulk lot ref: 2016084/18

Result Source: Measurement

Particle Name: Sediment

Accessory Name: Hydro 2000G (A)

Analysis model: General purpose

Sensitivity: Normal

Particle RI: 1.500

Absorption: 0.2

Size range: 0.050 to 2000.000 um

Obscuration: 18.67 %

Dispersant Name: Water

Dispersant RI: 1.330

Weighted Residual: 0.331 %

Result Emulation: Off

Concentration: 0.5671 %Vol

Span : 1.194

Uniformity: 0.377

Result units: Volume

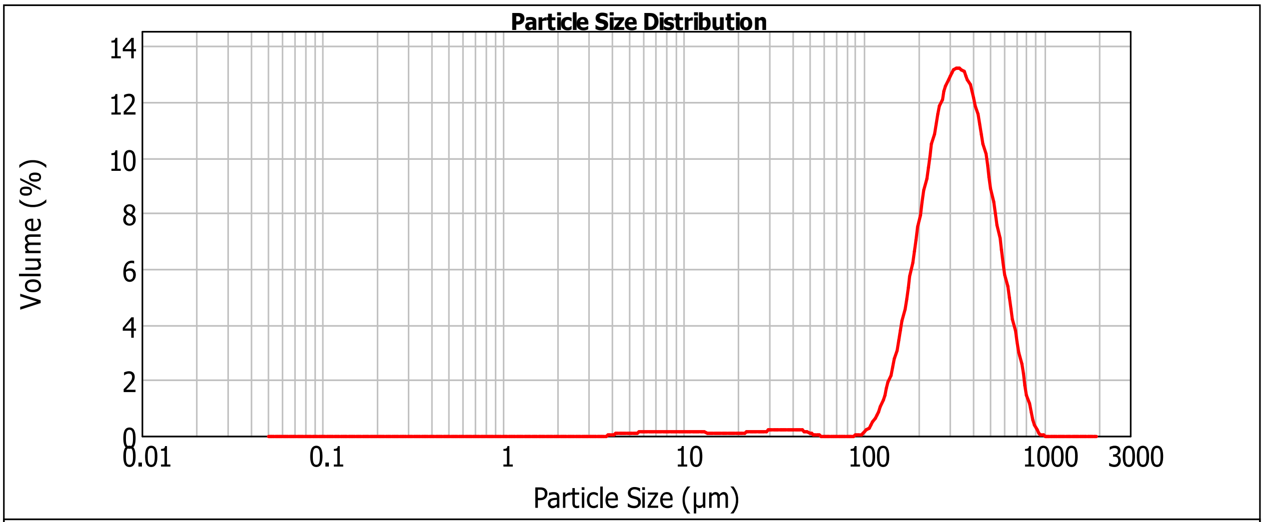
Specific Surface Area: 0.0305 m²/g

Surface Weighted Mean D[3,2]: 196.500 um

Vol. Weighted Mean D[4,3]: 351.329 um

Standard Deviation 156.885 um

d(0.1): 179.187 um **d(0.5):** 326.989 um **d(0.9):** 569.467 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	0.00	44.000	2.14	149.000	5.11	500.000	83.08	1680.000	100.00
0.060	0.00	3.900	0.00	53.000	2.32	177.000	9.56	590.000	91.55	2000.000	100.00
0.120	0.00	7.800	0.49	63.000	2.32	210.000	17.09	710.000	97.43		
0.240	0.00	10.000	0.73	74.000	2.32	250.000	28.15	840.000	99.73		
0.490	0.00	15.600	1.09	88.000	2.32	300.000	42.60	1000.000	100.00		
0.700	0.00	31.000	1.67	105.000	2.38	350.000	55.89	1190.000	100.00		
0.980	0.00	37.000	1.91	125.000	3.02	420.000	70.97	1410.000	100.00		

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
1578823.19

SOP Name:

Measured:
Thursday, 19 May 2016 11:38:41 a.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Thursday, 19 May 2016 11:38:43 a.m.

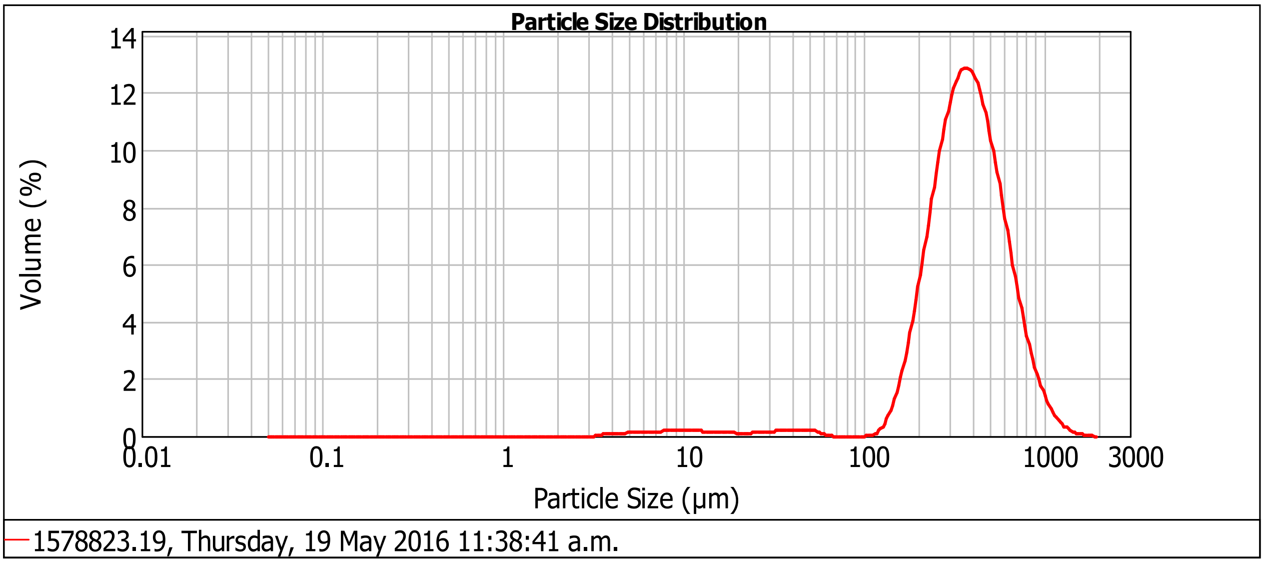
Sample bulk lot ref:
2016084/19

Result Source:
Measurement

Particle Name: Sediment	**Accessory Name:** Hydro 2000G (A)	**Analysis model:** General purpose	**Sensitivity:** Normal
Particle RI: 1.500	**Absorption:** 0.2	**Size range:** 0.050 to 2000.000 um	**Obscuration:** 16.54 %
Dispersant Name: Water	**Dispersant RI:** 1.330	**Weighted Residual:** 0.374 %	**Result Emulation:** Off

Concentration: 0.4830 %Vol	**Span :** 1.284	**Uniformity:** 0.414	**Result units:** Volume
Specific Surface Area: 0.0312 m²/g	**Surface Weighted Mean D[3,2]:** 192.288 um	**Vol. Weighted Mean D[4,3]:** 412.727 um	**Standard Deviation** 208.666 um

d(0.1): 203.166 um **d(0.5):** 373.485 um **d(0.9):** 682.542 um



Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %	Size (μm)	Vol Under %
0.050	0.00	2.000	0.00	44.000	2.48	149.000	3.74	500.000	73.14	1680.000	99.98
0.060	0.00	3.900	0.06	53.000	2.75	177.000	6.18	590.000	83.36	2000.000	100.00
0.120	0.00	7.800	0.65	63.000	2.88	210.000	11.22	710.000	91.43		
0.240	0.00	10.000	0.95	74.000	2.88	250.000	19.71	840.000	95.89		
0.490	0.00	15.600	1.45	88.000	2.88	300.000	32.10	1000.000	98.37		
0.700	0.00	31.000	2.01	105.000	2.88	350.000	44.53	1190.000	99.49		
0.980	0.00	37.000	2.23	125.000	2.95	420.000	59.80	1410.000	99.89		

Operator notes:

APPENDIX C1: Summary Chemical database for sectioned vibracore samples
collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V 1	V 1	V 1	V 1	V 1A	V 1A	V 1A	V 1A	V 1A	V 2	V 2	V 2	V 2
Sample Type: Sediment	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B
Sample Name:	27/02/16	27/02/16	27/02/16	27/02/16	27/02/16	27/02/16	27/02/16	27/02/16	27/02/16	28/02/16	28/02/16	28/02/16	28/02/16
Lab Number:	1545303.1	1545303.3	1545303.4	1545303.5	1545303.7	1545303.8	1545303.1	1545303.11	1545303.13	1545223.1	1545223.2	1545223.4	1545223.5
Dry Matter (g/100g as rcvd)	79	-	79	-	80	-	83	-	-	86	-	85	-
Total Organic Carbon (g/100g dry wt)	-	< 0.13	-	< 0.13	-	< 0.05	-	< 0.05	< 0.13	-	< 0.05	-	< 0.05
Antifouling cobiocides in sediment samples by LCMSMS													
Diuron	< 0.010	-	< 0.010	-	< 0.010	-	< 0.010	-	-	< 0.010	-	< 0.010	-
Irgarol	< 0.010	-	< 0.010	-	< 0.010	-	< 0.010	-	-	< 0.010	-	< 0.010	-
Isoproturon	< 0.010	-	< 0.010	-	< 0.010	-	< 0.010	-	-	< 0.010	-	< 0.010	-
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg													
Total Recoverable Arsenic	-	3.4	-	3.5	-	2.2	-	2.2	2.5	-	2.4	-	2.2
Total Recoverable Cadmium	-	< 0.010	-	0.011	-	< 0.010	-	< 0.010	0.013	-	< 0.010	-	< 0.010
Total Recoverable Chromium	-	8.9	-	11.4	-	6.9	-	7.2	5.9	-	7.5	-	18.2
Total Recoverable Copper	-	0.5	-	0.6	-	0.7	-	0.7	0.4	-	0.4	-	0.5
Total Recoverable Lead	-	1.12	-	1.4	-	1.07	-	1.56	0.81	-	0.91	-	1.43
Total Recoverable Mercury	-	< 0.010	-	< 0.010	-	< 0.010	-	< 0.010	< 0.010	-	< 0.010	-	< 0.010
Total Recoverable Nickel	-	1.9	-	2.5	-	1.6	-	1.8	1.9	-	2.1	-	8.7
Total Recoverable Zinc	-	9.1	-	11.7	-	8.1	-	8.5	5.7	-	9.3	-	6.2
Polycyclic Aromatic Hydrocarbons Screening in Soil													
Acenaphthene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Acenaphthylene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Anthracene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Benzo[a]anthracene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Benzo[a]pyrene (BAP)	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Benzo[g,h,i]perylene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Benzo[k]fluoranthene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Chrysene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Dibenzo[a,h]anthracene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V 1	V 1	V 1	V 1	V 1A	V 1A	V 1A	V 1A	V 1A	V 2	V 2	V 2	V 2
Sample Type: Sediment	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B
Fluoranthene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Fluorene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Indeno(1,2,3-c,d)pyrene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Naphthalene	< 0.14	-	< 0.14	-	< 0.14	-	< 0.13	-	-	< 0.13	-	< 0.13	-
Phenanthrene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Pyrene	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-	< 0.03	-	< 0.03	-
Haloethers in SVOC Soil Samples by GC-MS													
Bis(2-chloroethoxy) methane	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Bis(2-chloroethyl)ether	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Bis(2-chloroisopropyl)ether	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
4-Bromophenyl phenyl ether	< 0.4	-	-	-	< 0.4	-	-	-	-	< 0.4	-	-	-
4-Chlorophenyl phenyl ether	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Nitrogen containing compounds in SVOC Soil Samples by GC-MS													
2,4-Dinitrotoluene	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
2,6-Dinitrotoluene	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
Nitrobenzene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
N-Nitrosodi-n-propylamine	< 0.7	-	-	-	< 0.7	-	-	-	-	< 0.7	-	-	-
N-Nitrosodiphenylamine + Diphenylamine	< 0.7	-	-	-	< 0.7	-	-	-	-	< 0.7	-	-	-
Organochlorine Pesticides in SVOC Soil Samples by GC-MS													
Aldrin	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
alpha-BHC	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
beta-BHC	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
delta-BHC	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
gamma-BHC (Lindane)	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
4,4'-DDD	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
4,4'-DDE	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
4,4'-DDT	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
Dieldrin	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-

Results as mg/kg dry wt unless stated otherwise

	V 1	V 1	V 1	V 1	V 1A	V 1A	V 1A	V 1A	V 1A	V 2	V 2	V 2	V 2
Sample Type: Sediment	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B
Endosulfan I	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
Endosulfan II	< 2	-	-	-	< 2	-	-	-	-	< 2	-	-	-
Endosulfan sulphate	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
Endrin	< 0.7	-	-	-	< 0.7	-	-	-	-	< 0.7	-	-	-
Endrin ketone	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
Heptachlor	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Heptachlor epoxide	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Hexachlorobenzene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Polycyclic Aromatic Hydrocarbons in SVOC Soil Samples by GC-MS													
Acenaphthene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Acenaphthylene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Anthracene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Benzo[a]anthracene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Benzo[a]pyrene (BAP)	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Benzo[g,h,i]perylene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Benzo[k]fluoranthene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
1&2-Chloronaphthalene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Chrysene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Dibenzo[a,h]anthracene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Fluoranthene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Fluorene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Indeno(1,2,3-c,d)pyrene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
2-Methylnaphthalene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Naphthalene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Phenanthrene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Pyrene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Phenols in SVOC Soil Samples by GC-MS													

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V 1	V 1	V 1	V 1	V 1A	V 1A	V 1A	V 1A	V 1A	V 2	V 2	V 2	V 2
Sample Type: Sediment	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B
4-Chloro-3-methylphenol	< 5	-	-	-	< 5	-	-	-	-	< 5	-	-	-
2-Chlorophenol	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
2,4-Dichlorophenol	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
2,4-Dimethylphenol	< 3	-	-	-	< 3	-	-	-	-	< 3	-	-	-
3 & 4-Methylphenol (m- + p-cresol)	< 3	-	-	-	< 3	-	-	-	-	< 3	-	-	-
2-Methylphenol (o-Cresol)	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
2-Nitrophenol	< 5	-	-	-	< 5	-	-	-	-	< 5	-	-	-
Pentachlorophenol (PCP)	< 30	-	-	-	< 30	-	-	-	-	< 30	-	-	-
Phenol	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
2,4,5-Trichlorophenol	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
2,4,6-Trichlorophenol	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
Plasticisers in SVOC Soil Samples by GC-MS													
Bis(2-ethylhexyl)phthalate	< 5	-	-	-	< 5	-	-	-	-	< 5	-	-	-
Butylbenzylphthalate	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
Di(2-ethylhexyl)adipate	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
Diethylphthalate	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
Dimethylphthalate	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
Di-n-butylphthalate	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
Di-n-octylphthalate	< 1.0	-	-	-	< 1.0	-	-	-	-	< 1.0	-	-	-
Other Halogenated compounds in SVOC Soil Samples by GC-MS													
1,2-Dichlorobenzene	< 0.7	-	-	-	< 0.7	-	-	-	-	< 0.7	-	-	-
1,3-Dichlorobenzene	< 0.7	-	-	-	< 0.7	-	-	-	-	< 0.7	-	-	-
1,4-Dichlorobenzene	< 0.7	-	-	-	< 0.7	-	-	-	-	< 0.7	-	-	-
Hexachlorobutadiene	< 0.7	-	-	-	< 0.7	-	-	-	-	< 0.7	-	-	-
Hexachloroethane	< 0.7	-	-	-	< 0.7	-	-	-	-	< 0.7	-	-	-
1,2,4-Trichlorobenzene	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Other compounds in SVOC Soil Samples by GC-MS													
Benzyl alcohol	< 10	-	-	-	< 10	-	-	-	-	< 10	-	-	-

APPENDIX C1: Summary Chemical database for sectioned vibracore samples
collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V 1	V 1	V 1	V 1	V 1A	V 1A	V 1A	V 1A	V 1A	V 2	V 2	V 2	V 2
Sample Type: Sediment	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B
Carbazole	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Dibenzofuran	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Isophorone	< 0.5	-	-	-	< 0.5	-	-	-	-	< 0.5	-	-	-
Tributyl Tin Trace in Soil samples by GCMS													
Dibutyltin (as Sn)	< 0.005	-	< 0.005	-	< 0.005	-	< 0.005	-	-	< 0.005	-	< 0.005	-
Monobutyltin (as Sn)	< 0.007	-	< 0.007	-	< 0.007	-	< 0.007	-	-	< 0.007	-	< 0.007	-
Tributyltin (as Sn)	< 0.004	-	< 0.004	-	< 0.004	-	< 0.004	-	-	< 0.004	-	0.004	-
Triphenyltin (as Sn)	< 0.003	-	< 0.003	-	< 0.003	-	< 0.003	-	-	< 0.003	-	< 0.003	-
Total Petroleum Hydrocarbons in Soil													
C7 - C9	< 9	-	< 9	-	< 9	-	< 8	-	-	< 8	-	< 8	-
C10 - C14	< 20	-	< 20	-	< 20	-	< 20	-	-	< 20	-	< 20	-
C15 - C36	< 40	-	< 40	-	< 40	-	< 40	-	-	< 40	-	< 40	-
Total hydrocarbons (C7 - C36)	< 70	-	< 70	-	< 70	-	< 70	-	-	< 70	-	< 70	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V 2	V3	V3	V3	V3	V3	V5	V5	V5	V5	V5	V6	V6
Sample Type: Sediment	1.0-1.7m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.4m A	0-0.5m A	0-0.5m B 2
Sample Name:	28/02/16	25/02/16	25/02/16	25/02/16	25/02/16	25/02/16	27/02/16	27/02/16	27/02/16	27/02/16	27/02/16	28/02/16	8/02/16
Lab Number:	1545223.7	1544110.37	1544110.38	1544110.4	1544110.41	1544110.43	1545303.16	1545303.17	1545303.19	1545303.2	1545303.22	1545237.1	1545237.2
Dry Matter (g/100g as rcvd)	-	73	-	71	-	-	85	-	84	-	-	82	-
Total Organic Carbon (g/100g dry wt)	0.05	-	0.25	-	0.6	< 0.13	-	< 0.13	-	< 0.13	< 0.13	-	< 0.13
Antifouling cobiocides in sediment samples by LCMSMS													
Diuron	-	< 0.010	-	< 0.010	-	-	< 0.010	-	< 0.010	-	-	< 0.010	-
Irgarol	-	< 0.010	-	< 0.010	-	-	< 0.010	-	< 0.010	-	-	< 0.010	-
Isoproturon	-	< 0.010	-	< 0.010	-	-	< 0.010	-	< 0.010	-	-	< 0.010	-
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg													
Total Recoverable Arsenic	2.6	-	5.3	-	5.5	2.3	-	2.4	-	2.2	2	-	2.3
Total Recoverable Cadmium	0.022	-	< 0.10	-	0.162	0.011	-	0.022	-	0.021	0.029	-	0.03
Total Recoverable Chromium	11.2	-	13.6	-	16.9	5.1	-	6.2	-	5.9	6.2	-	6.3
Total Recoverable Copper	0.5	-	1.3	-	1.7	0.3	-	0.6	-	0.4	0.4	-	0.5
Total Recoverable Lead	0.77	-	2.1	-	2.8	0.83	-	1.18	-	0.8	0.84	-	1.01
Total Recoverable Mercury	< 0.010	-	< 0.010	-	< 0.010	< 0.010	-	< 0.010	-	< 0.010	< 0.010	-	0.011
Total Recoverable Nickel	5.2	-	4.1	-	5.6	1.7	-	2.9	-	2.8	2.8	-	2.7
Total Recoverable Zinc	5.8	-	12.6	-	15.8	5.2	-	6.8	-	4.9	5.1	-	6.4
Polycyclic Aromatic Hydrocarbons Screening in Soil													
Acenaphthene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Acenaphthylene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Anthracene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Benzo[a]anthracene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Benzo[a]pyrene (BAP)	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Benzo[g,h,i]perylene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Benzo[k]fluoranthene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Chrysene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Dibenzo[a,h]anthracene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V 2	V3	V3	V3	V3	V3	V5	V5	V5	V5	V5	V6	V6
Sample Type: Sediment	1.0-1.7m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.4m A	0-0.5m A	0-0.5m B 2
Fluoranthene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Fluorene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Indeno(1,2,3-c,d)pyrene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Naphthalene	-	< 0.15	-	< 0.16	-	-	< 0.13	-	< 0.13	-	-	< 0.14	-
Phenanthrene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Pyrene	-	< 0.03	-	< 0.04	-	-	< 0.03	-	< 0.03	-	-	< 0.03	-
Haloethers in SVOC Soil Samples by GC-MS													
Bis(2-chloroethoxy) methane	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Bis(2-chloroethyl)ether	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Bis(2-chloroisopropyl)ether	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
4-Bromophenyl phenyl ether	-	< 0.4	-	-	-	-	< 0.4	-	-	-	-	< 0.4	-
4-Chlorophenyl phenyl ether	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Nitrogen containing compounds in SVOC Soil Samples by GC-MS													
2,4-Dinitrotoluene	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
2,6-Dinitrotoluene	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
Nitrobenzene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
N-Nitrosodi-n-propylamine	-	< 0.8	-	-	-	-	< 0.7	-	-	-	-	< 0.7	-
N-Nitrosodiphenylamine + Diphenylamine	-	< 0.8	-	-	-	-	< 0.7	-	-	-	-	< 0.7	-
Organochlorine Pesticides in SVOC Soil Samples by GC-MS													
Aldrin	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
alpha-BHC	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
beta-BHC	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
delta-BHC	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
gamma-BHC (Lindane)	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
4,4'-DDD	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
4,4'-DDE	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
4,4'-DDT	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
Dieldrin	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V 2	V3	V3	V3	V3	V3	V5	V5	V5	V5	V5	V6	V6
Sample Type: Sediment	1.0-1.7m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.4m A	0-0.5m A	0-0.5m B 2
Endosulfan I	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
Endosulfan II	-	< 2	-	-	-	-	< 2	-	-	-	-	< 2	-
Endosulfan sulphate	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
Endrin	-	< 0.8	-	-	-	-	< 0.7	-	-	-	-	< 0.7	-
Endrin ketone	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
Heptachlor	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Heptachlor epoxide	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Hexachlorobenzene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Polycyclic Aromatic Hydrocarbons in SVOC Soil Samples by GC-MS													
Acenaphthene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Acenaphthylene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Anthracene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Benzo[a]anthracene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Benzo[a]pyrene (BAP)	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Benzo[g,h,i]perylene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Benzo[k]fluoranthene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
1&2-Chloronaphthalene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Chrysene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Dibenzo[a,h]anthracene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Fluoranthene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Fluorene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Indeno(1,2,3-c,d)pyrene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
2-Methylnaphthalene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Naphthalene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Phenanthrene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Pyrene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Phenols in SVOC Soil Samples by GC-MS													

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V 2	V3	V3	V3	V3	V3	V5	V5	V5	V5	V5	V6	V6
Sample Type: Sediment	1.0-1.7m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.4m A	0-0.5m A	0-0.5m B 2
4-Chloro-3-methylphenol	-	< 5	-	-	-	-	< 5	-	-	-	-	< 5	-
2-Chlorophenol	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
2,4-Dichlorophenol	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
2,4-Dimethylphenol	-	< 3	-	-	-	-	< 3	-	-	-	-	< 3	-
3 & 4-Methylphenol (m- + p-cresol)	-	< 3	-	-	-	-	< 3	-	-	-	-	< 3	-
2-Methylphenol (o-Cresol)	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
2-Nitrophenol	-	< 5	-	-	-	-	< 5	-	-	-	-	< 5	-
Pentachlorophenol (PCP)	-	< 30	-	-	-	-	< 30	-	-	-	-	< 30	-
Phenol	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
2,4,5-Trichlorophenol	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
2,4,6-Trichlorophenol	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
Plasticisers in SVOC Soil Samples by GC-MS													
Bis(2-ethylhexyl)phthalate	-	< 5	-	-	-	-	< 5	-	-	-	-	< 5	-
Butylbenzylphthalate	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
Di(2-ethylhexyl)adipate	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
Diethylphthalate	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
Dimethylphthalate	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
Di-n-butylphthalate	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
Di-n-octylphthalate	-	< 1.0	-	-	-	-	< 1.0	-	-	-	-	< 1.0	-
Other Halogenated compounds in SVOC Soil Samples by GC-MS													
1,2-Dichlorobenzene	-	< 0.8	-	-	-	-	< 0.7	-	-	-	-	< 0.7	-
1,3-Dichlorobenzene	-	< 0.8	-	-	-	-	< 0.7	-	-	-	-	< 0.7	-
1,4-Dichlorobenzene	-	< 0.8	-	-	-	-	< 0.7	-	-	-	-	< 0.7	-
Hexachlorobutadiene	-	< 0.8	-	-	-	-	< 0.7	-	-	-	-	< 0.7	-
Hexachloroethane	-	< 0.8	-	-	-	-	< 0.7	-	-	-	-	< 0.7	-
1,2,4-Trichlorobenzene	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Other compounds in SVOC Soil Samples by GC-MS													
Benzyl alcohol	-	< 10	-	-	-	-	< 10	-	-	-	-	< 10	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V 2	V3	V3	V3	V3	V3	V5	V5	V5	V5	V5	V6	V6
Sample Type: Sediment	1.0-1.7m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.4m A	0-0.5m A	0-0.5m B 2
Carbazole	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Dibenzofuran	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Isophorone	-	< 0.5	-	-	-	-	< 0.5	-	-	-	-	< 0.5	-
Tributyl Tin Trace in Soil samples by GCMS													
Dibutyltin (as Sn)	-	< 0.005	-	< 0.005	-	-	< 0.005	-	< 0.005	-	-	< 0.005	-
Monobutyltin (as Sn)	-	< 0.007	-	< 0.007	-	-	< 0.007	-	< 0.007	-	-	< 0.007	-
Tributyltin (as Sn)	-	< 0.004	-	< 0.004	-	-	< 0.004	-	< 0.004	-	-	< 0.004	-
Triphenyltin (as Sn)	-	< 0.003	-	< 0.003	-	-	< 0.003	-	< 0.003	-	-	< 0.003	-
Total Petroleum Hydrocarbons in Soil													
C7 - C9	-	< 9	-	< 10	-	-	< 8	-	< 8	-	-	< 8	-
C10 - C14	-	< 20	-	< 20	-	-	< 20	-	< 20	-	-	< 20	-
C15 - C36	-	< 40	-	< 40	-	-	< 40	-	< 40	-	-	< 40	-
Total hydrocarbons (C7 - C36)	-	< 70	-	< 70	-	-	< 70	-	< 70	-	-	< 70	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V6	V6	V6	V7	V7	V8	V8	V8	V8	V8	V10	V10	V10
Sample Type: Sediment	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0.5-1.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A
Sample Name:	28/02/16	28/02/16	28/02/16	26/02/16	26/02/16	28/02/16	28/02/16	28/02/16	28/02/16	28/02/16	26/02/16	26/02/16	26/02/16
Lab Number:	1545237.4	1545237.5	1545237.7	1544819.1	1544819.4	1546141.1	1546141.2	1546141.4	1546141.5	1546141.7	1545199.1	1545199.2	1545199.4
Dry Matter (g/100g as rcvd)	80	-	-	81	85	-	79	-	81	-	89	-	84
Total Organic Carbon (g/100g dry wt)	-	0.18	0.23			0.14	-	0.11	-	0.12	-	< 0.13	-
Antifouling cobiocides in sediment samples by LCMSMS													
Diuron	< 0.010	-	-			-	< 0.010	-	< 0.010	-	< 0.010	-	< 0.010
Irgarol	< 0.010	-	-			-	< 0.010	-	< 0.010	-	< 0.010	-	< 0.010
Isoproturon	< 0.010	-	-			-	< 0.010	-	< 0.010	-	< 0.010	-	< 0.010
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg													
Total Recoverable Arsenic	-	5.3	6.6			3.2	-	3.9	-	3.8	-	2	-
Total Recoverable Cadmium	-	0.083	0.05			0.023	-	0.022	-	0.034	-	< 0.010	-
Total Recoverable Chromium	-	10	13.5			9.3	-	10.1	-	12.6	-	11.4	-
Total Recoverable Copper	-	1.4	1.7			0.9	-	0.8	-	0.8	-	0.5	-
Total Recoverable Lead	-	1.7	2.3			1.76	-	1.73	-	1.62	-	0.57	-
Total Recoverable Mercury	-	< 0.010	0.011			< 0.010	-	< 0.010	-	< 0.010	-	< 0.010	-
Total Recoverable Nickel	-	4.2	5.4			3	-	3	-	4.7	-	5.8	-
Total Recoverable Zinc	-	11	14.7			10.4	-	11.3	-	11.1	-	4.4	-
Polycyclic Aromatic Hydrocarbons Screening in Soil													
Acenaphthene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Acenaphthylene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Anthracene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Benzo[a]anthracene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Benzo[a]pyrene (BAP)	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Benzo[b]fluoranthene + Benzo[j]fluoranthene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Benzo[g,h,i]perylene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Benzo[k]fluoranthene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Chrysene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Dibenzo[a,h]anthracene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V6	V6	V6	V7	V7	V8	V8	V8	V8	V8	V10	V10	V10
Sample Type: Sediment	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0.5-1.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A
Fluoranthene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Fluorene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Indeno(1,2,3-c,d)pyrene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Naphthalene	< 0.14	-	-	< 0.14	< 0.13	-	< 0.14	-	< 0.14	-	< 0.12	-	< 0.13
Phenanthrene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Pyrene	< 0.03	-	-	< 0.03	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03
Haloethers in SVOC Soil Samples by GC-MS													
Bis(2-chloroethoxy) methane	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Bis(2-chloroethyl)ether	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Bis(2-chloroisopropyl)ether	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
4-Bromophenyl phenyl ether	-	-	-			-	< 0.4	-	-	-	< 0.3	-	-
4-Chlorophenyl phenyl ether	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Nitrogen containing compounds in SVOC Soil Samples by GC-MS													
2,4-Dinitrotoluene	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
2,6-Dinitrotoluene	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
Nitrobenzene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
N-Nitrosodi-n-propylamine	-	-	-			-	< 0.7	-	-	-	< 0.6	-	-
N-Nitrosodiphenylamine + Diphenylamine	-	-	-			-	< 0.7	-	-	-	< 0.6	-	-
Organochlorine Pesticides in SVOC Soil Samples by GC-MS													
Aldrin	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
alpha-BHC	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
beta-BHC	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
delta-BHC	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
gamma-BHC (Lindane)	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
4,4'-DDD	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
4,4'-DDE	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
4,4'-DDT	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
Dieldrin	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples
collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V6	V6	V6	V7	V7	V8	V8	V8	V8	V8	V10	V10	V10
Sample Type: Sediment	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0.5-1.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A
Endosulfan I	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
Endosulfan II	-	-	-			-	< 2	-	-	-	< 2	-	-
Endosulfan sulphate	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
Endrin	-	-	-			-	< 0.7	-	-	-	< 0.6	-	-
Endrin ketone	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
Heptachlor	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Heptachlor epoxide	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Hexachlorobenzene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Polycyclic Aromatic Hydrocarbons in SVOC Soil Samples by GC-MS													
Acenaphthene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Acenaphthylene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Anthracene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Benzo[a]anthracene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Benzo[a]pyrene (BAP)	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Benzo[g,h,i]perylene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Benzo[k]fluoranthene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
1&2-Chloronaphthalene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Chrysene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Dibenzo[a,h]anthracene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Fluoranthene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Fluorene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Indeno(1,2,3-c,d)pyrene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
2-Methylnaphthalene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Naphthalene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Phenanthrene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Pyrene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Phenols in SVOC Soil Samples by GC-MS													

APPENDIX C1: Summary Chemical database for sectioned vibracore samples
collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V6	V6	V6	V7	V7	V8	V8	V8	V8	V8	V10	V10	V10
Sample Type: Sediment	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0.5-1.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A
4-Chloro-3-methylphenol	-	-	-			-	< 5	-	-	-	< 5	-	-
2-Chlorophenol	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
2,4-Dichlorophenol	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
2,4-Dimethylphenol	-	-	-			-	< 3	-	-	-	< 3	-	-
3 & 4-Methylphenol (m- + p-cresol)	-	-	-			-	< 3	-	-	-	< 3	-	-
2-Methylphenol (o-Cresol)	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
2-Nitrophenol	-	-	-			-	< 5	-	-	-	< 5	-	-
Pentachlorophenol (PCP)	-	-	-			-	< 30	-	-	-	< 30	-	-
Phenol	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
2,4,5-Trichlorophenol	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
2,4,6-Trichlorophenol	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
Plasticisers in SVOC Soil Samples by GC-MS													
Bis(2-ethylhexyl)phthalate	-	-	-			-	< 5	-	-	-	< 5	-	-
Butylbenzylphthalate	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
Di(2-ethylhexyl)adipate	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
Diethylphthalate	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
Dimethylphthalate	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
Di-n-butylphthalate	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
Di-n-octylphthalate	-	-	-			-	< 1.0	-	-	-	< 1.0	-	-
Other Halogenated compounds in SVOC Soil Samples by GC-MS													
1,2-Dichlorobenzene	-	-	-			-	< 0.7	-	-	-	< 0.6	-	-
1,3-Dichlorobenzene	-	-	-			-	< 0.7	-	-	-	< 0.6	-	-
1,4-Dichlorobenzene	-	-	-			-	< 0.7	-	-	-	< 0.6	-	-
Hexachlorobutadiene	-	-	-			-	< 0.7	-	-	-	< 0.6	-	-
Hexachloroethane	-	-	-			-	< 0.7	-	-	-	< 0.6	-	-
1,2,4-Trichlorobenzene	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Other compounds in SVOC Soil Samples by GC-MS													
Benzyl alcohol	-	-	-			-	< 10	-	-	-	< 10	-	-

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V6	V6	V6	V7	V7	V8	V8	V8	V8	V8	V10	V10	V10
Sample Type: Sediment	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0.5-1.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A
Carbazole	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Dibenzofuran	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Isophorone	-	-	-			-	< 0.5	-	-	-	< 0.5	-	-
Tributyl Tin Trace in Soil samples by GCMS													
Dibutyltin (as Sn)	< 0.005	-	-	< 0.005	< 0.005	-	< 0.005	-	< 0.005	-	< 0.005	-	< 0.005
Monobutyltin (as Sn)	< 0.007	-	-	< 0.007	< 0.007	-	< 0.007	-	< 0.007	-	< 0.007	-	< 0.007
Tributyltin (as Sn)	< 0.004	-	-	< 0.004	< 0.004	-	< 0.004	-	< 0.004	-	< 0.004	-	< 0.004
Triphenyltin (as Sn)	< 0.003	-	-	< 0.003	< 0.003	-	< 0.003	-	< 0.003	-	< 0.003	-	< 0.003
Total Petroleum Hydrocarbons in Soil													
C7 - C9	< 9	-	-	< 8	< 8	-	< 8	-	< 8	-	< 8	-	< 8
C10 - C14	< 20	-	-	< 20	< 20	-	< 20	-	< 20	-	< 20	-	< 20
C15 - C36	< 40	-	-	< 40	< 40	-	< 40	-	< 40	-	< 40	-	< 40
Total hydrocarbons (C7 - C36)	< 70	-	-	< 70	< 70	-	< 70	-	< 70	-	< 70	-	< 70

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V10	V10	V12	V12	V12	V12	V12	V13	V13	V13	V13		V13
Sample Type: Sediment	0.5-1.0m B	1.0-1.6m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B 2	1.0-2.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-2.7m A
Sample Name:	26/02/16	26/02/16	26/02/16	26/02/16	26/02/16	6/02/16	26/02/16	25/02/16	25/02/16	25/02/16	25/02/16	25/02/16	25/02/16
Lab Number:	1545199.5	1545199.7	1545290.3	1545290.4	1545290.6	1545290.7	1545290.9	1544110.1	1544110.2	1544110.4	1544110.5	1544110.7	1544110.1
Dry Matter (g/100g as rcvd)	-	-	85	-	89	-	-	-	87	-	88	-	-
Total Organic Carbon (g/100g dry wt)	< 0.13	< 0.13	-	< 0.13	-	< 0.13	< 0.13	< 0.13	-	< 0.13	-	< 0.13	< 0.13
Antifouling cobiocides in sediment samples by LCMSMS													
Diuron	-	-	< 0.010	-	< 0.010	-	-	-	< 0.010	-	< 0.010	-	-
Irgarol	-	-	< 0.010	-	< 0.010	-	-	-	< 0.010	-	< 0.010	-	-
Isoproturon	-	-	< 0.010	-	< 0.010	-	-	-	< 0.010	-	< 0.010	-	-
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg													
Total Recoverable Arsenic	1.9	1.6	-	1.8	-	1.8	2.5	< 2	-	< 2	-	< 1.9	< 1.9
Total Recoverable Cadmium	< 0.010	0.012	-	< 0.010	-	< 0.010	0.029	< 0.010	-	< 0.010	-	0.01	< 0.010
Total Recoverable Chromium	4.1	7.4	-	3.7	-	3.2	7.6	3.9	-	3	-	4.3	7
Total Recoverable Copper	0.3	0.4	-	0.4	-	0.2	0.6	0.3	-	0.3	-	0.3	0.3
Total Recoverable Lead	0.57	0.75	-	0.57	-	0.5	1.09	0.6	-	0.52	-	0.62	0.52
Total Recoverable Mercury	0.018	0.01	-	< 0.010	-	< 0.010	< 0.010	< 0.010	-	< 0.010	-	< 0.010	< 0.010
Total Recoverable Nickel	1.8	3.3	-	1.6	-	2.1	3.5	1.9	-	2.5	-	2	2.8
Total Recoverable Zinc	4.1	7.4	-	4.4	-	4.2	8.9	4.4	-	3.8	-	4.5	4.7
Polycyclic Aromatic Hydrocarbons Screening in Soil													
Acenaphthene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Acenaphthylene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Anthracene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Benzo[a]anthracene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Benzo[a]pyrene (BAP)	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Benzo[g,h,i]perylene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Benzo[k]fluoranthene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Chrysene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Dibenzo[a,h]anthracene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples
collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V10	V10	V12	V12	V12	V12	V12	V13	V13	V13	V13		V13
Sample Type: Sediment	0.5-1.0m B	1.0-1.6m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B 2	1.0-2.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-2.7m A
Fluoranthene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Fluorene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Indeno(1,2,3-c,d)pyrene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Naphthalene	-	-	< 0.13	-	< 0.13	-	-	-	< 0.13	-	< 0.13	-	-
Phenanthrene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Pyrene	-	-	< 0.03	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-
Haloethers in SVOC Soil Samples by GC-MS													
Bis(2-chloroethoxy) methane	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Bis(2-chloroethyl)ether	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Bis(2-chloroisopropyl)ether	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
4-Bromophenyl phenyl ether	-	-	< 0.4	-	-	-	-	-	< 0.4	-	-	-	-
4-Chlorophenyl phenyl ether	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Nitrogen containing compounds in SVOC Soil Samples by GC-MS													
2,4-Dinitrotoluene	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
2,6-Dinitrotoluene	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
Nitrobenzene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
N-Nitrosodi-n-propylamine	-	-	< 0.7	-	-	-	-	-	< 0.7	-	-	-	-
N-Nitrosodiphenylamine + Diphenylamine	-	-	< 0.7	-	-	-	-	-	< 0.7	-	-	-	-
Organochlorine Pesticides in SVOC Soil Samples by GC-MS													
Aldrin	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
alpha-BHC	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
beta-BHC	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
delta-BHC	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
gamma-BHC (Lindane)	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
4,4'-DDD	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
4,4'-DDE	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
4,4'-DDT	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
Dieldrin	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V10	V10	V12	V12	V12	V12	V12	V13	V13	V13	V13		V13
Sample Type: Sediment	0.5-1.0m B	1.0-1.6m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B 2	1.0-2.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-2.7m A
Endosulfan I	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
Endosulfan II	-	-	< 2	-	-	-	-	-	< 2	-	-	-	-
Endosulfan sulphate	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
Endrin	-	-	< 0.7	-	-	-	-	-	< 0.7	-	-	-	-
Endrin ketone	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
Heptachlor	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Heptachlor epoxide	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Hexachlorobenzene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Polycyclic Aromatic Hydrocarbons in SVOC Soil Samples by GC-MS													
Acenaphthene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Acenaphthylene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Anthracene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Benzo[a]anthracene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Benzo[a]pyrene (BAP)	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Benzo[g,h,i]perylene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Benzo[k]fluoranthene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
1&2-Chloronaphthalene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Chrysene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Dibenzo[a,h]anthracene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Fluoranthene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Fluorene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Indeno(1,2,3-c,d)pyrene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
2-Methylnaphthalene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Naphthalene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Phenanthrene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Pyrene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Phenols in SVOC Soil Samples by GC-MS													

APPENDIX C1: Summary Chemical database for sectioned vibracore samples
collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V10	V10	V12	V12	V12	V12	V12	V13	V13	V13	V13		V13
Sample Type: Sediment	0.5-1.0m B	1.0-1.6m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B 2	1.0-2.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-2.7m A
4-Chloro-3-methylphenol	-	-	< 5	-	-	-	-	-	< 5	-	-	-	-
2-Chlorophenol	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
2,4-Dichlorophenol	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
2,4-Dimethylphenol	-	-	< 3	-	-	-	-	-	< 3	-	-	-	-
3 & 4-Methylphenol (m- + p-cresol)	-	-	< 3	-	-	-	-	-	< 3	-	-	-	-
2-Methylphenol (o-Cresol)	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
2-Nitrophenol	-	-	< 5	-	-	-	-	-	< 5	-	-	-	-
Pentachlorophenol (PCP)	-	-	< 30	-	-	-	-	-	< 30	-	-	-	-
Phenol	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
2,4,5-Trichlorophenol	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
2,4,6-Trichlorophenol	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
Plasticisers in SVOC Soil Samples by GC-MS													
Bis(2-ethylhexyl)phthalate	-	-	< 5	-	-	-	-	-	< 5	-	-	-	-
Butylbenzylphthalate	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
Di(2-ethylhexyl)adipate	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
Diethylphthalate	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
Dimethylphthalate	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
Di-n-butylphthalate	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
Di-n-octylphthalate	-	-	< 1.0	-	-	-	-	-	< 1.0	-	-	-	-
Other Halogenated compounds in SVOC Soil Samples by GC-MS													
1,2-Dichlorobenzene	-	-	< 0.7	-	-	-	-	-	< 0.7	-	-	-	-
1,3-Dichlorobenzene	-	-	< 0.7	-	-	-	-	-	< 0.7	-	-	-	-
1,4-Dichlorobenzene	-	-	< 0.7	-	-	-	-	-	< 0.7	-	-	-	-
Hexachlorobutadiene	-	-	< 0.7	-	-	-	-	-	< 0.7	-	-	-	-
Hexachloroethane	-	-	< 0.7	-	-	-	-	-	< 0.7	-	-	-	-
1,2,4-Trichlorobenzene	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Other compounds in SVOC Soil Samples by GC-MS													
Benzyl alcohol	-	-	< 10	-	-	-	-	-	< 10	-	-	-	-

APPENDIX C1: Summary Chemical database for sectioned vibracore samples
collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V10	V10	V12	V12	V12	V12	V12	V13	V13	V13	V13		V13
Sample Type: Sediment	0.5-1.0m B	1.0-1.6m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B 2	1.0-2.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-2.7m A
Carbazole	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Dibenzofuran	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Isophorone	-	-	< 0.5	-	-	-	-	-	< 0.5	-	-	-	-
Tributyl Tin Trace in Soil samples by GCMS													
Dibutyltin (as Sn)	-	-	< 0.005	-	< 0.005	-	-	-	< 0.005	-	< 0.005	-	-
Monobutyltin (as Sn)	-	-	< 0.007	-	< 0.007	-	-	-	< 0.007	-	< 0.007	-	-
Tributyltin (as Sn)	-	-	< 0.004	-	< 0.004	-	-	-	< 0.004	-	< 0.004	-	-
Triphenyltin (as Sn)	-	-	< 0.003	-	< 0.003	-	-	-	< 0.003	-	< 0.003	-	-
Total Petroleum Hydrocarbons in Soil													
C7 - C9	-	-	< 8	-	< 8	-	-	-	< 8	-	< 8	-	-
C10 - C14	-	-	< 20	-	< 20	-	-	-	< 20	-	< 20	-	-
C15 - C36	-	-	< 40	-	< 40	-	-	-	< 40	-	< 40	-	-
Total hydrocarbons (C7 - C36)	-	-	< 70	-	< 70	-	-	-	< 70	-	< 70	-	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples
collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V14	V14	V14	V14	V14	V14	V15	V15	V15	V15	V15	V15	V16
Sample Type: Sediment	0.0-0.5m B	0.0-0.5m A	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-3.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-3.0m A	0-0.5m A
Sample Name:	25/02/16	25/02/16	25/02/16	25/02/16	-eb-2016 12:0	25/02/16	25/02/16	25/02/16	25/02/16	25/02/16	25/02/16	25/02/16	23/02/16
Lab Number:	1544110.13	1544110.14	1544110.16	1544110.17	1544110.19	1544110.22	1544110.25	1544110.26	1544110.28	1544110.29	1544110.31	1544110.34	1543364.1
Dry Matter (g/100g as rcvd)	73	-	-	81	-	-	-	86	-	88	-	-	84
Total Organic Carbon (g/100g dry wt)	-	< 0.13	< 0.13	-	< 0.13	< 0.13	< 0.13	-	< 0.13	-	< 0.13	< 0.13	0.17
Antifouling cobiocides in sediment samples by LCMSMS													
Diuron	< 0.010	-	-	< 0.010	-	-	-	< 0.010	-	< 0.010	-	-	< 0.010
Irgarol	< 0.010	-	-	< 0.010	-	-	-	< 0.010	-	< 0.010	-	-	< 0.010
Isoproturon	< 0.010	-	-	< 0.010	-	-	-	< 0.010	-	< 0.010	-	-	< 0.010
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg													
Total Recoverable Arsenic	-	5	3	-	2.3	< 2	2.1	-	2.2	-	< 2	2	3.8
Total Recoverable Cadmium	-	0.024	0.014	-	0.081	0.025	0.015	-	0.014	-	< 0.010	< 0.010	< 0.02
Total Recoverable Chromium	-	8.8	5.4	-	7.1	8.8	4.4	-	4.3	-	3.6	4.2	8.5
Total Recoverable Copper	-	1.6	0.6	-	0.8	1.8	0.6	-	0.4	-	0.3	< 0.2	1.3
Total Recoverable Lead	-	1.76	0.96	-	1.05	1.11	1.12	-	0.9	-	0.53	0.49	1.61
Total Recoverable Mercury	-	< 0.010	< 0.010	-	< 0.010	< 0.010	< 0.010	-	< 0.010	-	< 0.010	< 0.010	0.02
Total Recoverable Nickel	-	5.2	3.3	-	3.7	4.9	3.1	-	2.1	-	2.1	2	5.9
Total Recoverable Zinc	-	9.5	5.3	-	6.2	6.8	6.3	-	5.1	-	3.8	3.4	9.1
Polycyclic Aromatic Hydrocarbons Screening in Soil													
Acenaphthene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Acenaphthylene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Anthracene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Benzo[a]anthracene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Benzo[a]pyrene (BAP)	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Benzo[b]fluoranthene + Benzo[j]fluoranthene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Benzo[g,h,i]perylene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Benzo[k]fluoranthene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Chrysene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Dibenzo[a,h]anthracene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V14	V14	V14	V14	V14	V14	V15	V15	V15	V15	V15	V15	V16
Sample Type: Sediment	0.0-0.5m B	0.0-0.5m A	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-3.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-3.0m A	0-0.5m A
Fluoranthene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Fluorene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Indeno(1,2,3-c,d)pyrene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Naphthalene	< 0.15	-	-	< 0.14	-	-	-	< 0.13	-	< 0.13	-	-	< 0.13
Phenanthrene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Pyrene	< 0.03	-	-	< 0.03	-	-	-	< 0.03	-	< 0.03	-	-	< 0.03
Haloethers in SVOC Soil Samples by GC-MS													
Bis(2-chloroethoxy) methane	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Bis(2-chloroethyl)ether	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Bis(2-chloroisopropyl)ether	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
4-Bromophenyl phenyl ether	< 0.4	-	-	-	-	-	-	< 0.4	-	-	-	-	< 0.4
4-Chlorophenyl phenyl ether	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Nitrogen containing compounds in SVOC Soil Samples by GC-MS													
2,4-Dinitrotoluene	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
2,6-Dinitrotoluene	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
Nitrobenzene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
N-Nitrosodi-n-propylamine	< 0.8	-	-	-	-	-	-	< 0.7	-	-	-	-	< 0.7
N-Nitrosodiphenylamine + Diphenylamine	< 0.8	-	-	-	-	-	-	< 0.7	-	-	-	-	< 0.7
Organochlorine Pesticides in SVOC Soil Samples by GC-MS													
Aldrin	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
alpha-BHC	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
beta-BHC	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
delta-BHC	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
gamma-BHC (Lindane)	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
4,4'-DDD	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
4,4'-DDE	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
4,4'-DDT	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
Dieldrin	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples
collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V14	V14	V14	V14	V14	V14	V15	V15	V15	V15	V15	V15	V16
Sample Type: Sediment	0.0-0.5m B	0.0-0.5m A	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-3.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-3.0m A	0-0.5m A
Endosulfan I	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
Endosulfan II	< 2	-	-	-	-	-	-	< 2	-	-	-	-	< 2
Endosulfan sulphate	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
Endrin	< 0.8	-	-	-	-	-	-	< 0.7	-	-	-	-	< 0.7
Endrin ketone	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
Heptachlor	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Heptachlor epoxide	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Hexachlorobenzene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Polycyclic Aromatic Hydrocarbons in SVOC Soil Samples by GC-MS													
Acenaphthene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Acenaphthylene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Anthracene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Benzo[a]anthracene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Benzo[a]pyrene (BAP)	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Benzo[b]fluoranthene + Benzo[j]fluoranthene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Benzo[g,h,i]perylene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Benzo[k]fluoranthene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
1&2-Chloronaphthalene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Chrysene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Dibenzo[a,h]anthracene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Fluoranthene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Fluorene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Indeno(1,2,3-c,d)pyrene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
2-Methylnaphthalene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Naphthalene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Phenanthrene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Pyrene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Phenols in SVOC Soil Samples by GC-MS													

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V14	V14	V14	V14	V14	V14	V15	V15	V15	V15	V15	V15	V16
Sample Type: Sediment	0.0-0.5m B	0.0-0.5m A	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-3.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-3.0m A	0-0.5m A
4-Chloro-3-methylphenol	< 5	-	-	-	-	-	-	< 5	-	-	-	-	< 5
2-Chlorophenol	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
2,4-Dichlorophenol	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
2,4-Dimethylphenol	< 3	-	-	-	-	-	-	< 3	-	-	-	-	< 3
3 & 4-Methylphenol (m- + p-cresol)	< 3	-	-	-	-	-	-	< 3	-	-	-	-	< 3
2-Methylphenol (o-Cresol)	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
2-Nitrophenol	< 5	-	-	-	-	-	-	< 5	-	-	-	-	< 5
Pentachlorophenol (PCP)	< 30	-	-	-	-	-	-	< 30	-	-	-	-	< 30
Phenol	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
2,4,5-Trichlorophenol	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
2,4,6-Trichlorophenol	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
Plasticisers in SVOC Soil Samples by GC-MS													
Bis(2-ethylhexyl)phthalate	< 5	-	-	-	-	-	-	< 5	-	-	-	-	< 5
Butylbenzylphthalate	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
Di(2-ethylhexyl)adipate	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
Diethylphthalate	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
Dimethylphthalate	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
Di-n-butylphthalate	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
Di-n-octylphthalate	< 1.0	-	-	-	-	-	-	< 1.0	-	-	-	-	< 1.0
Other Halogenated compounds in SVOC Soil Samples by GC-MS													
1,2-Dichlorobenzene	< 0.8	-	-	-	-	-	-	< 0.7	-	-	-	-	< 0.7
1,3-Dichlorobenzene	< 0.8	-	-	-	-	-	-	< 0.7	-	-	-	-	< 0.7
1,4-Dichlorobenzene	< 0.8	-	-	-	-	-	-	< 0.7	-	-	-	-	< 0.7
Hexachlorobutadiene	< 0.8	-	-	-	-	-	-	< 0.7	-	-	-	-	< 0.7
Hexachloroethane	< 0.8	-	-	-	-	-	-	< 0.7	-	-	-	-	< 0.7
1,2,4-Trichlorobenzene	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Other compounds in SVOC Soil Samples by GC-MS													
Benzyl alcohol	< 10	-	-	-	-	-	-	< 10	-	-	-	-	< 10

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V14	V14	V14	V14	V14	V14	V15	V15	V15	V15	V15	V15	V16
Sample Type: Sediment	0.0-0.5m B	0.0-0.5m A	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-3.0m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	2.0-3.0m A	0-0.5m A
Carbazole	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Dibenzofuran	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Isophorone	< 0.5	-	-	-	-	-	-	< 0.5	-	-	-	-	< 0.5
Tributyl Tin Trace in Soil samples by GCMS													
Dibutyltin (as Sn)	< 0.005	-	-	< 0.005	-	-	-	< 0.005	-	< 0.005	-	-	< 0.005
Monobutyltin (as Sn)	< 0.007	-	-	< 0.007	-	-	-	< 0.007	-	< 0.007	-	-	< 0.007
Tributyltin (as Sn)	< 0.004	-	-	< 0.004	-	-	-	< 0.004	-	< 0.004	-	-	< 0.004
Triphenyltin (as Sn)	< 0.003	-	-	< 0.003	-	-	-	< 0.003	-	< 0.003	-	-	< 0.003
Total Petroleum Hydrocarbons in Soil													
C7 - C9	< 9	-	-	< 8	-	-	-	< 8	-	< 8	-	-	< 8
C10 - C14	< 20	-	-	< 20	-	-	-	< 20	-	< 20	-	-	< 20
C15 - C36	< 40	-	-	< 40	-	-	-	< 40	-	< 40	-	-	< 40
Total hydrocarbons (C7 - C36)	< 70	-	-	< 70	-	-	-	< 70	-	< 70	-	-	< 70

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V16	V16	V17	V17	V17	V17	V17	V17	V17	V18	V18	V18	V18
Sample Type: Sediment	0.5-1.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2m A	2-3m A	3-4m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B
Sample Name:	23/02/16	23/02/16	24/02/16	24/02/16	24/02/16	24/02/16	24/02/16	24/02/16	24/02/16	24/02/16	24/02/16	24/02/16	24/02/16
Lab Number:	1543364.3	1543364.5	1543396.1	1543396.2	1543396.4	1543396.5	1543396.7	1543396.1	1543396.13	1544100.9	1544100.1	1544100.12	1544100.13
Dry Matter (g/100g as rcvd)	85	-	-	89	-	85	-	-	-	-	88	-	84
Total Organic Carbon (g/100g dry wt)	0.4	-	< 0.13	-	< 0.13	-	< 0.13	< 0.13	< 0.13	< 0.13	-	< 0.05	-
Antifouling cobiocides in sediment samples by LCMSMS													
Diuron	< 0.010	-	-	< 0.010	-	< 0.010	-	-	-	-	< 0.010	-	< 0.010
Irgarol	< 0.010	-	-	< 0.010	-	< 0.010	-	-	-	-	< 0.010	-	< 0.010
Isoproturon	< 0.010	-	-	< 0.010	-	< 0.010	-	-	-	-	< 0.010	-	< 0.010
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg													
Total Recoverable Arsenic	< 4	2.4	2.3	-	1.9	-	2.4	5	3.3	1.9	-	2	-
Total Recoverable Cadmium	0.03	< 0.010	< 0.02	-	< 0.010	-	< 0.010	0.024	< 0.010	< 0.010	-	0.012	-
Total Recoverable Chromium	4.1	6.1	5.4	-	3.5	-	6.4	10.5	9.8	5.4	-	9.1	-
Total Recoverable Copper	1.1	0.4	0.5	-	0.3	-	0.4	0.6	0.7	0.4	-	0.3	-
Total Recoverable Lead	0.85	0.73	0.78	-	0.57	-	0.81	1.42	0.98	0.83	-	1.14	-
Total Recoverable Mercury	0.02	< 0.010	< 0.02	-	< 0.010	-	< 0.010	< 0.010	< 0.010	< 0.010	-	< 0.010	-
Total Recoverable Nickel	8.8	2.3	4.4	-	2.8	-	2.6	3.7	4.6	3.4	-	2.1	-
Total Recoverable Zinc	4.1	7.3	5.5	-	4.1	-	6.8	10.8	8.9	4.4	-	8.9	-
Polycyclic Aromatic Hydrocarbons Screening in Soil													
Acenaphthene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Acenaphthylene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Anthracene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Benzo[a]anthracene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Benzo[a]pyrene (BAP)	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Benzo[b]fluoranthene + Benzo[j]fluoranthene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Benzo[g,h,i]perylene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Benzo[k]fluoranthene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Chrysene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Dibenzo[a,h]anthracene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V16	V16	V17	V17	V17	V17	V17	V17	V17	V18	V18	V18	V18
Sample Type: Sediment	0.5-1.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2m A	2-3m A	3-4m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B
Fluoranthene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Fluorene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Indeno(1,2,3-c,d)pyrene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Naphthalene	< 0.14	-	-	< 0.12	-	< 0.13	-	-	-	-	< 0.13	-	< 0.13
Phenanthrene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Pyrene	< 0.03	-	-	< 0.03	-	< 0.03	-	-	-	-	< 0.03	-	< 0.03
Haloethers in SVOC Soil Samples by GC-MS													
Bis(2-chloroethoxy) methane	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Bis(2-chloroethyl)ether	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Bis(2-chloroisopropyl)ether	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
4-Bromophenyl phenyl ether	-	-	-	< 0.4	-	-	-	-	-	-	< 0.4	-	-
4-Chlorophenyl phenyl ether	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Nitrogen containing compounds in SVOC Soil Samples by GC-MS													
2,4-Dinitrotoluene	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
2,6-Dinitrotoluene	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
Nitrobenzene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
N-Nitrosodi-n-propylamine	-	-	-	< 0.7	-	-	-	-	-	-	< 0.7	-	-
N-Nitrosodiphenylamine + Diphenylamine	-	-	-	< 0.7	-	-	-	-	-	-	< 0.7	-	-
Organochlorine Pesticides in SVOC Soil Samples by GC-MS													
Aldrin	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
alpha-BHC	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
beta-BHC	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
delta-BHC	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
gamma-BHC (Lindane)	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
4,4'-DDD	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
4,4'-DDE	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
4,4'-DDT	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
Dieldrin	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V16	V16	V17	V17	V17	V17	V17	V17	V17	V18	V18	V18	V18
Sample Type: Sediment	0.5-1.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2m A	2-3m A	3-4m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B
Endosulfan I	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
Endosulfan II	-	-	-	< 2	-	-	-	-	-	-	< 2	-	-
Endosulfan sulphate	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
Endrin	-	-	-	< 0.7	-	-	-	-	-	-	< 0.7	-	-
Endrin ketone	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
Heptachlor	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Heptachlor epoxide	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Hexachlorobenzene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Polycyclic Aromatic Hydrocarbons in SVOC Soil Samples by GC-MS													
Acenaphthene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Acenaphthylene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Anthracene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Benzo[a]anthracene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Benzo[a]pyrene (BAP)	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Benzo[g,h,i]perylene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Benzo[k]fluoranthene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
1&2-Chloronaphthalene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Chrysene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Dibenzo[a,h]anthracene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Fluoranthene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Fluorene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Indeno(1,2,3-c,d)pyrene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
2-Methylnaphthalene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Naphthalene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Phenanthrene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Pyrene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Phenols in SVOC Soil Samples by GC-MS													

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V16	V16	V17	V17	V17	V17	V17	V17	V17	V18	V18	V18	V18
Sample Type: Sediment	0.5-1.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2m A	2-3m A	3-4m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B
4-Chloro-3-methylphenol	-	-	-	< 5	-	-	-	-	-	-	< 5	-	-
2-Chlorophenol	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
2,4-Dichlorophenol	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
2,4-Dimethylphenol	-	-	-	< 3	-	-	-	-	-	-	< 3	-	-
3 & 4-Methylphenol (m- + p-cresol)	-	-	-	< 3	-	-	-	-	-	-	< 3	-	-
2-Methylphenol (o-Cresol)	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
2-Nitrophenol	-	-	-	< 5	-	-	-	-	-	-	< 5	-	-
Pentachlorophenol (PCP)	-	-	-	< 30	-	-	-	-	-	-	< 30	-	-
Phenol	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
2,4,5-Trichlorophenol	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
2,4,6-Trichlorophenol	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
Plasticisers in SVOC Soil Samples by GC-MS													
Bis(2-ethylhexyl)phthalate	-	-	-	< 5	-	-	-	-	-	-	< 5	-	-
Butylbenzylphthalate	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
Di(2-ethylhexyl)adipate	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
Diethylphthalate	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
Dimethylphthalate	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
Di-n-butylphthalate	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
Di-n-octylphthalate	-	-	-	< 1.0	-	-	-	-	-	-	< 1.0	-	-
Other Halogenated compounds in SVOC Soil Samples by GC-MS													
1,2-Dichlorobenzene	-	-	-	< 0.7	-	-	-	-	-	-	< 0.7	-	-
1,3-Dichlorobenzene	-	-	-	< 0.7	-	-	-	-	-	-	< 0.7	-	-
1,4-Dichlorobenzene	-	-	-	< 0.7	-	-	-	-	-	-	< 0.7	-	-
Hexachlorobutadiene	-	-	-	< 0.7	-	-	-	-	-	-	< 0.7	-	-
Hexachloroethane	-	-	-	< 0.7	-	-	-	-	-	-	< 0.7	-	-
1,2,4-Trichlorobenzene	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Other compounds in SVOC Soil Samples by GC-MS													
Benzyl alcohol	-	-	-	< 10	-	-	-	-	-	-	< 10	-	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V16	V16	V17	V17	V17	V17	V17	V17	V17	V18	V18	V18	V18
Sample Type: Sediment	0.5-1.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2m A	2-3m A	3-4m A	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B
Carbazole	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Dibenzofuran	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Isophorone	-	-	-	< 0.5	-	-	-	-	-	-	< 0.5	-	-
Tributyl Tin Trace in Soil samples by GCMS													
Dibutyltin (as Sn)	< 0.005	-	-	< 0.005	-	< 0.005	-	-	-	-	< 0.005	-	< 0.005
Monobutyltin (as Sn)	< 0.007	-	-	< 0.007	-	< 0.007	-	-	-	-	< 0.007	-	< 0.007
Tributyltin (as Sn)	< 0.004	-	-	< 0.004	-	< 0.004	-	-	-	-	< 0.004	-	< 0.004
Triphenyltin (as Sn)	< 0.003	-	-	< 0.003	-	< 0.003	-	-	-	-	< 0.003	-	< 0.003
Total Petroleum Hydrocarbons in Soil													
C7 - C9	< 8	-	-	< 8	-	< 8	-	-	-	-	< 8	-	< 8
C10 - C14	< 20	-	-	< 20	-	< 20	-	-	-	-	< 20	-	< 20
C15 - C36	< 40	-	-	< 40	-	< 40	-	-	-	-	< 40	-	< 40
Total hydrocarbons (C7 - C36)	< 70	-	-	< 70	-	< 70	-	-	-	-	< 70	-	< 70

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V18	V18	V19	V19	V19	V19	V19	V19A	V19A	V19A	V19A	V19A
Sample Type: Sediment	2.0-3.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1m A	0.5-1m B	1-1.5m A
Sample Name:	24/02/16	24/02/16	24/02/16	24/02/16	24/02/16	24/02/16	24/02/16	29/02/16	29/02/16	29/02/16	29/02/16	29/02/16
Lab Number:	1544100.16	1544100.19	1544100.22	1544100.23	1544100.25	1544100.26	1544100.28	1546000.1	1546000.2	1546000.4	1546000.5	1546000.7
Dry Matter (g/100g as rcvd)	-	-	-	86	-	82	-	82	-	82	-	-
Total Organic Carbon (g/100g dry wt)	0.17	< 0.05	< 0.13	-	0.06	-	< 0.13	-	< 0.05	-	< 0.05	< 0.05
Antifouling cobiocides in sediment samples by LCMSMS												
Diuron	-	-	-	< 0.010	-	< 0.010	-	< 0.010	-	< 0.010	-	-
Irgarol	-	-	-	< 0.010	-	< 0.010	-	< 0.010	-	< 0.010	-	-
Isoproturon	-	-	-	< 0.010	-	< 0.010	-	< 0.010	-	< 0.010	-	-
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg												
Total Recoverable Arsenic	4	2.6	2	-	2	-	2.4	-	2.9	-	2.2	2.5
Total Recoverable Cadmium	0.038	0.011	< 0.010	-	0.027	-	0.037	-	< 0.010	-	< 0.010	0.015
Total Recoverable Chromium	14.7	8.3	5.5	-	12.2	-	34	-	50	-	10.6	37
Total Recoverable Copper	0.7	0.3	0.4	-	0.5	-	0.8	-	1.1	-	0.4	0.8
Total Recoverable Lead	1.66	1	0.68	-	1.45	-	1.05	-	1.19	-	0.87	0.9
Total Recoverable Mercury	< 0.010	< 0.010	< 0.010	-	< 0.010	-	< 0.010	-	< 0.010	-	< 0.010	< 0.010
Total Recoverable Nickel	5	1.9	2.4	-	3.1	-	17.1	-	20	-	3.7	20
Total Recoverable Zinc	10.6	8.3	4.9	-	10.2	-	7.8	-	8.3	-	6.6	7.2
Polycyclic Aromatic Hydrocarbons Screening in Soil												
Acenaphthene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Acenaphthylene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Anthracene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Benzo[a]anthracene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Benzo[a]pyrene (BAP)	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Benzo[g,h,i]perylene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Benzo[k]fluoranthene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Chrysene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Dibenzo[a,h]anthracene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples
collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V18	V18	V19	V19	V19	V19	V19	V19A	V19A	V19A	V19A	V19A
Sample Type: Sediment	2.0-3.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1m A	0.5-1m B	1-1.5m A
Fluoranthene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Fluorene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Indeno(1,2,3-c,d)pyrene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Naphthalene	-	-	-	< 0.13	-	< 0.14	-	< 0.14	-	< 0.13	-	-
Phenanthrene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Pyrene	-	-	-	< 0.03	-	< 0.03	-	< 0.03	-	< 0.03	-	-
Haloethers in SVOC Soil Samples by GC-MS												
Bis(2-chloroethoxy) methane	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Bis(2-chloroethyl)ether	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Bis(2-chloroisopropyl)ether	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
4-Bromophenyl phenyl ether	-	-	-	< 0.4	-	-	-	< 0.4	-	-	-	-
4-Chlorophenyl phenyl ether	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Nitrogen containing compounds in SVOC Soil Samples by GC-MS												
2,4-Dinitrotoluene	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
2,6-Dinitrotoluene	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
Nitrobenzene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
N-Nitrosodi-n-propylamine	-	-	-	< 0.7	-	-	-	< 0.7	-	-	-	-
N-Nitrosodiphenylamine + Diphenylamine	-	-	-	< 0.7	-	-	-	< 0.7	-	-	-	-
Organochlorine Pesticides in SVOC Soil Samples by GC-MS												
Aldrin	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
alpha-BHC	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
beta-BHC	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
delta-BHC	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
gamma-BHC (Lindane)	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
4,4'-DDD	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
4,4'-DDE	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
4,4'-DDT	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
Dieldrin	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-

APPENDIX C1: Summary Chemical database for sectioned vibracore samples
collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V18	V18	V19	V19	V19	V19	V19	V19A	V19A	V19A	V19A	V19A
Sample Type: Sediment	2.0-3.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1m A	0.5-1m B	1-1.5m A
Endosulfan I	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
Endosulfan II	-	-	-	< 2	-	-	-	< 2	-	-	-	-
Endosulfan sulphate	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
Endrin	-	-	-	< 0.7	-	-	-	< 0.7	-	-	-	-
Endrin ketone	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
Heptachlor	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Heptachlor epoxide	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Hexachlorobenzene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Polycyclic Aromatic Hydrocarbons in SVOC Soil Samples by GC-MS												
Acenaphthene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Acenaphthylene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Anthracene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Benzo[a]anthracene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Benzo[a]pyrene (BAP)	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Benzo[g,h,i]perylene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Benzo[k]fluoranthene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
1&2-Chloronaphthalene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Chrysene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Dibenzo[a,h]anthracene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Fluoranthene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Fluorene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Indeno(1,2,3-c,d)pyrene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
2-Methylnaphthalene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Naphthalene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Phenanthrene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Pyrene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Phenols in SVOC Soil Samples by GC-MS												

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V18	V18	V19	V19	V19	V19	V19	V19A	V19A	V19A	V19A	V19A
Sample Type: Sediment	2.0-3.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1m A	0.5-1m B	1-1.5m A
4-Chloro-3-methylphenol	-	-	-	< 5	-	-	-	< 5	-	-	-	-
2-Chlorophenol	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
2,4-Dichlorophenol	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
2,4-Dimethylphenol	-	-	-	< 3	-	-	-	< 3	-	-	-	-
3 & 4-Methylphenol (m- + p-cresol)	-	-	-	< 3	-	-	-	< 3	-	-	-	-
2-Methylphenol (o-Cresol)	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
2-Nitrophenol	-	-	-	< 5	-	-	-	< 5	-	-	-	-
Pentachlorophenol (PCP)	-	-	-	< 30	-	-	-	< 30	-	-	-	-
Phenol	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
2,4,5-Trichlorophenol	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
2,4,6-Trichlorophenol	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
Plasticisers in SVOC Soil Samples by GC-MS												
Bis(2-ethylhexyl)phthalate	-	-	-	< 5	-	-	-	< 5	-	-	-	-
Butylbenzylphthalate	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
Di(2-ethylhexyl)adipate	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
Diethylphthalate	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
Dimethylphthalate	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
Di-n-butylphthalate	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
Di-n-octylphthalate	-	-	-	< 1.0	-	-	-	< 1.0	-	-	-	-
Other Halogenated compounds in SVOC Soil Samples by GC-MS												
1,2-Dichlorobenzene	-	-	-	< 0.7	-	-	-	< 0.7	-	-	-	-
1,3-Dichlorobenzene	-	-	-	< 0.7	-	-	-	< 0.7	-	-	-	-
1,4-Dichlorobenzene	-	-	-	< 0.7	-	-	-	< 0.7	-	-	-	-
Hexachlorobutadiene	-	-	-	< 0.7	-	-	-	< 0.7	-	-	-	-
Hexachloroethane	-	-	-	< 0.7	-	-	-	< 0.7	-	-	-	-
1,2,4-Trichlorobenzene	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Other compounds in SVOC Soil Samples by GC-MS												
Benzyl alcohol	-	-	-	< 10	-	-	-	< 10	-	-	-	-

APPENDIX C1: Summary Chemical database for sectioned vibracore samples
collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V18	V18	V19	V19	V19	V19	V19	V19A	V19A	V19A	V19A	V19A
Sample Type: Sediment	2.0-3.0m A	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-2.0m A	0-0.5m A	0-0.5m B	0.5-1m A	0.5-1m B	1-1.5m A
Carbazole	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Dibenzofuran	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Isophorone	-	-	-	< 0.5	-	-	-	< 0.5	-	-	-	-
Tributyl Tin Trace in Soil samples by GCMS												
Dibutyltin (as Sn)	-	-	-	< 0.005	-	< 0.005	-	< 0.005	-	< 0.005	-	-
Monobutyltin (as Sn)	-	-	-	< 0.007	-	< 0.007	-	< 0.007	-	< 0.007	-	-
Tributyltin (as Sn)	-	-	-	< 0.004	-	< 0.004	-	< 0.004	-	< 0.004	-	-
Triphenyltin (as Sn)	-	-	-	< 0.003	-	< 0.003	-	< 0.003	-	< 0.003	-	-
Total Petroleum Hydrocarbons in Soil												
C7 - C9	-	-	-	< 8	-	< 9	-	< 9	-	< 8	-	-
C10 - C14	-	-	-	< 20	-	< 20	-	< 20	-	< 20	-	-
C15 - C36	-	-	-	< 40	-	< 40	-	< 40	-	< 40	-	-
Total hydrocarbons (C7 - C36)	-	-	-	< 70	-	< 70	-	< 70	-	< 70	-	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V20	V20	V20	V20	V20
Sample Type: Sediment	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-1.5m A
Sample Name:	24/02/16	24/02/16	24/02/16	24/02/16	24/02/16
Lab Number:	1544100.1	1544100.2	1544100.4	1544100.5	1544100.6
Dry Matter (g/100g as rcvd)	-	84	-	85	-
Total Organic Carbon (g/100g dry wt)	< 0.13	-	0.06	-	0.05
Antifouling cobiocides in sediment samples by LCMSMS					
Diuron	-	< 0.010	-	< 0.010	-
Irgarol	-	< 0.010	-	< 0.010	-
Isoproturon	-	< 0.010	-	< 0.010	-
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	3	-	2.6	-	2.7
Total Recoverable Cadmium	0.083	-	0.02	-	0.017
Total Recoverable Chromium	210	-	8	-	8.9
Total Recoverable Copper	3.8	-	0.5	-	0.4
Total Recoverable Lead	1.35	-	0.96	-	1.07
Total Recoverable Mercury	< 0.010	-	< 0.010	-	< 0.010
Total Recoverable Nickel	123	-	1.9	-	2.2
Total Recoverable Zinc	8.9	-	7.6	-	8.1
Polycyclic Aromatic Hydrocarbons Screening in Soil					
Acenaphthene	-	< 0.03	-	< 0.03	-
Acenaphthylene	-	< 0.03	-	< 0.03	-
Anthracene	-	< 0.03	-	< 0.03	-
Benzo[a]anthracene	-	< 0.03	-	< 0.03	-
Benzo[a]pyrene (BAP)	-	< 0.03	-	< 0.03	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	-	< 0.03	-	< 0.03	-
Benzo[g,h,i]perylene	-	< 0.03	-	< 0.03	-
Benzo[k]fluoranthene	-	< 0.03	-	< 0.03	-
Chrysene	-	< 0.03	-	< 0.03	-
Dibenzo[a,h]anthracene	-	< 0.03	-	< 0.03	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V20	V20	V20	V20	V20
Sample Type: Sediment	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-1.5m A
Fluoranthene	-	< 0.03	-	< 0.03	-
Fluorene	-	< 0.03	-	< 0.03	-
Indeno(1,2,3-c,d)pyrene	-	< 0.03	-	< 0.03	-
Naphthalene	-	< 0.13	-	< 0.13	-
Phenanthrene	-	< 0.03	-	< 0.03	-
Pyrene	-	< 0.03	-	< 0.03	-
Haloethers in SVOC Soil Samples by GC-MS					
Bis(2-chloroethoxy) methane	-	< 0.5	-	-	-
Bis(2-chloroethyl)ether	-	< 0.5	-	-	-
Bis(2-chloroisopropyl)ether	-	< 0.5	-	-	-
4-Bromophenyl phenyl ether	-	< 0.4	-	-	-
4-Chlorophenyl phenyl ether	-	< 0.5	-	-	-
Nitrogen containing compounds in SVOC Soil Samples by GC-MS					
2,4-Dinitrotoluene	-	< 1.0	-	-	-
2,6-Dinitrotoluene	-	< 1.0	-	-	-
Nitrobenzene	-	< 0.5	-	-	-
N-Nitrosodi-n-propylamine	-	< 0.7	-	-	-
N-Nitrosodiphenylamine + Diphenylamine	-	< 0.7	-	-	-
Organochlorine Pesticides in SVOC Soil Samples by GC-MS					
Aldrin	-	< 0.5	-	-	-
alpha-BHC	-	< 0.5	-	-	-
beta-BHC	-	< 0.5	-	-	-
delta-BHC	-	< 0.5	-	-	-
gamma-BHC (Lindane)	-	< 0.5	-	-	-
4,4'-DDD	-	< 0.5	-	-	-
4,4'-DDE	-	< 0.5	-	-	-
4,4'-DDT	-	< 1.0	-	-	-
Dieldrin	-	< 0.5	-	-	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V20	V20	V20	V20	V20
Sample Type: Sediment	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-1.5m A
Endosulfan I	-	< 1.0	-	-	-
Endosulfan II	-	< 2	-	-	-
Endosulfan sulphate	-	< 1.0	-	-	-
Endrin	-	< 0.7	-	-	-
Endrin ketone	-	< 1.0	-	-	-
Heptachlor	-	< 0.5	-	-	-
Heptachlor epoxide	-	< 0.5	-	-	-
Hexachlorobenzene	-	< 0.5	-	-	-
Polycyclic Aromatic Hydrocarbons in SVOC Soil Samples by GC-MS					
Acenaphthene	-	< 0.5	-	-	-
Acenaphthylene	-	< 0.5	-	-	-
Anthracene	-	< 0.5	-	-	-
Benzo[a]anthracene	-	< 0.5	-	-	-
Benzo[a]pyrene (BAP)	-	< 0.5	-	-	-
Benzo[b]fluoranthene + Benzo[j]fluoranthene	-	< 0.5	-	-	-
Benzo[g,h,i]perylene	-	< 0.5	-	-	-
Benzo[k]fluoranthene	-	< 0.5	-	-	-
1&2-Chloronaphthalene	-	< 0.5	-	-	-
Chrysene	-	< 0.5	-	-	-
Dibenzo[a,h]anthracene	-	< 0.5	-	-	-
Fluoranthene	-	< 0.5	-	-	-
Fluorene	-	< 0.5	-	-	-
Indeno(1,2,3-c,d)pyrene	-	< 0.5	-	-	-
2-Methylnaphthalene	-	< 0.5	-	-	-
Naphthalene	-	< 0.5	-	-	-
Phenanthrene	-	< 0.5	-	-	-
Pyrene	-	< 0.5	-	-	-
Phenols in SVOC Soil Samples by GC-MS					

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V20	V20	V20	V20	V20
Sample Type: Sediment	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-1.5m A
4-Chloro-3-methylphenol	-	< 5	-	-	-
2-Chlorophenol	-	< 1.0	-	-	-
2,4-Dichlorophenol	-	< 1.0	-	-	-
2,4-Dimethylphenol	-	< 3	-	-	-
3 & 4-Methylphenol (m- + p-cresol)	-	< 3	-	-	-
2-Methylphenol (o-Cresol)	-	< 1.0	-	-	-
2-Nitrophenol	-	< 5	-	-	-
Pentachlorophenol (PCP)	-	< 30	-	-	-
Phenol	-	< 1.0	-	-	-
2,4,5-Trichlorophenol	-	< 1.0	-	-	-
2,4,6-Trichlorophenol	-	< 1.0	-	-	-
Plasticisers in SVOC Soil Samples by GC-MS					
Bis(2-ethylhexyl)phthalate	-	< 5	-	-	-
Butylbenzylphthalate	-	< 1.0	-	-	-
Di(2-ethylhexyl)adipate	-	< 1.0	-	-	-
Diethylphthalate	-	< 1.0	-	-	-
Dimethylphthalate	-	< 1.0	-	-	-
Di-n-butylphthalate	-	< 1.0	-	-	-
Di-n-octylphthalate	-	< 1.0	-	-	-
Other Halogenated compounds in SVOC Soil Samples by GC-MS					
1,2-Dichlorobenzene	-	< 0.7	-	-	-
1,3-Dichlorobenzene	-	< 0.7	-	-	-
1,4-Dichlorobenzene	-	< 0.7	-	-	-
Hexachlorobutadiene	-	< 0.7	-	-	-
Hexachloroethane	-	< 0.7	-	-	-
1,2,4-Trichlorobenzene	-	< 0.5	-	-	-
Other compounds in SVOC Soil Samples by GC-MS					
Benzyl alcohol	-	< 10	-	-	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C1: Summary Chemical database for sectioned vibracore samples collected by Tonkin Taylor and analysed by R.J. Hill Laboratories

	V20	V20	V20	V20	V20
Sample Type: Sediment	0.0-0.5m A	0.0-0.5m B	0.5-1.0m A	0.5-1.0m B	1.0-1.5m A
Carbazole	-	< 0.5	-	-	-
Dibenzofuran	-	< 0.5	-	-	-
Isophorone	-	< 0.5	-	-	-
Tributyl Tin Trace in Soil samples by GCMS					
Dibutyltin (as Sn)	-	< 0.005	-	< 0.005	-
Monobutyltin (as Sn)	-	< 0.007	-	< 0.007	-
Tributyltin (as Sn)	-	< 0.004	-	< 0.004	-
Triphenyltin (as Sn)	-	< 0.003	-	< 0.003	-
Total Petroleum Hydrocarbons in Soil					
C7 - C9	-	< 8	-	< 8	-
C10 - C14	-	< 20	-	< 20	-
C15 - C36	-	< 40	-	< 40	-
Total hydrocarbons (C7 - C36)	-	< 70	-	< 70	-

Results as mg/kg dry wt unless stated otherwise

APPENDIX C2

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ANALYSIS REPORT

Client:	Tonkin & Taylor	**Lab No:**	1546000 SPv2
Contact:	A Pomfret	**Date Registered:**	02-Mar-2016
	C/- Tonkin & Taylor	**Date Reported:**	22-Apr-2016
	PO Box 5271	**Quote No:**	74906
	Auckland 1141	**Order No:**	98701
		Client Reference:	Contamination Sampling Marsden Point
		Submitted By:	J Yule

Amended Report

This report replaces an earlier report issued on the 10 Mar 2016 at 4:21 pm
Elutriation testing has been added at the request of the client.

Sample Type: Sediment

Sample Name:		V19A 0-0.5m A 29-Feb-2016 11:00 am	V19A 0-0.5m B 29-Feb-2016 11:00 am	V19A 0.5-1m A 29-Feb-2016 11:00 am	V19A 0.5-1m B 29-Feb-2016 11:00 am	V19A 1-1.5m A 29-Feb-2016 11:00 am
Lab Number:		1546000.1	1546000.2	1546000.4	1546000.5	1546000.7
Individual Tests						
Dry Matter	g/100g as rcvd	82	-	82	-	-
Total Organic Carbon*	g/100g dry wt	-	< 0.05	-	< 0.05	< 0.05
Antifouling cobiocides in sediment samples by LCMSMS						
Diuron*	mg/kg dry wt	< 0.010	-	< 0.010	-	-
Irgarol*	mg/kg dry wt	< 0.010	-	< 0.010	-	-
Isoproturon*	mg/kg dry wt	< 0.010	-	< 0.010	-	-
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	-	2.9	-	2.2	2.5
Total Recoverable Cadmium	mg/kg dry wt	-	< 0.010	-	< 0.010	0.015
Total Recoverable Chromium	mg/kg dry wt	-	50	-	10.6	37
Total Recoverable Copper	mg/kg dry wt	-	1.1	-	0.4	0.8
Total Recoverable Lead	mg/kg dry wt	-	1.19	-	0.87	0.90
Total Recoverable Mercury	mg/kg dry wt	-	< 0.010	-	< 0.010	< 0.010
Total Recoverable Nickel	mg/kg dry wt	-	20	-	3.7	20
Total Recoverable Zinc	mg/kg dry wt	-	8.3	-	6.6	7.2
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Acenaphthylene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Anthracene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Chrysene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Fluoranthene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Fluorene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Naphthalene	mg/kg dry wt	< 0.14	-	< 0.13	-	-
Phenanthrene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Pyrene	mg/kg dry wt	< 0.03	-	< 0.03	-	-
Haloethers in SVOC Soil Samples by GC-MS						

Sample Type: Sediment						
Sample Name:		V19A 0-0.5m A 29-Feb-2016 11:00 am	V19A 0-0.5m B 29-Feb-2016 11:00 am	V19A 0.5-1m A 29-Feb-2016 11:00 am	V19A 0.5-1m B 29-Feb-2016 11:00 am	V19A 1-1.5m A 29-Feb-2016 11:00 am
Lab Number:		1546000.1	1546000.2	1546000.4	1546000.5	1546000.7
Haloethers in SVOC Soil Samples by GC-MS						
Bis(2-chloroethoxy) methane	mg/kg dry wt	< 0.5	-	-	-	-
Bis(2-chloroethyl)ether	mg/kg dry wt	< 0.5	-	-	-	-
Bis(2-chloroisopropyl)ether	mg/kg dry wt	< 0.5	-	-	-	-
4-Bromophenyl phenyl ether	mg/kg dry wt	< 0.4	-	-	-	-
4-Chlorophenyl phenyl ether	mg/kg dry wt	< 0.5	-	-	-	-
Nitrogen containing compounds in SVOC Soil Samples by GC-MS						
2,4-Dinitrotoluene	mg/kg dry wt	< 1.0	-	-	-	-
2,6-Dinitrotoluene	mg/kg dry wt	< 1.0	-	-	-	-
Nitrobenzene	mg/kg dry wt	< 0.5	-	-	-	-
N-Nitrosodi-n-propylamine	mg/kg dry wt	< 0.7	-	-	-	-
N-Nitrosodiphenylamine + Diphenylamine	mg/kg dry wt	< 0.7	-	-	-	-
Organochlorine Pesticides in SVOC Soil Samples by GC-MS						
Aldrin	mg/kg dry wt	< 0.5	-	-	-	-
alpha-BHC	mg/kg dry wt	< 0.5	-	-	-	-
beta-BHC	mg/kg dry wt	< 0.5	-	-	-	-
delta-BHC	mg/kg dry wt	< 0.5	-	-	-	-
gamma-BHC (Lindane)	mg/kg dry wt	< 0.5	-	-	-	-
4,4'-DDD	mg/kg dry wt	< 0.5	-	-	-	-
4,4'-DDE	mg/kg dry wt	< 0.5	-	-	-	-
4,4'-DDT	mg/kg dry wt	< 1.0	-	-	-	-
Dieldrin	mg/kg dry wt	< 0.5	-	-	-	-
Endosulfan I	mg/kg dry wt	< 1.0	-	-	-	-
Endosulfan II	mg/kg dry wt	< 2	-	-	-	-
Endosulfan sulphate	mg/kg dry wt	< 1.0	-	-	-	-
Endrin	mg/kg dry wt	< 0.7	-	-	-	-
Endrin ketone	mg/kg dry wt	< 1.0	-	-	-	-
Heptachlor	mg/kg dry wt	< 0.5	-	-	-	-
Heptachlor epoxide	mg/kg dry wt	< 0.5	-	-	-	-
Hexachlorobenzene	mg/kg dry wt	< 0.5	-	-	-	-
Polycyclic Aromatic Hydrocarbons in SVOC Soil Samples by GC-MS						
Acenaphthene	mg/kg dry wt	< 0.5	-	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.5	-	-	-	-
Anthracene	mg/kg dry wt	< 0.5	-	-	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.5	-	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.5	-	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.5	-	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.5	-	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.5	-	-	-	-
1&2-Chloronaphthalene	mg/kg dry wt	< 0.5	-	-	-	-
Chrysene	mg/kg dry wt	< 0.5	-	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.5	-	-	-	-
Fluoranthene	mg/kg dry wt	< 0.5	-	-	-	-
Fluorene	mg/kg dry wt	< 0.5	-	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.5	-	-	-	-
2-Methylnaphthalene	mg/kg dry wt	< 0.5	-	-	-	-
Naphthalene	mg/kg dry wt	< 0.5	-	-	-	-
Phenanthrene	mg/kg dry wt	< 0.5	-	-	-	-
Pyrene	mg/kg dry wt	< 0.5	-	-	-	-
Phenols in SVOC Soil Samples by GC-MS						
4-Chloro-3-methylphenol	mg/kg dry wt	< 5	-	-	-	-
2-Chlorophenol	mg/kg dry wt	< 1.0	-	-	-	-
2,4-Dichlorophenol	mg/kg dry wt	< 1.0	-	-	-	-

Sample Type: Sediment						
	Sample Name:	V19A 0-0.5m A 29-Feb-2016 11:00 am	V19A 0-0.5m B 29-Feb-2016 11:00 am	V19A 0.5-1m A 29-Feb-2016 11:00 am	V19A 0.5-1m B 29-Feb-2016 11:00 am	V19A 1-1.5m A 29-Feb-2016 11:00 am
	Lab Number:	1546000.1	1546000.2	1546000.4	1546000.5	1546000.7
Phenols in SVOC Soil Samples by GC-MS						
2,4-Dimethylphenol	mg/kg dry wt	< 3	-	-	-	-
3 & 4-Methylphenol (m- + p-cresol)	mg/kg dry wt	< 3	-	-	-	-
2-Methylphenol (o-Cresol)	mg/kg dry wt	< 1.0	-	-	-	-
2-Nitrophenol	mg/kg dry wt	< 5	-	-	-	-
Pentachlorophenol (PCP)	mg/kg dry wt	< 30	-	-	-	-
Phenol	mg/kg dry wt	< 1.0	-	-	-	-
2,4,5-Trichlorophenol	mg/kg dry wt	< 1.0	-	-	-	-
2,4,6-Trichlorophenol	mg/kg dry wt	< 1.0	-	-	-	-
Plasticisers in SVOC Soil Samples by GC-MS						
Bis(2-ethylhexyl)phthalate	mg/kg dry wt	< 5	-	-	-	-
Butylbenzylphthalate	mg/kg dry wt	< 1.0	-	-	-	-
Di(2-ethylhexyl)adipate	mg/kg dry wt	< 1.0	-	-	-	-
Diethylphthalate	mg/kg dry wt	< 1.0	-	-	-	-
Dimethylphthalate	mg/kg dry wt	< 1.0	-	-	-	-
Di-n-butylphthalate	mg/kg dry wt	< 1.0	-	-	-	-
Di-n-octylphthalate	mg/kg dry wt	< 1.0	-	-	-	-
Other Halogenated compounds in SVOC Soil Samples by GC-MS						
1,2-Dichlorobenzene	mg/kg dry wt	< 0.7	-	-	-	-
1,3-Dichlorobenzene	mg/kg dry wt	< 0.7	-	-	-	-
1,4-Dichlorobenzene	mg/kg dry wt	< 0.7	-	-	-	-
Hexachlorobutadiene	mg/kg dry wt	< 0.7	-	-	-	-
Hexachloroethane	mg/kg dry wt	< 0.7	-	-	-	-
1,2,4-Trichlorobenzene	mg/kg dry wt	< 0.5	-	-	-	-
Other compounds in SVOC Soil Samples by GC-MS						
Benzyl alcohol	mg/kg dry wt	< 10	-	-	-	-
Carbazole	mg/kg dry wt	< 0.5	-	-	-	-
Dibenzofuran	mg/kg dry wt	< 0.5	-	-	-	-
Isophorone	mg/kg dry wt	< 0.5	-	-	-	-
Tributyl Tin Trace in Soil samples by GCMS						
Dibutyltin (as Sn)	mg/kg dry wt	< 0.005	-	< 0.005	-	-
Monobutyltin (as Sn)	mg/kg dry wt	< 0.007	-	< 0.007	-	-
Tributyltin (as Sn)	mg/kg dry wt	< 0.004	-	< 0.004	-	-
Triphenyltin (as Sn)	mg/kg dry wt	< 0.003	-	< 0.003	-	-
Total Petroleum Hydrocarbons in Soil						
C7 - C9	mg/kg dry wt	< 9	-	< 8	-	-
C10 - C14	mg/kg dry wt	< 20	-	< 20	-	-
C15 - C36	mg/kg dry wt	< 40	-	< 40	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 70	-	< 70	-	-

Sample Type: Aqueous						
	Sample Name:	V19A 0-0.5m A [Elutriation extract]				
	Lab Number:	1546000.10				
Individual Tests						
Total Chromium*	g/m^3	< 0.0011	-	-	-	-
Total Nickel*	g/m^3	< 0.007	-	-	-	-

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**

Sample Type: Sediment			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Antifouling cobiocides in sediment samples by LCMSMS*		0.010 mg/kg dry wt	1, 4
Antifouling cobiocides suite in sediment by LCMSMS*	Ethyl acetate extraction, SPE cleanup, determination by LCMSMS.	-	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%.	-	1-2, 4-5, 7
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	2, 5, 7
Elutriation testing*	Extn with (client supplied) water, eg seawater, Sed:Water 1:4 by vol, mix 30 min, settle 1 hr, filtration or centrifugation. US EPA 503/8-91/001, "Evaluation of Dredged Material for Ocean Disposal".	-	1
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample. [KBIs:5786,2805,2695]	0.010 - 0.05 mg/kg dry wt	1, 4
Semivolatile Organic Compounds Screening in Soil by GC-MS	Sonication extraction, GPC cleanup (if required), GC-MS FS analysis. Tested on as received sample	0.3 - 30 mg/kg dry wt	1
Tributyl Tin Trace in Soil samples by GCMS	Solvent extraction, ethylation, SPE cleanup, GC-MS SIM analysis. Tested on dried sample	0.003 - 0.007 mg/kg dry wt	1, 4
Total Petroleum Hydrocarbons in Soil	Sonication extraction in DCM, Silica cleanup, GC-FID analysis US EPA 8015B/MfE Petroleum Industry Guidelines. Tested on as received sample [KBIs:5786,2805,10734]	8 - 60 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. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1, 4
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	2, 5, 7
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	2, 5, 7

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Digestion of Saline Samples*	Nitric acid digestion. APHA 3030 E 22nd ed. 2012 (modified).	-	10
Total Chromium*	Nitric acid digestion, ICP-MS with dynamic reaction cell, ultratrace. APHA 3125 B 22nd ed. 2012.	0.0011 g/m^3	10
Total Nickel*	Nitric acid digestion, ICP-MS with universal cell, ultratrace. APHA 3125 B 22nd ed. 2012.	0.0011 g/m^3	10

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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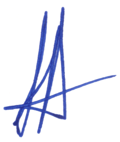

Ara Heron BSc (Tech)
Client Services Manager - Environmental Division

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ANALYSIS REPORT

Client:	Tonkin & Taylor	**Lab No:**	1544100 SUPv2
Contact:	A Pomfret	**Date Registered:**	27-Feb-2016
	C/- Tonkin & Taylor	**Date Reported:**	22-Apr-2016
	PO Box 5271	**Quote No:**	74906
	Auckland 1141	**Order No:**	98701
		Client Reference:	Contamination sampling Marsden Point
		Submitted By:	J Yule

Amended Report

This report replaces an earlier report issued on the 10 Mar 2016 at 12:28 pm
Elutriation testing has been added at the request of the client.

Sample Type: Sediment					
Sample Name:		V20 0.0-0.5m A 24-Feb-2016 11:00 am	V20 0.0-0.5m B 24-Feb-2016 11:00 am	V20 0.5-1.0m A 24-Feb-2016 11:00 am	V20 0.5-1.0m B 24-Feb-2016 11:00 am
Lab Number:		1544100.1	1544100.2	1544100.4	1544100.5
Individual Tests					
Dry Matter	g/100g as rcvd	-	83.5 ± 5.0	-	84.6 ± 5.0
Total Organic Carbon*	g/100g dry wt	< 0.13 ± 0.042	-	0.055 ± 0.041	-
Antifouling cobiocides in sediment samples by LCMSMS					
Diuron*	mg/kg dry wt	-	< 0.010	-	< 0.010
Irgarol*	mg/kg dry wt	-	< 0.010	-	< 0.010
Isoproturon*	mg/kg dry wt	-	< 0.010	-	< 0.010
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	2.71 ± 0.31	-	2.58 ± 0.29	-
Total Recoverable Cadmium	mg/kg dry wt	0.083 ± 0.012	-	0.0202 ± 0.0065	-
Total Recoverable Chromium	mg/kg dry wt	213 ± 26	-	8.04 ± 0.98	-
Total Recoverable Copper	mg/kg dry wt	3.83 ± 0.56	-	0.46 ± 0.15	-
Total Recoverable Lead	mg/kg dry wt	1.35 ± 0.17	-	0.96 ± 0.12	-
Total Recoverable Mercury	mg/kg dry wt	< 0.010 ± 0.0067	-	< 0.010 ± 0.0067	-
Total Recoverable Nickel	mg/kg dry wt	123 ± 13	-	1.86 ± 0.23	-
Total Recoverable Zinc	mg/kg dry wt	8.9 ± 1.5	-	7.6 ± 1.3	-
Polycyclic Aromatic Hydrocarbons Screening in Soil					
Acenaphthene	mg/kg dry wt	-	< 0.03 ± 0.0094	-	< 0.03 ± 0.0093
Acenaphthylene	mg/kg dry wt	-	< 0.03 ± 0.0070	-	< 0.03 ± 0.0070
Anthracene	mg/kg dry wt	-	< 0.03 ± 0.0097	-	< 0.03 ± 0.0096
Benzo[a]anthracene	mg/kg dry wt	-	< 0.03 ± 0.0090	-	< 0.03 ± 0.0089
Benzo[a]pyrene (BAP)	mg/kg dry wt	-	< 0.03 ± 0.0069	-	< 0.03 ± 0.0069
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	-	< 0.03 ± 0.0082	-	< 0.03 ± 0.0082
Benzo[g,h,i]perylene	mg/kg dry wt	-	< 0.03 ± 0.0078	-	< 0.03 ± 0.0078
Benzo[k]fluoranthene	mg/kg dry wt	-	< 0.03 ± 0.0073	-	< 0.03 ± 0.0073
Chrysene	mg/kg dry wt	-	< 0.03 ± 0.0075	-	< 0.03 ± 0.0075
Dibenzo[a,h]anthracene	mg/kg dry wt	-	< 0.03 ± 0.0073	-	< 0.03 ± 0.0073
Fluoranthene	mg/kg dry wt	-	< 0.03 ± 0.0071	-	< 0.03 ± 0.0071
Fluorene	mg/kg dry wt	-	< 0.03 ± 0.0073	-	< 0.03 ± 0.0072
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	-	< 0.03 ± 0.0070	-	< 0.03 ± 0.0070
Naphthalene	mg/kg dry wt	-	< 0.13 ± 0.044	-	< 0.13 ± 0.044
Phenanthrene	mg/kg dry wt	-	< 0.03 ± 0.0075	-	< 0.03 ± 0.0074
Pyrene	mg/kg dry wt	-	< 0.03 ± 0.0073	-	< 0.03 ± 0.0073
Haloethers in SVOC Soil Samples by GC-MS					
Bis(2-chloroethoxy) methane	mg/kg dry wt	-	< 0.5 ± 0.34	-	-

Sample Type: Sediment					
Sample Name:		V20 0.0-0.5m A 24-Feb-2016 11:00 am	V20 0.0-0.5m B 24-Feb-2016 11:00 am	V20 0.5-1.0m A 24-Feb-2016 11:00 am	V20 0.5-1.0m B 24-Feb-2016 11:00 am
Lab Number:		1544100.1	1544100.2	1544100.4	1544100.5
Haloethers in SVOC Soil Samples by GC-MS					
Bis(2-chloroethyl)ether	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Bis(2-chloroisopropyl)ether	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
4-Bromophenyl phenyl ether	mg/kg dry wt	-	< 0.4 ± 0.21	-	-
4-Chlorophenyl phenyl ether	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Nitrogen containing compounds in SVOC Soil Samples by GC-MS					
2,4-Dinitrotoluene	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
2,6-Dinitrotoluene	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
Nitrobenzene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
N-Nitrosodi-n-propylamine	mg/kg dry wt	-	< 0.7 ± 0.35	-	-
N-Nitrosodiphenylamine + Diphenylamine	mg/kg dry wt	-	< 0.7 ± 0.43	-	-
Organochlorine Pesticides in SVOC Soil Samples by GC-MS					
Aldrin	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
alpha-BHC	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
beta-BHC	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
delta-BHC	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
gamma-BHC (Lindane)	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
4,4'-DDD	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
4,4'-DDE	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
4,4'-DDT	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
Dieldrin	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Endosulfan I	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
Endosulfan II	mg/kg dry wt	-	< 2 ± 1.4	-	-
Endosulfan sulphate	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
Endrin	mg/kg dry wt	-	< 0.7 ± 0.40	-	-
Endrin ketone	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
Heptachlor	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Heptachlor epoxide	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Hexachlorobenzene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Polycyclic Aromatic Hydrocarbons in SVOC Soil Samples by GC-MS					
Acenaphthene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Acenaphthylene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Anthracene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Benzo[a]anthracene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Benzo[k]fluoranthene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
1&2-Chloronaphthalene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Chrysene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Fluoranthene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Fluorene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
2-Methylnaphthalene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Naphthalene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Phenanthrene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Pyrene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Phenols in SVOC Soil Samples by GC-MS					
4-Chloro-3-methylphenol	mg/kg dry wt	-	< 5 ± 3.4	-	-
2-Chlorophenol	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
2,4-Dichlorophenol	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
2,4-Dimethylphenol	mg/kg dry wt	-	< 3 ± 1.2	-	-

Sample Type: Sediment					
Sample Name:		V20 0.0-0.5m A 24-Feb-2016 11:00 am	V20 0.0-0.5m B 24-Feb-2016 11:00 am	V20 0.5-1.0m A 24-Feb-2016 11:00 am	V20 0.5-1.0m B 24-Feb-2016 11:00 am
Lab Number:		1544100.1	1544100.2	1544100.4	1544100.5
Phenols in SVOC Soil Samples by GC-MS					
3 & 4-Methylphenol (m- + p-cresol)	mg/kg dry wt	-	< 3 ± 1.2	-	-
2-Methylphenol (o-Cresol)	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
2-Nitrophenol	mg/kg dry wt	-	< 5 ± 3.4	-	-
Pentachlorophenol (PCP)	mg/kg dry wt	-	< 30 ± 68	-	-
Phenol	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
2,4,5-Trichlorophenol	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
2,4,6-Trichlorophenol	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
Plasticisers in SVOC Soil Samples by GC-MS					
Bis(2-ethylhexyl)phthalate	mg/kg dry wt	-	< 5 ± 3.4	-	-
Butylbenzylphthalate	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
Di(2-ethylhexyl)adipate	mg/kg dry wt	-	< 1.0 ± 5.1	-	-
Diethylphthalate	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
Dimethylphthalate	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
Di-n-butylphthalate	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
Di-n-octylphthalate	mg/kg dry wt	-	< 1.0 ± 0.67	-	-
Other Halogenated compounds in SVOC Soil Samples by GC-MS					
1,2-Dichlorobenzene	mg/kg dry wt	-	< 0.7 ± 0.35	-	-
1,3-Dichlorobenzene	mg/kg dry wt	-	< 0.7 ± 0.35	-	-
1,4-Dichlorobenzene	mg/kg dry wt	-	< 0.7 ± 0.35	-	-
Hexachlorobutadiene	mg/kg dry wt	-	< 0.7 ± 0.35	-	-
Hexachloroethane	mg/kg dry wt	-	< 0.7 ± 0.36	-	-
1,2,4-Trichlorobenzene	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Other compounds in SVOC Soil Samples by GC-MS					
Benzyl alcohol	mg/kg dry wt	-	< 10 ± 6.7	-	-
Carbazole	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Dibenzofuran	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Isophorone	mg/kg dry wt	-	< 0.5 ± 0.34	-	-
Tributyl Tin Trace in Soil samples by GCMS					
Dibutyltin (as Sn)	mg/kg dry wt	-	< 0.005 ± 0.0056	-	< 0.005 ± 0.0056
Monobutyltin (as Sn)	mg/kg dry wt	-	< 0.007 ± 0.0075	-	< 0.007 ± 0.0075
Tributyltin (as Sn)	mg/kg dry wt	-	< 0.004 ± 0.0044	-	< 0.004 ± 0.0044
Triphenyltin (as Sn)	mg/kg dry wt	-	< 0.003 ± 0.0021	-	< 0.003 ± 0.0021
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	-	< 8 ± 5.4	-	< 8 ± 5.4
C10 - C14	mg/kg dry wt	-	< 20 ± 7.6	-	< 20 ± 7.6
C15 - C36	mg/kg dry wt	-	< 40 ± 9.3	-	< 40 ± 9.3
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	< 70 ± 14	-	< 70 ± 14

Sample Name:		V201.0-1.5m A 24-Feb-2016 11:00 am	V18 0.0-0.5m A 24-Feb-2016 1:00 pm	V18 0.0-0.5m B 24-Feb-2016 1:00 pm	V18 0.5-1.0m A 24-Feb-2016 1:00 pm
Lab Number:		1544100.6	1544100.9	1544100.10	1544100.12
Individual Tests					
Dry Matter	g/100g as rcvd	-	-	88.1 ± 5.0	-
Total Organic Carbon*	g/100g dry wt	0.052 ± 0.041	< 0.13 ± 0.042	-	< 0.05 ± 0.041
Antifouling cobiocides in sediment samples by LCMSMS					
Diuron*	mg/kg dry wt	-	-	< 0.010	-
Irgarol*	mg/kg dry wt	-	-	< 0.010	-
Isoproturon*	mg/kg dry wt	-	-	< 0.010	-
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	2.68 ± 0.30	1.92 ± 0.24	-	2.21 ± 0.26
Total Recoverable Cadmium	mg/kg dry wt	0.0174 ± 0.0064	< 0.010 ± 0.0062	-	0.0121 ± 0.0062
Total Recoverable Chromium	mg/kg dry wt	8.9 ± 1.1	5.44 ± 0.67	-	9.1 ± 1.1
Total Recoverable Copper	mg/kg dry wt	0.45 ± 0.15	0.41 ± 0.15	-	0.35 ± 0.14
Total Recoverable Lead	mg/kg dry wt	1.07 ± 0.14	0.83 ± 0.11	-	1.14 ± 0.14

Sample Type: Sediment					
	Sample Name:	V201.0-1.5m A 24-Feb-2016 11:00 am	V18 0.0-0.5m A 24-Feb-2016 1:00 pm	V18 0.0-0.5m B 24-Feb-2016 1:00 pm	V18 0.5-1.0m A 24-Feb-2016 1:00 pm
	Lab Number:	1544100.6	1544100.9	1544100.10	1544100.12
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Mercury	mg/kg dry wt	< 0.010 ± 0.0067	< 0.010 ± 0.0067	-	< 0.010 ± 0.0067
Total Recoverable Nickel	mg/kg dry wt	2.16 ± 0.26	3.39 ± 0.37	-	2.10 ± 0.25
Total Recoverable Zinc	mg/kg dry wt	8.1 ± 1.4	4.38 ± 0.75	-	8.9 ± 1.5
Polycyclic Aromatic Hydrocarbons Screening in Soil					
Acenaphthene	mg/kg dry wt	-	-	< 0.03 ± 0.0092	-
Acenaphthylene	mg/kg dry wt	-	-	< 0.03 ± 0.0070	-
Anthracene	mg/kg dry wt	-	-	< 0.03 ± 0.0095	-
Benzo[a]anthracene	mg/kg dry wt	-	-	< 0.03 ± 0.0089	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	-	-	< 0.03 ± 0.0069	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	-	-	< 0.03 ± 0.0081	-
Benzo[g,h,i]perylene	mg/kg dry wt	-	-	< 0.03 ± 0.0077	-
Benzo[k]fluoranthene	mg/kg dry wt	-	-	< 0.03 ± 0.0073	-
Chrysene	mg/kg dry wt	-	-	< 0.03 ± 0.0075	-
Dibenzo[a,h]anthracene	mg/kg dry wt	-	-	< 0.03 ± 0.0073	-
Fluoranthene	mg/kg dry wt	-	-	< 0.03 ± 0.0071	-
Fluorene	mg/kg dry wt	-	-	< 0.03 ± 0.0072	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	-	-	< 0.03 ± 0.0070	-
Naphthalene	mg/kg dry wt	-	-	< 0.13 ± 0.043	-
Phenanthrene	mg/kg dry wt	-	-	< 0.03 ± 0.0074	-
Pyrene	mg/kg dry wt	-	-	< 0.03 ± 0.0073	-
Haloethers in SVOC Soil Samples by GC-MS					
Bis(2-chloroethoxy) methane	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Bis(2-chloroethyl)ether	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Bis(2-chloroisopropyl)ether	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
4-Bromophenyl phenyl ether	mg/kg dry wt	-	-	< 0.4 ± 0.21	-
4-Chlorophenyl phenyl ether	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Nitrogen containing compounds in SVOC Soil Samples by GC-MS					
2,4-Dinitrotoluene	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
2,6-Dinitrotoluene	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
Nitrobenzene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
N-Nitrosodi-n-propylamine	mg/kg dry wt	-	-	< 0.7 ± 0.35	-
N-Nitrosodiphenylamine + Diphenylamine	mg/kg dry wt	-	-	< 0.7 ± 0.40	-
Organochlorine Pesticides in SVOC Soil Samples by GC-MS					
Aldrin	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
alpha-BHC	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
beta-BHC	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
delta-BHC	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
gamma-BHC (Lindane)	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
4,4'-DDD	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
4,4'-DDE	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
4,4'-DDT	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
Dieldrin	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Endosulfan I	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
Endosulfan II	mg/kg dry wt	-	-	< 2 ± 1.4	-
Endosulfan sulphate	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
Endrin	mg/kg dry wt	-	-	< 0.7 ± 0.38	-
Endrin ketone	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
Heptachlor	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Heptachlor epoxide	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Hexachlorobenzene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Polycyclic Aromatic Hydrocarbons in SVOC Soil Samples by GC-MS					
Acenaphthene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Acenaphthylene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-

Sample Type: Sediment					
	Sample Name:	V201.0-1.5m A 24-Feb-2016 11:00 am	V18 0.0-0.5m A 24-Feb-2016 1:00 pm	V18 0.0-0.5m B 24-Feb-2016 1:00 pm	V18 0.5-1.0m A 24-Feb-2016 1:00 pm
	Lab Number:	1544100.6	1544100.9	1544100.10	1544100.12
Polycyclic Aromatic Hydrocarbons in SVOC Soil Samples by GC-MS					
Anthracene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Benzo[a]anthracene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Benzo[g,h,i]perylene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Benzo[k]fluoranthene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
1&2-Chloronaphthalene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Chrysene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Dibenzo[a,h]anthracene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Fluoranthene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Fluorene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
2-Methylnaphthalene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Naphthalene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Phenanthrene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Pyrene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Phenols in SVOC Soil Samples by GC-MS					
4-Chloro-3-methylphenol	mg/kg dry wt	-	-	< 5 ± 3.4	-
2-Chlorophenol	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
2,4-Dichlorophenol	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
2,4-Dimethylphenol	mg/kg dry wt	-	-	< 3 ± 1.2	-
3 & 4-Methylphenol (m- + p-cresol)	mg/kg dry wt	-	-	< 3 ± 1.2	-
2-Methylphenol (o-Cresol)	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
2-Nitrophenol	mg/kg dry wt	-	-	< 5 ± 3.4	-
Pentachlorophenol (PCP)	mg/kg dry wt	-	-	< 30 ± 68	-
Phenol	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
2,4,5-Trichlorophenol	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
2,4,6-Trichlorophenol	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
Plasticisers in SVOC Soil Samples by GC-MS					
Bis(2-ethylhexyl)phthalate	mg/kg dry wt	-	-	< 5 ± 3.4	-
Butylbenzylphthalate	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
Di(2-ethylhexyl)adipate	mg/kg dry wt	-	-	< 1.0 ± 5.1	-
Diethylphthalate	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
Dimethylphthalate	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
Di-n-butylphthalate	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
Di-n-octylphthalate	mg/kg dry wt	-	-	< 1.0 ± 0.67	-
Other Halogenated compounds in SVOC Soil Samples by GC-MS					
1,2-Dichlorobenzene	mg/kg dry wt	-	-	< 0.7 ± 0.35	-
1,3-Dichlorobenzene	mg/kg dry wt	-	-	< 0.7 ± 0.35	-
1,4-Dichlorobenzene	mg/kg dry wt	-	-	< 0.7 ± 0.35	-
Hexachlorobutadiene	mg/kg dry wt	-	-	< 0.7 ± 0.35	-
Hexachloroethane	mg/kg dry wt	-	-	< 0.7 ± 0.36	-
1,2,4-Trichlorobenzene	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Other compounds in SVOC Soil Samples by GC-MS					
Benzyl alcohol	mg/kg dry wt	-	-	< 10 ± 6.7	-
Carbazole	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Dibenzofuran	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Isophorone	mg/kg dry wt	-	-	< 0.5 ± 0.34	-
Tributyl Tin Trace in Soil samples by GCMS					
Dibutyltin (as Sn)	mg/kg dry wt	-	-	< 0.005 ± 0.0056	-
Monobutyltin (as Sn)	mg/kg dry wt	-	-	< 0.007 ± 0.0075	-
Tributyltin (as Sn)	mg/kg dry wt	-	-	< 0.004 ± 0.0044	-
Triphenyltin (as Sn)	mg/kg dry wt	-	-	< 0.003 ± 0.0021	-

Sample Type: Sediment					
Sample Name:		V201.0-1.5m A 24-Feb-2016 11:00 am	V18 0.0-0.5m A 24-Feb-2016 1:00 pm	V18 0.0-0.5m B 24-Feb-2016 1:00 pm	V18 0.5-1.0m A 24-Feb-2016 1:00 pm
Lab Number:		1544100.6	1544100.9	1544100.10	1544100.12
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	-	-	< 8 ± 5.4	-
C10 - C14	mg/kg dry wt	-	-	< 20 ± 7.6	-
C15 - C36	mg/kg dry wt	-	-	< 40 ± 9.3	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	-	-	< 70 ± 14	-

Sample Name:		V18 0.5-1.0m B 24-Feb-2016 1:00 pm	V18 2.0-3.0m A 24-Feb-2016 1:00 pm	V18 1.0-2.0m A 24-Feb-2016 1:00 pm	V19 0-0.5m A 24-Feb-2016 12:00 pm
Lab Number:		1544100.13	1544100.16	1544100.19	1544100.22
Individual Tests					
Dry Matter	g/100g as rcvd	84.0 ± 5.0	-	-	-
Total Organic Carbon*	g/100g dry wt	-	0.166 ± 0.043	< 0.05 ± 0.041	< 0.13 ± 0.042
Antifouling cobiocides in sediment samples by LCMSMS					
Diuron*	mg/kg dry wt	< 0.010	-	-	-
Irgarol*	mg/kg dry wt	< 0.010	-	-	-
Isoproturon*	mg/kg dry wt	< 0.010	-	-	-
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	-	4.18 ± 0.44	2.60 ± 0.30	2.49 ± 0.29
Total Recoverable Cadmium	mg/kg dry wt	-	0.0380 ± 0.0076	0.0105 ± 0.0062	< 0.010 ± 0.0062
Total Recoverable Chromium	mg/kg dry wt	-	14.7 ± 1.8	8.3 ± 1.1	5.54 ± 0.68
Total Recoverable Copper	mg/kg dry wt	-	0.68 ± 0.17	0.35 ± 0.14	0.39 ± 0.15
Total Recoverable Lead	mg/kg dry wt	-	1.66 ± 0.21	1.00 ± 0.13	0.685 ± 0.087
Total Recoverable Mercury	mg/kg dry wt	-	< 0.010 ± 0.0067	< 0.010 ± 0.0067	< 0.010 ± 0.0067
Total Recoverable Nickel	mg/kg dry wt	-	4.98 ± 0.52	1.92 ± 0.24	2.38 ± 0.28
Total Recoverable Zinc	mg/kg dry wt	-	10.6 ± 1.8	8.3 ± 1.4	4.90 ± 0.83
Polycyclic Aromatic Hydrocarbons Screening in Soil					
Acenaphthene	mg/kg dry wt	< 0.03 ± 0.0093	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.03 ± 0.0070	-	-	-
Anthracene	mg/kg dry wt	< 0.03 ± 0.0096	-	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.03 ± 0.0090	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.03 ± 0.0069	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.03 ± 0.0082	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.03 ± 0.0078	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.03 ± 0.0073	-	-	-
Chrysene	mg/kg dry wt	< 0.03 ± 0.0075	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.03 ± 0.0073	-	-	-
Fluoranthene	mg/kg dry wt	< 0.03 ± 0.0071	-	-	-
Fluorene	mg/kg dry wt	< 0.03 ± 0.0072	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.03 ± 0.0070	-	-	-
Naphthalene	mg/kg dry wt	< 0.13 ± 0.044	-	-	-
Phenanthrene	mg/kg dry wt	< 0.03 ± 0.0074	-	-	-
Pyrene	mg/kg dry wt	< 0.03 ± 0.0073	-	-	-
Tributyl Tin Trace in Soil samples by GCMS					
Dibutyltin (as Sn)	mg/kg dry wt	< 0.005 ± 0.0056	-	-	-
Monobutyltin (as Sn)	mg/kg dry wt	< 0.007 ± 0.0075	-	-	-
Tributyltin (as Sn)	mg/kg dry wt	< 0.004 ± 0.0044	-	-	-
Triphenyltin (as Sn)	mg/kg dry wt	< 0.003 ± 0.0021	-	-	-
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	< 8 ± 5.4	-	-	-
C10 - C14	mg/kg dry wt	< 20 ± 7.6	-	-	-
C15 - C36	mg/kg dry wt	< 40 ± 9.3	-	-	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 70 ± 14	-	-	-

Sample Type: Sediment					
Sample Name:		V19 0-0.5m B 24-Feb-2016 12:00 pm	V19 0.5-1.0m A 24-Feb-2016 12:00 pm	V19 0.5-1.0m B 24-Feb-2016 12:00 pm	V19 1.0-2.0m A 24-Feb-2016 12:00 pm
Lab Number:		1544100.23	1544100.25	1544100.26	1544100.28
Individual Tests					
Dry Matter	g/100g as rcvd	86.3 ± 5.0	-	81.9 ± 5.0	-
Total Organic Carbon*	g/100g dry wt	-	0.059 ± 0.041	-	< 0.13 ± 0.042
Antifouling cobiocides in sediment samples by LCMSMS					
Diuron*	mg/kg dry wt	< 0.010	-	< 0.010	-
Irgarol*	mg/kg dry wt	< 0.010	-	< 0.010	-
Isoproturon*	mg/kg dry wt	< 0.010	-	< 0.010	-
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	-	2.44 ± 0.28	-	2.37 ± 0.28
Total Recoverable Cadmium	mg/kg dry wt	-	0.0271 ± 0.0069	-	0.0368 ± 0.0075
Total Recoverable Chromium	mg/kg dry wt	-	12.2 ± 1.5	-	34.1 ± 4.1
Total Recoverable Copper	mg/kg dry wt	-	0.49 ± 0.15	-	0.80 ± 0.18
Total Recoverable Lead	mg/kg dry wt	-	1.45 ± 0.18	-	1.05 ± 0.13
Total Recoverable Mercury	mg/kg dry wt	-	< 0.010 ± 0.0067	-	< 0.010 ± 0.0067
Total Recoverable Nickel	mg/kg dry wt	-	3.07 ± 0.34	-	17.1 ± 1.8
Total Recoverable Zinc	mg/kg dry wt	-	10.2 ± 1.7	-	7.8 ± 1.3
Polycyclic Aromatic Hydrocarbons Screening in Soil					
Acenaphthene	mg/kg dry wt	< 0.03 ± 0.0095	-	< 0.03 ± 0.0098	-
Acenaphthylene	mg/kg dry wt	< 0.03 ± 0.0070	-	< 0.03 ± 0.0071	-
Anthracene	mg/kg dry wt	< 0.03 ± 0.0098	-	< 0.03 ± 0.011	-
Benzo[a]anthracene	mg/kg dry wt	< 0.03 ± 0.0091	-	< 0.03 ± 0.0094	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.03 ± 0.0069	-	< 0.03 ± 0.0070	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.03 ± 0.0083	-	< 0.03 ± 0.0084	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.03 ± 0.0078	-	< 0.03 ± 0.0080	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.03 ± 0.0073	-	< 0.03 ± 0.0074	-
Chrysene	mg/kg dry wt	< 0.03 ± 0.0076	-	< 0.03 ± 0.0077	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.03 ± 0.0074	-	< 0.03 ± 0.0074	-
Fluoranthene	mg/kg dry wt	< 0.03 ± 0.0071	-	< 0.03 ± 0.0072	-
Fluorene	mg/kg dry wt	< 0.03 ± 0.0073	-	< 0.03 ± 0.0073	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.03 ± 0.0071	-	< 0.03 ± 0.0071	-
Naphthalene	mg/kg dry wt	< 0.13 ± 0.044	-	< 0.14 ± 0.046	-
Phenanthrene	mg/kg dry wt	< 0.03 ± 0.0075	-	< 0.03 ± 0.0076	-
Pyrene	mg/kg dry wt	< 0.03 ± 0.0074	-	< 0.03 ± 0.0074	-
Haloethers in SVOC Soil Samples by GC-MS					
Bis(2-chloroethoxy) methane	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Bis(2-chloroethyl)ether	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Bis(2-chloroisopropyl)ether	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
4-Bromophenyl phenyl ether	mg/kg dry wt	< 0.4 ± 0.21	-	-	-
4-Chlorophenyl phenyl ether	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Nitrogen containing compounds in SVOC Soil Samples by GC-MS					
2,4-Dinitrotoluene	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
2,6-Dinitrotoluene	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
Nitrobenzene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
N-Nitrosodi-n-propylamine	mg/kg dry wt	< 0.7 ± 0.35	-	-	-
N-Nitrosodiphenylamine + Diphenylamine	mg/kg dry wt	< 0.7 ± 0.41	-	-	-
Organochlorine Pesticides in SVOC Soil Samples by GC-MS					
Aldrin	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
alpha-BHC	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
beta-BHC	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
delta-BHC	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
gamma-BHC (Lindane)	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
4,4'-DDD	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
4,4'-DDE	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
4,4'-DDT	mg/kg dry wt	< 1.0 ± 0.67	-	-	-

Sample Type: Sediment					
	Sample Name:	V19 0-0.5m B 24-Feb-2016 12:00 pm	V19 0.5-1.0m A 24-Feb-2016 12:00 pm	V19 0.5-1.0m B 24-Feb-2016 12:00 pm	V19 1.0-2.0m A 24-Feb-2016 12:00 pm
	Lab Number:	1544100.23	1544100.25	1544100.26	1544100.28
Organochlorine Pesticides in SVOC Soil Samples by GC-MS					
Dieldrin	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Endosulfan I	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
Endosulfan II	mg/kg dry wt	< 2 ± 1.4	-	-	-
Endosulfan sulphate	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
Endrin	mg/kg dry wt	< 0.7 ± 0.39	-	-	-
Endrin ketone	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
Heptachlor	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Heptachlor epoxide	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Hexachlorobenzene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Polycyclic Aromatic Hydrocarbons in SVOC Soil Samples by GC-MS					
Acenaphthene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Acenaphthylene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Anthracene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Benzo[a]anthracene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Benzo[k]fluoranthene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
1&2-Chloronaphthalene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Chrysene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Fluoranthene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Fluorene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
2-Methylnaphthalene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Naphthalene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Phenanthrene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Pyrene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Phenols in SVOC Soil Samples by GC-MS					
4-Chloro-3-methylphenol	mg/kg dry wt	< 5 ± 3.4	-	-	-
2-Chlorophenol	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
2,4-Dichlorophenol	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
2,4-Dimethylphenol	mg/kg dry wt	< 3 ± 1.2	-	-	-
3 & 4-Methylphenol (m- + p-cresol)	mg/kg dry wt	< 3 ± 1.2	-	-	-
2-Methylphenol (o-Cresol)	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
2-Nitrophenol	mg/kg dry wt	< 5 ± 3.4	-	-	-
Pentachlorophenol (PCP)	mg/kg dry wt	< 30 ± 68	-	-	-
Phenol	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
2,4,5-Trichlorophenol	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
2,4,6-Trichlorophenol	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
Plasticisers in SVOC Soil Samples by GC-MS					
Bis(2-ethylhexyl)phthalate	mg/kg dry wt	< 5 ± 3.4	-	-	-
Butylbenzylphthalate	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
Di(2-ethylhexyl)adipate	mg/kg dry wt	< 1.0 ± 5.1	-	-	-
Diethylphthalate	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
Dimethylphthalate	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
Di-n-butylphthalate	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
Di-n-octylphthalate	mg/kg dry wt	< 1.0 ± 0.67	-	-	-
Other Halogenated compounds in SVOC Soil Samples by GC-MS					
1,2-Dichlorobenzene	mg/kg dry wt	< 0.7 ± 0.35	-	-	-
1,3-Dichlorobenzene	mg/kg dry wt	< 0.7 ± 0.35	-	-	-
1,4-Dichlorobenzene	mg/kg dry wt	< 0.7 ± 0.35	-	-	-
Hexachlorobutadiene	mg/kg dry wt	< 0.7 ± 0.35	-	-	-

Sample Type: Sediment					
	Sample Name:	V19 0-0.5m B 24-Feb-2016 12:00 pm	V19 0.5-1.0m A 24-Feb-2016 12:00 pm	V19 0.5-1.0m B 24-Feb-2016 12:00 pm	V19 1.0-2.0m A 24-Feb-2016 12:00 pm
	Lab Number:	1544100.23	1544100.25	1544100.26	1544100.28
Other Halogenated compounds in SVOC Soil Samples by GC-MS					
Hexachloroethane	mg/kg dry wt	< 0.7 ± 0.36	-	-	-
1,2,4-Trichlorobenzene	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Other compounds in SVOC Soil Samples by GC-MS					
Benzyl alcohol	mg/kg dry wt	< 10 ± 6.7	-	-	-
Carbazole	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Dibenzofuran	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Isophorone	mg/kg dry wt	< 0.5 ± 0.34	-	-	-
Tributyl Tin Trace in Soil samples by GCMS					
Dibutyltin (as Sn)	mg/kg dry wt	< 0.005 ± 0.0056	-	< 0.005 ± 0.0056	-
Monobutyltin (as Sn)	mg/kg dry wt	< 0.007 ± 0.0075	-	< 0.007 ± 0.0075	-
Tributyltin (as Sn)	mg/kg dry wt	< 0.004 ± 0.0044	-	< 0.004 ± 0.0044	-
Triphenyltin (as Sn)	mg/kg dry wt	< 0.003 ± 0.0021	-	< 0.003 ± 0.0021	-
Total Petroleum Hydrocarbons in Soil					
C7 - C9	mg/kg dry wt	< 8 ± 5.4	-	< 9 ± 5.4	-
C10 - C14	mg/kg dry wt	< 20 ± 7.6	-	< 20 ± 7.6	-
C15 - C36	mg/kg dry wt	< 40 ± 9.3	-	< 40 ± 9.3	-
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 70 ± 14	-	< 70 ± 14	-

Sample Type: Aqueous					
	Sample Name:	V20 0.0-0.5m A [Elutriation extract]			
	Lab Number:	1544100.31			
Individual Tests					
Total Chromium*	g/m^3	< 0.0011 ± 0.00074	-	-	-
Total Nickel*	g/m^3	0.014	-	-	-

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

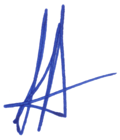
Test	Method Description	Default Detection Limit	Sample No
Antifouling cobiocides in sediment samples by LCMSMS*		0.010 mg/kg dry wt	2, 5, 10, 13, 23, 26
Antifouling cobiocides suite in sediment by LCMSMS*	Ethyl acetate extraction, SPE cleanup, determination by LCMSMS.	-	2, 5, 10, 13, 23, 26
Environmental 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%.	-	1-2, 4-6, 9-10, 12-13, 16, 19, 22-23, 25-26, 28
TPH Oil Industry Profile + PAHscreen	Sonication in DCM extraction, SPE cleanup, GC-FID & GC-MS analysis. Tested on as received sample. US EPA 8015B/MfE Petroleum Industry Guidelines [KBIs:5786,2805,10734;2695]	0.010 - 60 mg/kg dry wt	2, 5, 10, 13, 23, 26
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, 4, 6, 9, 12, 16, 19, 22, 25, 28
Elutriation testing*	Extn with (client supplied) water, eg seawater, Sed:Water 1:4 by vol, mix 30 min, settle 1 hr, filtration or centrifugation. US EPA 503/8-91/001, "Evaluation of Dredged Material for Ocean Disposal".	-	1
Semivolatile Organic Compounds Screening in Soil by GC-MS	Sonication extraction, GPC cleanup (if required), GC-MS FS analysis. Tested on as received sample	0.3 - 30 mg/kg dry wt	2, 10, 23

Sample Type: Sediment			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Tributyl Tin Trace in Soil samples by GCMS	Solvent extraction, ethylation, SPE cleanup, GC-MS SIM analysis. Tested on dried sample	0.003 - 0.007 mg/kg dry wt	2, 5, 10, 13, 23, 26
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	2, 5, 10, 13, 23, 26
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1, 4, 6, 9, 12, 16, 19, 22, 25, 28
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, 6, 9, 12, 16, 19, 22, 25, 28

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Digestion of Saline Samples*	Nitric acid digestion. APHA 3030 E 22nd ed. 2012 (modified).	-	31
Total Chromium*	Nitric acid digestion, ICP-MS with dynamic reaction cell, ultratrace. APHA 3125 B 22nd ed. 2012.	0.0011 g/m^3	31
Total Nickel*	Nitric acid digestion, ICP-MS with universal cell, ultratrace. APHA 3125 B 22nd ed. 2012.	0.0011 g/m^3	31

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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