REPORT

Bay of Plenty Regional Council

Opureora Dredging Spoil Disposal Assessment

Tonkin & Taylor

ENVIRONMENTAL AND ENGINEERING CONSULTANTS

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Executive summary

Bay of Plenty Regional Council (Council) commissioned Tonkin & Taylor Ltd (T&T) to assess potential disposal sites for the Opureora Channel dredge spoil. The objective of the study is to assess potential disposal sites, taking into account indicative costs and the feasibility of the physical works. The physical dredging works have been assessed based on both the cutter suction dredge and barge mounted excavator method.

Council have resource consent to dredge the Opureora Channel. However, the consent does not provide for the disposal of dredged material. Based on previous work and consultation with the local community Council have identified 10 potential disposal sites (refer to Table below).

Potential Opureora Channel dredge spoil disposal option list identified by Council (cost estimates based on dredging 7,100 m^3)

Option	Disposal description	Feasible	Cost estimate
1	Port of Tauranga Main Ocean disposal site, Mt Maunganui	Yes	$533,000
2	J. Swap's sand stockpile yard, Sulphur Point	Yes	$565,000
3	Sub-tidal location within the harbour for natural redistribution	No	
4	Land based disposal on the mainland (Ōmokoroa Peninsula)	Yes	$622,000
5	Land based disposal to Matakana Island	Yes	$565,000
6	Land based disposal or beach nourishment at Opureora sandspit	Yes – nourishment No – land based	$380,000
7	Land based disposal on Motuhoa Island or Rangiwāea Island	Yes	$622,000
8	Beach renourishment or erosion protection backfill material at Opureora Marae	No - both	
9	Beach renourishment west of the Opureora Boat ramp	No - both	
10	Beach renourishment or erosion protection backfill material on Rangiwāea Island	No - both	

The cost estimates have been provided in the above table for the options considered to be feasible. The estimates are for the total physical works costs of dredging based on the most economic method and also the professional fees for lodging a resource consent application.

We consider the four options to be unfeasible due to the following reasons:

- The sub-tidal deposition is a relatively uncontrolled method and there is a high risk of resource consent being declined for this activity (Option 3).
- Land based disposal is not considered feasible on Opureora Spit because it has been identified in the BOPRC Coastal Plan as a Coastal Habitat Preservation Zone (CHPZ19). The spit is listed as a significant marsh bird (New Zealand Fern Bird) habitat including searush and tussock land (Option 6 – land based).

- Approximately 80% of the dredge spoil placed as beach nourishment in front of the three cliff locations is expected to be transported alongshore and offshore (winnowed) from the beach face to other parts of the beach profile below MSL. Therefore, we do not consider the dredged spoil to be suitable for beach nourishment at these locations (Option 8, 9 and 10 - nourishment).
- Backfill behind an erosion protection structure would only account for a small proportion of the sediment requiring disposal and is not considered to be a feasible option on its own (Option 8 and 10 – erosion protection backfill).

The other six options identified in the above table are practically feasible and range in cost from $385,000 to $622,000 for the 7,100 m^3 volume scenario, including professional fees associated with lodging an application for resource consent. The land based disposal options have the highest cost due to the double handling of truck transfer. The beach nourishment of Opureora Spit has the lowest cost due to the close proximity to the site and the suitability of the cutter suction dredge method.

We recommend assessing the channel infilling rates based on the survey data undertaken on the second anniversary of completing the dredging, which is required under the existing consent. Maintenance dredging using the cutter suction dredge method is likely to be more economic over a longer time interval of 5 – 10 years, due to the high mobilisation costs.

1 Introduction

Bay of Plenty Regional Council (Council) commissioned Tonkin & Taylor Ltd (T&T) to assess potential disposal sites for the Opureora Channel dredge spoil. The objective of the study is to assess potential disposal sites, taking into account indicative costs and the feasibility of the physical works. The physical dredging works have been assessed based on both the cutter suction dredge and barge mounted excavator method.

The Opureora Channel is located within the Tauranga Harbour adjacent to Opureora, Matakana Island (refer to Appendix A for a site location plan). The Opureora Channel is approximately 1.8 km long and is the main access channel for the Omokoroa to Matakana Island vehicle ferry.

Council have an existing consent for the proposed dredging (Consent 63226 attached in Appendix B), which allows for up to 12,000 m^3 of material to be removed from the Opureora Channel over an area 20 m wide by 850 m long. The vehicle ferry requires a minimum water depth of 1.2 m below Chart Datum for all tide access when fully loaded. Council is also considering an overdredging buffer of 200 mm resulting in the following two dredging volume scenarios (refer to Appendix C for a Figure of the proposed dredging alignment):

- 10,500 m^3 based on a minimum cut depth of 1.4 m below Chart Datum
- 7,100 m^3 based on a minimum cut depth of 1.2 m below Chart Datum.

The consent does not provide for the disposal of dredged material and prohibits disposal in the coastal marine area (CMA). The consent is based on the assumption that the dredging will be undertaken by barge mounted excavator and limits the dredging activity to the outgoing tide. Based on previous work and consultation with the local community Council have identified 10 potential disposal sites (refer to Table 1). The 10 potential options can be categorised into the following three groups:

- offsite marine disposal location (Group A)
- land based disposal (Group B)
- foreshore based disposal for local erosion protection purposes (Group C).

Table 1 Potential Opureora Channel dredge spoil disposal option list identified by BOPRC

Option	Disposal description	Group
1	Port of Tauranga Main Ocean disposal site, Mt Maunganui	A
2	J. Swap's sand stockpile yard, Sulphur Point	B
3	Sub-tidal location within the harbour for natural redistribution	A
4	Land based disposal on the mainland (Ōmokoroa Peninsula)	B
5	Land based disposal to Matakana Island	B
6	Land based disposal or beach nourishment at Opureora sandspit	B/C
7	Land based disposal on Motuhoa Island or Rangiwāea Island	B
8	Beach renourishment or erosion protection backfill material at Opureora Marae	C
9	Beach renourishment west of the Opureora Boat ramp	C
10	Beach renourishment or erosion protection backfill material on Rangiwāea Island	C

2 Site inspection

A site inspection was undertaken by Mark Ivamy (T&T) and Bruce Gardner (Council) on 28 March 2014. The site inspection was based at Opureora, Matakana Island and covered inspecting the shoreline 400 m either side of the Opureora boat ramp including the basal end of the Opureora Spit. The primary purpose of the site inspections was to make visual observations and appraise the proposed beach nourishment disposal sites on Matakana Island. Surficial sediment samples from the proposed beach nourishment sites were also collected during the site visit.

The cliff system north of the boat ramp is actively eroding where the base of the cliff is undercut and the cliff face slumps onto the foreshore. A portion of the eroding cliff material is a source of sediment for the local beaches in this area. The direction of longshore transport is south toward the boat ramp, as evident from the sandy beach formed against the updrift side of the Opureora boat ramp. A rock seawall exists on the south eastern side of the boat ramp that is approximately 40 m long. There is currently no sandy beach east of the seawall along the south facing cliff section of shoreline fronting the Opureora Marae. There is sand build up on the western side of a private jetty located east of this cliff section at the basal end of the Opureora Spit. The build-up of sand on the western side of the jetty has formed a short beach, which is evidence of sand movement in an easterly direction. The Opureora Spit extends in a south east direction for approximately 800 m.

There were four existing sandy beaches identified during the site visit (refer to Figure 1 for site photographs):

- Opureora Spit
    - medium sand beach
    - 800 m long
    - minimal berm, erosion scarp evident
    - 12(Horizontal):1(Vertical) beach slope.
- Opureora East – located west of a private jetty adjacent to the basal end of the spit
    - coarse sand beach
    - 30 m long
    - 2 m wide berm
    - 10(Horizontal):1(Vertical) beach slope.
- Opureora West – located immediately north west of the Opureora boat ramp
    - coarse sand beach
    - 80 m long
    - 2 m wide berm
    - 10(Horizontal):1(Vertical) beach slope.
- Opureora West Wharf – located adjacent to the historic wharf some 300 m north west of the Opureora boat ramp
    - coarse sand beach
    - 40 m long
    - 2 m wide berm
    - 10(Horizontal):1(Vertical) beach slope.

A – Opureora Spit Beach

B – Opureora East Beach

C – Opureora West Beach

D – Opureora West Wharf Beach

Figure 1 Site photographs

3 Sediment analysis

3.1 Existing beaches

Surficial sediment samples were collected from each of the four existing beach locations (listed in the above section) to investigate the suitability of the dredge spoil for beach nourishment. Refer to the location plan attached in Appendix A for a location of the sediment sample points. The sediment samples were analysed for grain size at the University of Waikato using the Malvern Rapid Sediment Size Analyser.

Table 2 outlines the results of the beach sediment grain size analysis. Refer to Appendix D for a full set of the sediment analysis results.

Table 2 Beach sediment sample summary

Sample	Location	D50 (mm)	Standard Deviation (mm)
Opureora East	Beach Berm	0.517	0.208
Opureora West	Beach Berm	0.516	0.210
Opureora West Wharf	Beach Berm	0.516	0.208
Opureora Spit	Beach Slope 12(H):1(V)	0.359	0.207
Opureora East	Beach Slope 10(H):1(V)	0.610	0.365
Opureora West	Beach Slope 10(H):1(V)	0.670	0.334
Opureora West Wharf	Beach Slope 10(H):1(V)	0.750	0.380
Opureora East	Beach Toe	0.420	0.270
Opureora West	Beach Toe	0.345	0.178
Opureora West Wharf	Beach Toe	0.414	0.230

The beach slope sediment grain size appears to be greatest in the north west at the Opureora West Wharf beach and reduces further to the south east in the direction of longshore transport. The greatest beach sediment grain size is located on the active beach slope and then the berm area above high tide. The smallest beach sediment grain size is located below the mean sea level (MSL) elevation at the beach toe.

3.2 Opureora Channel

Subsurface sediment samples will be collected from 5 sites along the proposed dredged alignment to a depth of up to 1 m using the Ogeechee Sand Sampler. Refer to the location plan attached in Appendix A for a location of the sediment sample points. The sediment samples were analysed for grain size at the University of Waikato using the Malvern Rapid Sediment Size Analyser. Table 3 outlines the results of the beach sediment grain size analysis. Refer to Appendix D for a full set of the sediment analysis results.

Table 3 Opureora Channel sediment sample summary

Sample (vertical distance below surface)	Location	D50 (mm)	Standard Deviation (mm)
BH5A (0 – 150 mm)	Channel Sub-surface	0.308	0.227
BH5B (150 – 800 mm)	Channel Sub-surface	0.293	0.150
BH4 (0 – 800 mm)	Channel Sub-surface	0.356	0.196
BH3A (0 – 400 mm)	Channel Sub-surface	0.322	0.220
BH3B (400 – 800 mm)	Channel Sub-surface	0.298	0.220
BH2A (0 – 400 mm)	Channel Sub-surface	0.191	0.249
BH2B (400 – 800 mm)	Channel Sub-surface	0.82	0.190
BH1 (0 – 500 mm)	Channel Sub-surface	0.111	0.255

BH1 and BH2 comprised very fine sand and coarse silt. BH3, BH4 and BH5 comprise fine to medium sand sediment. Refer to Appendix D for a full set of the sediment analysis results.

The two samples located in close proximity to the ferry boat ramp, wharf and Opureora mainland (BH1 and BH2) where a higher risk of contamination could be expected were also analysed for both heavy metal and pesticide contamination. Both sites returned low values for all tests, which are below the NES Human Health Soil Guidelines for the Bay of Plenty Region. Refer to Appendix E for the contamination test results.

3.3 Sediment compatibility

The Opureora Channel dredge spoil is likely to be more prone to movement on the beach face than the in-situ material as the sediment is generally smaller and therefore more mobile and also will have a flatter stable angle than the existing beaches. The sediment sampled from BH1 is unsuitable for beach nourishment because of the very fine sand and silt material being too different to the in-situ material. The remaining Opureora Channel samples from BH2, BH3, BH4 and BH5 are fine to medium sand sediment and have some cross-over in grain size characteristics with the in-situ material. An estimate on the likely volume of dredged sediment required to replicate the natural shoreline has been assessed using a beach overfill ratio method (USACE, 1995).

The overfill ratio is used to estimate the volume of dredged material required to produce a stable unit of usable beach nourishment material with the same sediment characteristics as the in-situ material. Table 4 shows the estimated overfill ratios (R_A) for channel sediment samples based on an average of the four in-situ beach sediment samples taken from the beach slope.

Table 4 Estimates of the overfill ratio (R_A)

	BH5A	BH5B	BH4	BH3A	BH3B	BH2A	Average
R_A	4.5	4.0	3.5	4.5	5.0	7.0	5

Based on the average overfill ratio (R_A) estimate of 5, 5 m^3 of dredged sediment is required to replicate placement of 1 m^3 of the in-situ material, but may be as high as 7 m^3. Therefore, on average approximately 20 % of the dredged material is expected to remain on the beach if used as beach nourishment material. And 80% of the material is expected to be transported offshore (winnowed) from the beach face to other parts of the beach profile below MSL. Therefore, we do not consider the dredged spoil material to be suitable for beach nourishment at locations north of the boat ramp or in front of the Marae.

The sediment sampled from the Opureora Spit beach slope is much closer to the sediment characteristics of the sediment sampled from the Opureora Channel. The average overfill ratio for the Opureora Spit beach face only is 1.8 (Table 5). Therefore, on average approximately 60% of dredged sediment is expected to remain on the beach and approximately 40% of the material is expected to be transported offshore (winnowed) from the beach face to other parts of the beach profile seaward of the beach toe. Therefore, the dredged material from the Opureora Channel is considered to be suitable for placement along the shoreline of the Opureora Spit.

Table 5 Estimates of the overfill ratio for Opureora Spit only (R_A)

	BH5A	BH5B	BH4	BH3A	BH3B	BH2A	Average
R_A	1.4	1.4	1.0	1.4	1.7	5	1.8

4 Options assessment

4.1 Descriptions

Port of Tauranga offshore disposal site (Option 1)

The Port of Tauranga (POT) have resource consent to dispose of dredged spoil material from Tauranga Harbour (sand sized sediment) in the nearshore zone located approximately 2 km offshore from Mt Maunganui main beach. This deposition ground is described as Area D (Main Ocean) under consent 40157, which has a maximum deposition allowance of 720,000 m^3 per year. The largest volume of sediment deposited within Area D in any given year over the last 10 years is approximately 67,000 m^3.

The dredge spoil from Opureora Channel could be disposed at this location assuming it meets the conditions of the consent and the POT agree to this activity. A new resource consent or consent variation would be required to undertake this disposal option. We consider this option to be a relatively low level consent risk.

Due to the distance from the site the only dredging method suitable for this option is a barge mounted excavator. The material would need to be transported by two split hopper barges operating in tandem to provide continuous transport and minimise down time.

Sulphur Point sand supply stock pile (Option 2)

Sand sized sediment from the POT dredging programme is stock piled at the Sulphur Point sand supply yard owned by J.Swap Ltd. The Opureora Channel dredge spoil could be deposited at this location assuming the yard has capacity and is willing to accept the material. The Opureora Channel dredging works would need to be scheduled to fit in with the POT dredging programme.

Due to the distance from the site the only dredging method suitable for this option is a barge mounted excavator. The material would need to be transported by two split hopper barges operating in tandem to provide continuous transport and minimise down time. The sediment could be unloaded at the Sulphur Point adjacent to the stock pile yard using a long reach excavator and transported using a front end loader. A land use resource consent would be required for this option because the temporary stockpile would be located within 50 m of mean high water springs. We consider this option to be a relatively low level consent risk.

There may be an opportunity to utilise the dredge spoil stockpiled at the Sulphur Point for nourishment of inner harbour city beaches, dependant on grain size compatibility analysis.

Sub-tidal site (Option 3)

The Opureora Channel dredge spoil could be deposited in an intertidal area close to the site for natural redistribution. This sub-tidal area should be located south of the Opureora Channel to minimise the risk of the material being transported back into the channel over time by longshore transport. There are large sand shoals currently located in the lee of Motuhoa Island. Due to the distance from the site the only dredging method suitable for this option is a barge mounted excavator. The sediment could then be transported and deposited by a single split hopper barge.

Resource consent would be required from BOPRC for this option to deposit material in the CMA. In our opinion, we consider this option unfeasible due to the relatively uncontrolled method of deposition and the high risk of resource consent being declined. We consider this option to be a relatively high level consent risk.

Land based disposal (Option 4, 5 and 7)

The Opureora Channel dredge spoil could be transported to temporary stockpile locations with good road access and used for land filling purposes. Council have identified the following four locations for land based disposal:

- Ōmokoroa
- Matakana Island
- Rangiwāea Island
- Motuhoa Island.

Matakana Island is the only location close enough to the site suitable for land based disposal using the cutter suction dredge method. Both Matakana Island and Omokoroa Island have suitable loading facilities for using the barge mounted excavator method. The Opureora Channel dredge spoil could be dredged and transported to the loading area using the barge mounted excavator. The dredge material would be transferred to a temporary stockpile where it could be loaded into trucks for transport. Two trucks operating in tandem and a 12T excavator would be required to shift the daily estimated dredge volume of two barge loads (180 m^3). A land use resource consent would be required for this option because the temporary stockpile would be located within 50 m of mean high water springs. We consider these options to be a relatively medium level consent risk.

There are limitations to the loading area at each site due to limited space and high vehicular usage. The ferry ramp car park area located along the landward edge of the seawall is the most suitable stock pile area at Matakana Island and would need to be temporarily closed for the duration of the works. There is also limited turning space for trucks at this location and temporary traffic controls may need to be implemented, particularly at the ferry loading and queuing area. The public boat ramp is the most suitable stock pile area at Ōmokoroa and it would need to be temporarily closed for the duration of the works and boat launching would be limited to the adjacent ferry ramp over this period. Truck transport in these two areas is also likely to involve the following disadvantages:

- Pressure on traffic at the ferry loading area and surrounding roads
- Maintenance work may be required on local roads and both the Omokoroa boat ramp and Matakana Island ferry car park due to the significant truck volumes.

Both Rangiwāea Island and Motuhoa Island could be used as locations for land based disposal using the barge mounted excavator method. However, the loading facilities are not ideal and the sediment would need to be temporarily stockpiled in the intertidal area at certain tides making the transfer to trucks more difficult. A front end loader would also be required in addition to an excavator to transfer the sediment into trucks. There is also likely to be some losses of sediment volume if it remains in the intertidal area over a tidal cycle. Resource consent would be required from BOPRC for this option to temporarily deposit material in the CMA. We consider these options to be a relatively medium level consent risk.

Opureora Spit (Option 6)

The Opureora Spit is located to the east of the site and is approximately 800 m long. Land based disposal is not considered feasible on Opureora Spit because it has been identified in the BOPRC Coastal Plan as a Coastal Habitat Preservation Zone (CHPZ19). The spit is listed as a significant marsh bird (New Zealand Fern Bird) habitat including sea-rush and tussock land.

The Opureora Channel dredge spoil could be deposited along the south west facing shoreline of the Opureora Spit as beach nourishment. The material could also act as a temporary stockpile if

the material was required for backfill behind a protection structure located in front of Opureora Marae at a later stage. Due to the predominant easterly sediment transport direction, the material is expected to move south east over time, in the direction of the natural spit extension. Resource consent would be required from BOPRC for this option to deposit material in the CMA. We consider this option to be a relatively medium level consent risk.

Only the cutter suction dredge method is suitable for this option due to the wide, shallow intertidal flat located between the spit and the channel, which significantly restricts the barge access.

Beach protection (Option 8, 9, 10)

The Opureora Channel dredge spoil could potentially be disposed at local locations near Opureora for the purpose of erosion protection in the form of either beach nourishment or backfill for a seawall structure. Council have identified the following three locations for erosion protection:

- Opureora Marae, Matakana Island
- North west of Opureora Boat Ramp, Matakana Island
- South west side of Rangiwāea Island.

The two locations on Matakana Island are the only locations close enough to the site suitable for disposal using the cutter suction dredge method for beach protection. Due to the predominant easterly sediment transport direction, the material is expected to move south east over time. Therefore, sand material placed in front of the Marae is expected to move east toward the Opureora Spit. Dredge spoil material placed north of the boat ramp is expected to move south toward the boat ramp and channel. Furthermore, approximately 80% of the placed material is expected to be transported offshore (winnowed) from the beach face to other parts of the beach profile below MSL (refer to Section 3.3). Therefore, we do not consider the dredged spoil to be suitable for beach nourishment at locations north of the boat ramp or in front of the Marae.

The dredge spoil could be transported to the south west side of Rangiwāea Island for beach nourishment using the barge mounted excavator method. The dredge spoil material can be dredged and transported to the location using the barge mounted excavator. The sediment will most likely need to be stockpiled in the intertidal area at certain tides. Some losses of sediment volume is likely if it remains in the intertidal area over a tidal cycle before placement. We would expect the dredge spoil placed as beach nourishment to behave in a similar way at Rangiwāea Island as at Opureora. Therefore, we do not consider the dredged spoil to be suitable for beach nourishment at Rangiwāea Island.

The dredge spoil could be transported to these locations for backfill material behind an erosion protection structure. A rock revetment is likely to be the most suitable erosion protection structure based on the wave climate and design life. A rock revetment design is likely to require a maximum backfill volume of 4 m^3 per linear meter. This equates to approximately 800 m^3 of required sediment over the 200 m shoreline section in front of the Opureora Marae. Therefore, this option would only account for a small proportion of the sediment requiring disposal and is not considered to be a feasible option on its own.

Resource consent would be required from BOPRC for this option to deposit material in the CMA. We consider these options to be a relatively medium level consent risk.

4.2 Rough order cost estimate

The scope of works for this report required the following two dredging methods to be considered for costing purposes:

- Cutter suction dredge (CSD)

- Barge mounted excavator (BME).

The majority of the options can be undertaken using the barge mounted excavator method, with the exception of Option 6 due to the depth limiting conditions of the wide intertidal flats restricting barge access. The cutter suction dredge method has only been considered for disposal options that are located close to the site where the slurry pipe does not interfere with marine navigation. Options 6, 8 and 9 can also be undertaken using the cutter suction dredge method. If the cutter suction dredge method is selected, then a variation to the existing dredging consent will most likely be required. Table 6 lists the plant required for the 10 options based on the relevant dredging method.

Table 6 Plant required to complete the dredging for each option

Option	Disposal description	Plant
1	Port of Tauranga offshore disposal site, Mt Maunganui	Barge mounted excavator Two Split Hopper Barges (240 m^3 per barge)
2	J. Swap's sand stockpile yard, Sulphur Point	Barge mounted excavator Two Split Hopper Barges (240 m^3 per barge) Land based excavator and front end loader
3	Sub-tidal location within the harbour for natural redistribution	Barge mounted excavator One Split Hopper Barge (240 m^3 per barge)
4	Land based disposal on the mainland (Ōmokoroa Peninsula)	Barge mounted excavator (90 m^3 per barge) Land based excavator and two trucks
5	Land based disposal to Matakana Island	Barge mounted excavator (90 m^3 per barge) Land based excavator and two trucks or cutter suction dredge with slurry pipeline Land based excavator and two trucks
6	Land based disposal or beach nourishment at Opureora sandspit	Cutter suction dredge with slurry pipeline Front end loader
7	Land based disposal on Motuhoa Island or Rangiwāea Island	Barge mounted excavator (90 m^3 per barge) Land based excavator and two Trucks
8	Beach renourishment or erosion protection backfill material at Opureora Marae	Barge mounted excavator (90 m^3 per barge) Land based excavator and two trucks Front end loader or cutter suction dredge with slurry pipeline Front end loader
9	Beach renourishment west of the Opureora Boat ramp and Jetty	Barge mounted excavator (90 m^3 per barge) Land based excavator and two trucks Front end loader or cutter suction dredge with slurry pipeline Front end loader
10	Beach renourishment or erosion protection backfill material on Rangiwāea Island	Barge mounted excavator (90 m^3 per barge) Land based excavator and two trucks Front end loader

The existing consent for dredging allows material to be removed from the channel by a barge mounted excavator and is limited to the outgoing tide. This condition effectively sets a maximum allowable daily operation time of six hours between sunrise and sunset. However, six hours will not always be available on the outgoing tide between sunrise and sunset. Based on LINZ tide tables we estimate the available operational hours will be reduced by approximately 20%, due to the limitation of dredging on the outgoing tide. We have assumed a full eight hour day can be worked using the cutter suction dredge method regardless of tides. The effects of the slurry discharge associated with this method would need to be addressed at the resource consenting stage.

The rough order cost estimates are based on our understanding of industry rates and have been provided for comparison budget estimate purposes only. This cost does not include professional fees for detailed design and construction supervision or contract administration.

The rough order cost for an erosion protection structure is based on a rock revetment at $3,000 per linear meter.

The rough order cost estimates are presented in a m^3 rate based on dredging and disposing both 7,100 m^3 and 10,500 m^3 and includes a 20 % contingency. The rough order cost estimate for dredging and disposing of the dredged spoil has been developed for the 10 options as outlined in Table 7.

Table 7 Rough order cost estimate summary for dredging and disposal of spoil

Option	Dredging unit rate estimate ($/$m^3$) (7,100 m^3 - 10,500 m^3)		Total dredging cost estimate based on the most economic method	
	BME	**CSD**	**7,100 m^3**	**10,500 m^3**
1	68 - 62	n/a	$483,000	$651,000
2	76 - 70	n/a	$540,000	$735,000
3	48 - 38	n/a	$340,000	$399,000
4	84 - 80	n/a	$597,000	$840,000
5	84 – 80	76 - 66	$540,000	$693,000
6	n/a	50 - 39	$355,000	$410,000
7	84 - 80	n/a	$597,000	$840,000
8	70 – 67	50 - 39	$355,000	$410,000
9	70 – 67	50 - 39	$355,000	$410,000
10	84 - 80	n/a	$597,000	$840,000

We recommend assessing the channel infilling rates based on the survey data undertaken on the second anniversary of completing the dredging, which is required under the existing consent. Maintenance dredging using the cutter suction dredge method is likely to be more economic over a longer time interval of 5 – 10 years, due to the high mobilisation costs.

The rough order costs for preparing and lodging a consent application for each option have been estimated including a 30 % contingency. The costs are estimated up to the point of lodgement and do not include lodgement fees, responses to requests for further info, preparation of evidence or attendance at a hearing. The consenting cost estimates can be grouped into three costs based on the disposal activity:

- Option 1 - $50,000
- Option 3 - $125,000
- Option 2,4,5,6,7,8,9 and 10 - $25,000.

4.3 Summary

A summary of the 10 potential options identified by Council is presented in Table 8 listing the advantages and disadvantages and the rough order cost based estimate based on dredging and disposing the spoil.

Table 8 Summary of potential options

Option	Method	Dredging cost estimate 10,500 m^3 scenario (7,100 m^3 scenario)	Lodging Consent cost estimate	Protection cost estimate	Total cost estimate 10,500 m^3 scenario (7,100 m^3 scenario)	Advantages	Disadvantages	Consent risk
1	BME only	$651,000 ($483,000)	$50,000	n/a	$701,000 ($533,000)	No effect on local road network and ferry operations.	No local use of sediment for erosion protection. Consent most likely required.	Low
2	BME only	$735,000 ($540,000)	$25,000	n/a	$760,000 ($565,000)	No effect on local road network and ferry operations. Material could be used for inner city beach nourishment.	No local use of sediment for erosion protection. Consent most likely required.	Low
3	BME only	$399,000 ($340,000)	$125,000	n/a	$524,000 ($465,000)	No effect on local road network and ferry operations.	No local use of sediment for erosion protection. Potentially high ecological effect of relatively uncontrolled disposal in the CMA.	High

Option	Method	Dredging cost estimate 10,500 m^3 scenario (7,100 m^3 scenario)	Lodging Consent cost estimate	Protection cost estimate	Total cost estimate 10,500 m^3 scenario (7,100 m^3 scenario)	Advantages	Disadvantages	Consent risk
							Not feasible due to the high risk of consent being declined.	
4	BME only	$840,000 ($597,000)	$25,000	n/a	$845,000 ($622,000)	Local land based use.	No local use of sediment for erosion protection. High effect on local road network and ferry operations. Consent most likely required.	Medium
5	BME CSD	$840,000 ($597,000) $693,000 ($540,000)	$25,000 $25,000	n/a n/a	$865,000 ($622,000) $718,000 ($565,000)	Local land based use.	No local use of sediment for erosion protection. High effect on local road network and ferry operations. Consent most likely required.	Medium
6	CSD only	$410,000 ($355,000)	$25,000	n/a	$435,000 ($380,000)	Local use of sediment for erosion protection along Opureora Spit. No effect on local road network and ferry operations.	Consent most likely required.	Medium
7	BME only	$840,000 ($597,000)	$25,000	n/a	$865,000 ($622,000)	Local land based use.	No local use of sediment for erosion protection.	Medium

Option	Method	Dredging cost estimate 10,500 m^3 scenario (7,100 m^3 scenario)	Lodging Consent cost estimate	Protection cost estimate	Total cost estimate 10,500 m^3 scenario (7,100 m^3 scenario)	Advantages	Disadvantages	Consent risk
							High effect on local road network and ferry operations. Consent most likely required.	
8, 9 Seawall backfill	BME	$704,000 ($497,000)	$25,000	$600,000[1]	$1,329,000 ($1,122,000)	Local use of sediment for erosion protection.	Consent most likely required. High effect on local road network and ferry operations. Not feasible as backfill would only dispose of approximately 800 m^3.	Medium
	CSD	$410,000 ($355,000)	$25,000	$600,000	$1,035,000 ($980,000)	Local use of sediment for erosion protection. No effect on local road network and ferry operations.	Consent most likely required. Not feasible as backfill would only dispose of approximately 800 m^3.	Medium
8,9 Beach Nourishment	BME	$704,000 ($497,000)	$25,000	n/a	$729,000 ($522,000)	Local use of sediment for erosion protection.	Consent most likely required. High effect on local road network and ferry operations. Not feasible as only 20% of material is expected to remain on the beach.	Medium
	CSD	$410,000 ($360,000)	$25,000	n/a	$435,000 ($385,000)	Local use of sediment for erosion protection.	Consent most likely required.	Medium

Option	Method	Dredging cost estimate 10,500 m^3 scenario (7,100 m^3 scenario)	Lodging Consent cost estimate	Protection cost estimate	Total cost estimate 10,500 m^3 scenario (7,100 m^3 scenario)	Advantages	Disadvantages	Consent risk
						No effect on local road network and ferry operations.	Not feasible as only 20% of material is expected to remain on the beach.	
10 Seawall backfill	BME	$840,000 ($597,000)	$25,000	$600,000[1]	$1,465,000 ($1,222,000)	Local use of sediment for erosion protection. No effect on local road network and ferry operations.	Consent most likely required. High effect on local road network and ferry operations. Not feasible as backfill would only dispose of approximately 800 m^3.	Medium
10 Beach Nourishment	BME	$840,000 ($597,000)	$25,000	n/a	$865,000 ($622,000)	Local use of sediment for erosion protection. No effect on local road network and ferry operations.	Consent most likely required. High effect on local road network and ferry operations. Not feasible as only 20% of material is expected to remain on the beach.	Medium

[1]The seawall cost is based on a length of 200 m.

5 Conclusions

Council have resource consent to dredge the Opureora Channel. However, the consent does not provide for the disposal of dredged material. Based on previous work and consultation with the local community Council have identified 10 potential disposal sites (refer to Table below).

Potential Opureora Channel dredge spoil disposal option list identified by Council (cost estimates based on dredging 7,100 m^3)

Option	Disposal description	Feasible	Cost estimate
1	Port of Tauranga Main Ocean disposal site, Mt Maunganui	Yes	$533,000
2	J. Swap's sand stockpile yard, Sulphur Point	Yes	$565,000
3	Sub-tidal location within the harbour for natural redistribution	No	
4	Land based disposal on the mainland (Ōmokoroa Peninsula)	Yes	$622,000
5	Land based disposal to Matakana Island	Yes	$565,000
6	Land based disposal or beach nourishment at Opureora sandspit	Yes – nourishment No – land based	$380,000
7	Land based disposal on Motuhoa Island or Rangiwāea Island	Yes	$622,000
8	Beach renourishment or erosion protection backfill material at Opureora Marae	No - both	
9	Beach renourishment west of the Opureora Boatramp	No - both	
10	Beach renourishment or erosion protection backfill material on Rangiwāea Island	No - both	

The cost estimates have been provided in the above table for the options considered to be feasible. The estimates are for the total physical works costs of dredging based on the most economic method and also the professional fees for lodging a resource consent application.

We consider the following four groups of options to be unfeasible due to the following reasons:

- The sub-tidal deposition is a relatively uncontrolled method and there is a high risk of resource consent being declined for this activity (Option 3).
- Land based disposal is not considered feasible on Opureora Spit because it has been identified in the BOPRC Coastal Plan as a Coastal Habitat Preservation Zone (CHPZ19). The spit is listed as a significant marsh bird (New Zealand Fern Bird) habitat including searush and tussock land (Option 6 – land based).
- Approximately 80% of the dredge spoil placed as beach nourishment in front of the three cliff locations is expected to be transported alongshore and offshore (winnowed) from the beach face to other parts of the beach profile below MSL. Therefore, we do not consider the dredged spoil to be suitable for beach nourishment at these locations (Option 8, 9 and 10 - nourishment).

- Backfill behind an erosion protection structure would only account for a small proportion of the sediment requiring disposal and is not considered to be a feasible option on its own (Option 8 and 10 – erosion protection backfill).

The other six options identified in the above table are practically feasible and range in cost from $385,000 to $622,000 for the 7,100 m^3 volume scenario, including professional fees associated with lodging an application for resource consent. The land based disposal options have the highest cost due to the double handling of truck transfer. The beach nourishment of Opureora Spit has the lowest cost due to the close proximity to the site and the suitability of the cutter suction dredge method.

We recommend assessing the channel infilling rates based on the survey data undertaken on the second anniversary of completing the dredging, which is required under the existing consent. Maintenance dredging using the cutter suction dredge method is likely to be more economic over a longer time interval of 5 – 10 years, due to the high mobilisation costs.

6 Applicability

This report has been prepared for the benefit of Bay of Plenty Regional Council with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
.....	.....
Mark Ivamy	Richard Reinen-Hamill
Senior Coastal Scientist	Project Director

MCI

P:\851786\IssuedDocuments\Final\140520.mci.FinalReport.docx

Appendix A: Location Plan

Aerial photo sourced from Google Earth(Copyright: 2012).

SCALE 1:50,000
0 500 1000 1500 2000 2500(m)

T:\Tauranga\Projects\851786\WorkingMaterial\CAD\851786.01.dwg, F01, 21/05/2014 10:35:44 a.m., dwn, 1:1

Tonkin & Taylor Environmental and Engineering Consultants Level 1, 525 Cameron Road, Tauranga www.tonkin.co.nz	DRAWN	AMC May.14
	DRAFTING CHECKED	GAN 5/14
	APPROVED	MCI 5/14
	CADFILE : \\851786.01.dwg	
	SCALES (AT A3 SIZE) 1:50,000	
	PROJECT No. 851786.00	

BAY OF PLENTY REGIONAL COUNCIL
CHANNEL DREDGING SPOIL DISPOSAL
OPUREORA
Location Plan

FIG. No. Figure 1 REV. 0

West wharf beach

East beach

Beach west of boat ramp

Opureora marae

Opureora boat ramp

Opureora spit

BH1

BH2

BH3

Proposed northern dredging area

BH4

BH5

Proposed southern dredging area

Omokoroa boat ramp

Motuhoal Island

Sub tidal sand shoal

N

Aerial photo sourced from Google Earth(Copyright: 2012).

SCALE 1: 10,000

0 100 200 300 400 500 (m)

Tonkin & Taylor
Environmental and Engineering Consultants
Level 1, 525 Cameron Road, Tauranga
www.tonkin.co.nz

DRAWN	AMC	May. 14
DRAFTING CHECKED	CGN	5/14
APPROVED	MCL	5/14
CADFILE :	\\851786.02.dwg	
SCALES (AT A3 SIZE)	1: 10,000	
PROJECT No.	851786.00	

BAY OF PLENTY REGIONAL COUNCIL

CHANNEL DREDGING SPOIL DISPOSAL OPUREORA

Site Plan

FIG. No. Figure 2

REV. 0

Appendix B: Resource Consent

Consent Number: **63226**

Bay of Plenty Regional Council

Resource Consent

Pursuant to section 105 of the Resource Management Act 1991, the **Bay of Plenty Regional Council**, by a decision dated 8 September 2005, **Hereby Grants** to:

BAY OF PLENTY REGIONAL COUNCIL

P O Box 364
WHAKATANE

A coastal permit:

a) pursuant to section 12(1)(c) of the Resource Management Act 1991 and Rule 14.2.4(b) of the Bay of Plenty Regional Coastal Environment Plan to undertake a discretionary activity being to **Disturb the Foreshore or Seabed of Tauranga Harbour;** and

b) pursuant to section 12(1)(e) of the Resource Management Act 1991 and Rule 14.2.4(b) of the Bay of Plenty Regional Coastal Environment Plan to undertake a discretionary activity being to **Destroy, Damage or Disturb the Foreshore or Seabed of Tauranga Harbour in a Manner That is Likely to Have an Adverse Effect on Plants, Animals or their Habitat;** and

c) pursuant to section 12(2)(b) of the Resource Management Act 1991 and Rule 14.2.4(b) of the Bay of Plenty Regional Coastal Environment Plan to undertake a discretionary activity being to **Remove Sand, Shingle, Shell or Other Natural Material from Crown Land in the Coastal Marine Area;** and

d) pursuant to section 15(1)(a) of the Resource Management Act 1991 and Rule 9.2.4(b) of the Bay of Plenty Regional Coastal Environment Plan to undertake a discretionary activity being to **Discharge Sediment-Laden Water to the Tauranga Harbour;**

subject to the following conditions:

1 Purpose

For the purpose of excavating by dredging, material from the seabed of the Opureora Channel in the Tauranga Harbour to gain sufficient depth to restore navigability during most tidal conditions.

2 Quantity of Excavation

2.1 The quantity of material removed from the coastal marine area as capital dredging shall not exceed 12000 cubic metres.

2.2 The quantity of material removed from the coastal marine area as maintenance dredging shall not exceed 6000 cubic metres during any two-year period.

3 Location

At Opureora Channel, Tauranga Harbour as shown on BOPRC Plan Number RC 63226/1 submitted with the application for this consent.

4 Map Reference

Between or about map reference NZMS 260 U14: 8158 9300 and U14: 8275 9215.

5 Legal Description

Crown Land (Seabed), Tauranga Harbour (Western Bay of Plenty District).

6 Dredging Works

6.1 Works shall be located and carried out generally in accordance with "Opureora Channel Capital and Maintenance Dredging Assessment of Environmental Effects, June 2005", and BOPRC Plan Number RC 63226/1, included in the application for this consent.

6.2 Capital dredging shall be completed within four months of the date of commencement.

6.3 Maintenance dredging shall be completed within four weeks of the date of commencement.

6.4 Dredging shall be carried out to provide a maximum water depth of 1.5 metres below chart datum and a maximum width of 20 metres including batters.

6.5 Dredging shall only be carried out on an ebb tide when the direction of flow is out to the main channel.

6.6 The consent holder shall ensure that no contaminants, including fuel oils, are permitted to enter the ocean waters as a result of these works.

6.7 No refuelling activities or fuel storage shall occur on the foreshore or seabed or within 20 metres of mean high water springs. The consent holder shall employ methods to avoid or minimise any fuel spillage, including the provision of appropriate security and containment measures, where necessary.

6.8 No dredging activities shall be undertaken on Saturdays, Sundays or public holidays.

7 Disposal of Dredged Material

No dredged material shall be disposed of within the coastal marine area.

8 Discharge

8.1 There shall be no discharge above mean low water springs and where practicable discharge shall be made via a weighted pipe to an adjacent channel.

8.2 The permit holder shall ensure that, after reasonable mixing, any discharge under this consent shall not result in any of the following;

- The production of conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
- Any conspicuous change in colour or visual clarity;
- Any emission of objectionable odour; and/or
- Significant adverse effects on aquatic life.

9 Notification of Intention to Dredge

9.1 The consent holder shall advise the Regional Council Harbour Master, the Coastguard and Matakana Ferries Ltd in writing at least 10 working days prior to carrying out any dredging and shall provide details of the expected duration of the dredging and the name and contact details of the person supervising the works.

9.2 The consent holder shall place notices in the Bay of Plenty Times advising of the intention to dredge, the area which is to be dredged, the period over which dredging is expected to occur, and the restrictions to navigation that will apply, not less than seven days prior to, and on the day prior to commencement of dredging.

9.3 The consent holder shall place signage at the Omokoroa and Opureora Jetties at least 10 working days prior to carrying out any dredging and shall provide details of the expected duration of the dredging, and the name and contact details of the person supervising the works. Signage shall remain for the duration of any dredging.

9.4 The consent holder shall inform the Regional Council, in writing, within five working days following the completion of each dredging operation under this consent.

10 Monitoring

10.1 On each day that excavations occur within the coastal marine area the consent holder shall (during excavation operations), take water samples:

- From a site 200 metres up current of the excavation site; and
- From a point 350 metres down current of the site, in the direction of the plume.

10.2 From each sampling site one surface water sample shall be taken, in a minimum depth of 60 centimetres of water, and analysed as soon as practicable for suspended solids concentration.

10.3 All sampling and analyses required by condition 10.1 shall be carried out in accordance with the latest edition of: "Standard Methods for the Examination of Water and Wastewater APHA, AWWA, WEF" or such other method as may be agreed in writing by the Chief Executive of the Regional Council or delegate.

10.4 At the completion of works for each two-year period the consent holder shall undertake a harbour floor contour survey of the dredged area.

10.5 The consent holder shall make records of any analysis undertaken in accordance with 10.2 available to the Chief Executive of the Regional Council or delegate as required.

11 Reporting

11.1 The consent holder shall forward a report to the Regional Council within 20 working days of completion of the initial works and any subsequent maintenance works describing:

a) The area excavated; and

b) The quantity of sediment removed; and

c) The quantity of sediment disposed of and the area/s to which the sediment has been disposed.

11.2 Within three months of the completion of the dredging operation the consent holder shall supply the results of the monitoring required by condition 10.1 to the Regional Council.

11.3 Within three months of the completion of the dredging operation the consent holder shall forward to the Regional Council results of the harbour floor contour survey as required by condition 10.4.

12 Term of Consent

This consent shall expire on 31 July 2015.

13 Resource Management Charges

The consent holder shall pay the Bay of Plenty Regional Council such administrative charges as are fixed from time to time by the Regional Council in accordance with section 36 of the Resource Management Act 1991.

14 **The Permit** hereby authorised is granted under the Resource Management Act 1991 and does not constitute an authority under any other Act, Regulation or Bylaw.

Advice Notes:

1 *This permit does not authorise the holder to modify or disturb any archaeological or historic sites or deposits within the area affected by this consent. Should any artefacts, bones, shell midden or any other sites of archaeological or cultural significance be discovered within the area affected by this operation, written authorisation should be obtained from the Historic Places Trust before any damage, modification or destruction is undertaken.*

2 *This permit does not authorise the discharge of any contaminant to Tauranga Harbour.*

3 *Notification requirements pursuant to condition 8.2 of this permit should be made in writing (fax or letter) to the Bay of Plenty Regional Council, Environment Bay of Plenty, P O Box 364, Whakatane.*

4 *The permit holder is advised that non-compliance with permit conditions may result in enforcement action against the permit holder and/or their contractors.*

5 *The permit holder is responsible for ensuring that all contractors carrying out works under this permit are made aware of the relevant consent conditions, plans and associated documents.*

6 *This permit does not provide for disposal of any dredged material within the Coastal Marine Area.*

7 *This permit does not allow for the material attained through the dredging process to be on sold for profit.*

DATED at Whakatane this 13th day of October 2005

For and on behalf of
The Bay of Plenty Regional Council

J A Jones
Chief Executive

Appendix C: Dredge Plan

OPUREORA CHANNEL

Surveyed 16 August 2013
Datum/Grid: BOP2000
Depths referred to Chart Datum

Contour Lines depicted at 0.5m, 1.0m

Proposed North Dredge Area

Proposed South Dredge Area

Move Beacon OP10 20m SW

Move Beacon OP8 30m SW

Move Beacon Op4 25m NE

Op20
Op18
Op16
Op14
Op12
Op10
Op8
Op6
Op4
Op2
Western B

0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
-4.5

815400
815200
815000
814800
814600
814400

365400
365600
365800
366000
366200
366400
366600

Appendix D: Sediment Samples

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH1
Hole Location: Refer to location plan.
SHEET 1 OF 1

PROJECT: Opureora Channel — LOCATION: Opureora Channel, Tauranga Harbour. JOB No: 851786

CO-ORDINATES:
R.L.: -1.00 m
DATUM: Chart Datum Level

DRILL TYPE: Ogeechee
DRILL METHOD: Hand
DRILL FLUID:

HOLE STARTED: 23/3/14
HOLE FINISHED: 23/3/14
DRILLED BY: MCI
LOGGED BY: MCI CHECKED: DEPP

GEOLOGICAL									ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
Marine sediment			100	Hand push tube	None			-1.0			S					Fine to medium SAND; dark grey. Saturated.
											W					CLAY; white. Wet.
								0.5								0.5 **0.5m END OF SAMPLE AT 0.5m BELOW HARBOUR BED LEVEL**
								1								

T+T DATATEMPLATE.GDT aaaw

Log Scale 1:5

BORELOG 851786 OPUREORA CHANNEL INFO.GPJ 15-May-2014

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH2
Hole Location: Refer to location plan.
SHEET 1 OF 1

PROJECT: Opureora Channel — LOCATION: Opureora Channel, Tauranga Harbour. JOB No: 851786

CO-ORDINATES:
R.L.: -0.50 m
DATUM: Chart Datum Level

DRILL TYPE: Ogeechee
DRILL METHOD: Hand
DRILL FLUID:

HOLE STARTED: 23/3/14
HOLE FINISHED: 23/3/14
DRILLED BY: MCI
LOGGED BY: MCI CHECKED: DEPP

GEOLOGICAL									ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
Marine sediment			100	Hand push tube	None			-0.5			S					Fine to medium SAND with some shell fragments; dark grey. Saturated.
								0.5			W					SILT; grey. Wet.
											S					Fine to medium SAND with some silt; grey. Saturated.
																SILT with minor sand; grey. Saturated; sand, fine.
								1								**0.8m END OF SAMPLE AT 0.8m BELOW HARBOUR BED LEVEL**

T+T DATATEMPLATE.GDT aaaw

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH3
Hole Location: Refer to location plan.
SHEET 1 OF 1

PROJECT: Opureora Channel		LOCATION: Opureora Channel, Tauranga Harbour. JOB No: 851786	
CO-ORDINATES:		DRILL TYPE: Ogeechee	HOLE STARTED: 23/3/14
		DRILL METHOD: Hand	HOLE FINISHED: 23/3/14
R.L.:	-0.50 m		DRILLED BY: MCI
DATUM:	Chart Datum Level	DRILL FLUID:	LOGGED BY: MCI CHECKED: DEPP

GEOLOGICAL									ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
Marine sediment			100	Hand push tube	None			-0.5			S					Medium to coarse SAND with some shell fragments; dark grey. Saturated.
								0.5								Medium to coarse SAND; brownish grey. Saturated.
								1								**0.8m END OF SAMPLE AT 0.8m BELOW HARBOUR BED LEVEL**

T+T DATATEMPLATE.GDT aaaw

Log Scale 1:5

BORELOG 851786 OPUREORA CHANNEL INFO.GPJ 15-May-2014

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH4
Hole Location: Refer to location plan.
SHEET 1 OF 1

PROJECT: Opureora Channel		LOCATION: Opureora Channel, Tauranga Harbour. JOB No: 851786	
CO-ORDINATES:		DRILL TYPE: Ogeechee	HOLE STARTED: 23/3/14
		DRILL METHOD: Hand	HOLE FINISHED: 23/3/14
R.L.:	-0.50 m		DRILLED BY: MCI
DATUM:	Chart Datum Level	DRILL FLUID:	LOGGED BY: MCI CHECKED: DEPP

GEOLOGICAL									ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
Marine sediment			100	Hand push tube	None			-0.5 0.5			S					Medium to coarse SAND with some shell fragments; grey. Saturated. 0.5
								1								**0.8m END OF SAMPLE AT 0.8m BELOW HARBOUR BED LEVEL**

T+T DATATEMPLATE.GDT aaaw

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No:BH5
Hole Location: Refer to location plan.
SHEET 1 OF 1

PROJECT: Opureora Channel — LOCATION: Opureora Channel, Tauranga Harbour. JOB No: 851786

CO-ORDINATES:
R.L.: -0.50 m
DATUM: Chart Datum Level

DRILL TYPE: Ogeechee
DRILL METHOD: Hand
DRILL FLUID:

HOLE STARTED: 23/3/14
HOLE FINISHED: 23/3/14
DRILLED BY: MCI
LOGGED BY: MCI CHECKED: DEPP

GEOLOGICAL									ENGINEERING DESCRIPTION							
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (mm) 50 250 1000 2000	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
Marine sediment			100	Hand push tube	None			-0.5			S					Fine to medium SAND; brownish grey. Saturated.
								0.5								Medium to coarse SAND with some shell fragements; dark grey. Saturated.
								1								**0.8m END OF SAMPLE AT 0.8m BELOW HARBOUR BED LEVEL**

T+T DATATEMPLATE.GDT aaaw

THE UNIVERSITY OF WAIKATO
Te Whare Wānanga o Waikato
Facility of Science and Engineering
The University of Waikato
Private Bag 3105
Hamilton, New Zealand

MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
1 Operureora East, Spit

SOP Name:
Marine Sediment

Measured:
Thursday, 10 April 2014 1:56:08 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Thursday, 10 April 2014 1:56:10 p.m.

Sample bulk lot ref:
2014052/1

Result Source:
Measurement

Particle Name:
Marine 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:
17.16 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.414 %

Result Emulation:
Off

Concentration:
0.5946 %Vol

Span :
1.409

Uniformity:
0.441

Result units:
Volume

Specific Surface Area:
0.0266 m²/g

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

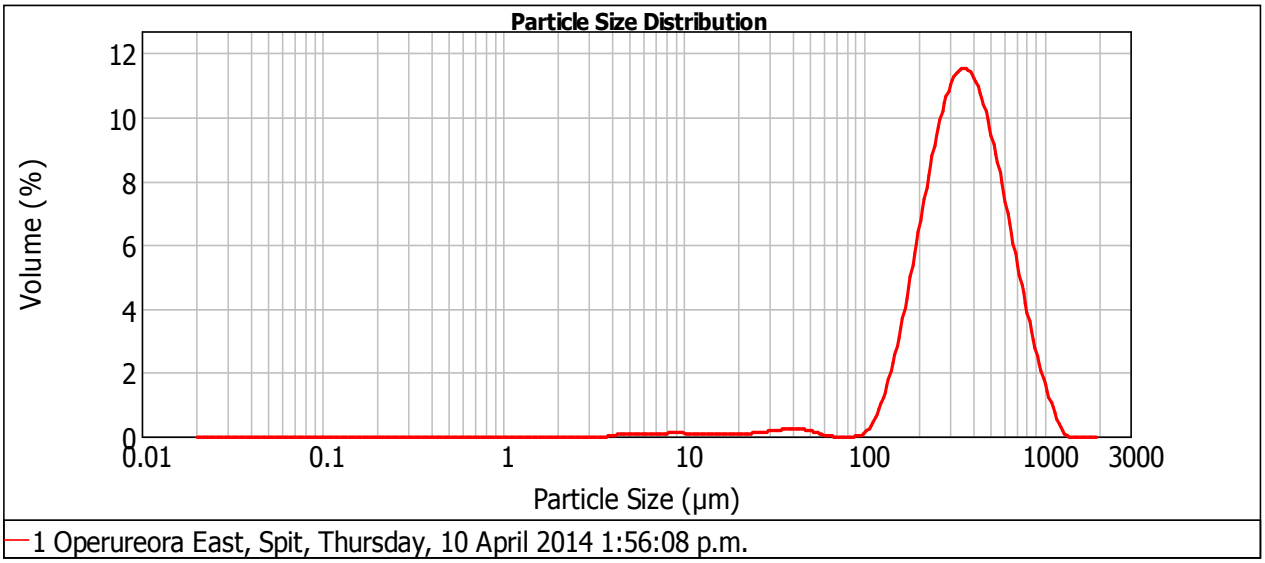
Vol. Weighted Mean D[4,3]:
402.097 um

Standard Deviation
207.893 um

---

d(0.1): 184.422 um **d(0.5):** 359.004 um **d(0.9):** 690.420 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	0.980	0.00	37.000	1.48	105.000	2.11	300.000	36.65	840.000	95.82
0.060	0.00	2.000	0.00	44.000	1.74	125.000	2.72	350.000	48.08	1000.000	98.67
0.120	0.00	3.900	0.00	53.000	1.98	149.000	4.70	420.000	61.70	1190.000	99.88
0.240	0.00	7.800	0.35	63.000	2.07	177.000	8.68	500.000	73.61	1410.000	100.00
0.490	0.00	15.600	0.79	74.000	2.07	210.000	15.16	590.000	83.06	1680.000	100.00
0.700	0.00	31.000	1.24	88.000	2.07	250.000	24.48	710.000	91.02	2000.000	100.00

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
2 Operureora East, Beach

SOP Name:
Marine Sediment

Measured:
Thursday, 10 April 2014 2:02:39 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Thursday, 10 April 2014 2:02:41 p.m.

Sample bulk lot ref:
2014052/2

Result Source:
Measurement

Particle Name:
Marine 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:
12.14 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.734 %

Result Emulation:
Off

Concentration:
0.7335 %Vol

Span :
1.498

Uniformity:
0.465

Result units:
Volume

Specific Surface Area:
0.0149 m²/g

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

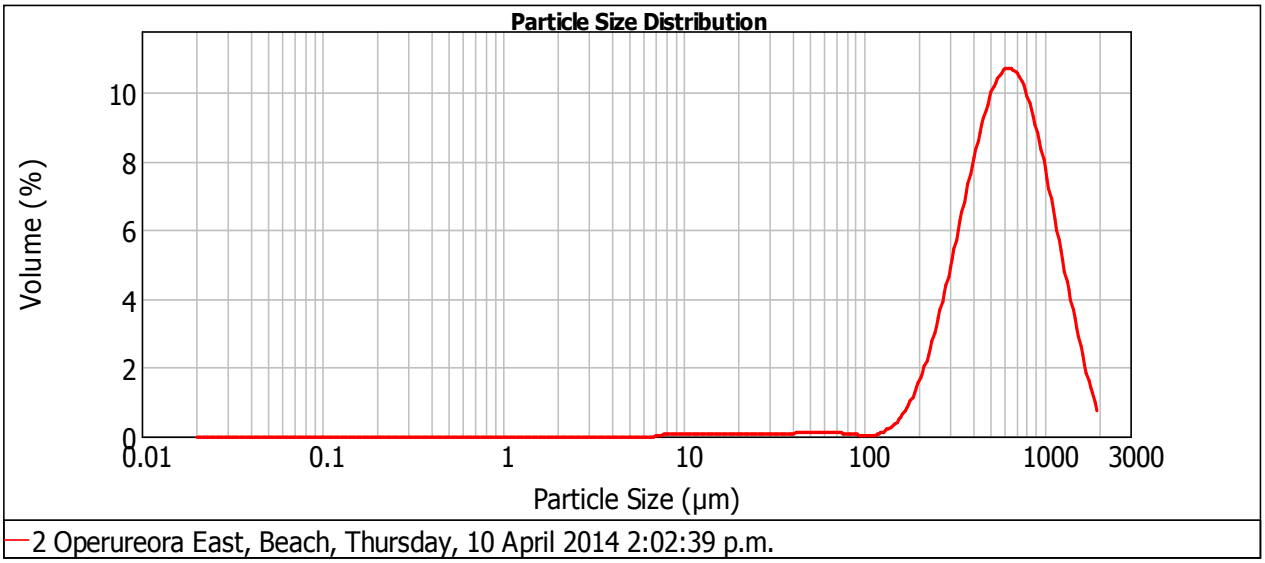
Vol. Weighted Mean D[4,3]:
684.444 um

Standard Deviation
365.569 um

---

d(0.1): 287.367 um **d(0.5):** 610.747 um **d(0.9):** 1202.229 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	0.980	0.00	37.000	0.75	105.000	1.39	300.000	11.31	840.000	71.70
0.060	0.00	2.000	0.00	44.000	0.85	125.000	1.44	350.000	17.03	1000.000	81.75
0.120	0.00	3.900	0.00	53.000	0.99	149.000	1.69	420.000	25.95	1190.000	89.61
0.240	0.00	7.800	0.02	63.000	1.13	177.000	2.36	500.000	36.42	1410.000	95.02
0.490	0.00	15.600	0.35	74.000	1.26	210.000	3.83	590.000	47.59	1680.000	98.46
0.700	0.00	31.000	0.66	88.000	1.36	250.000	6.59	710.000	60.54	2000.000	100.00

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
3 Opureora West, Ramp Beach

SOP Name:
Marine Sediment

Measured:
Friday, 11 April 2014 3:58:31 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Friday, 11 April 2014 3:58:33 p.m.

Sample bulk lot ref:
2014052/3

Result Source:
Measurement

Particle Name:
Marine 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:
14.72 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
2.891 %

Result Emulation:
Off

Concentration:
1.3999 %Vol

Span :
1.253

Uniformity:
0.385

Result units:
Volume

Specific Surface Area:
0.00969 m²/g

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

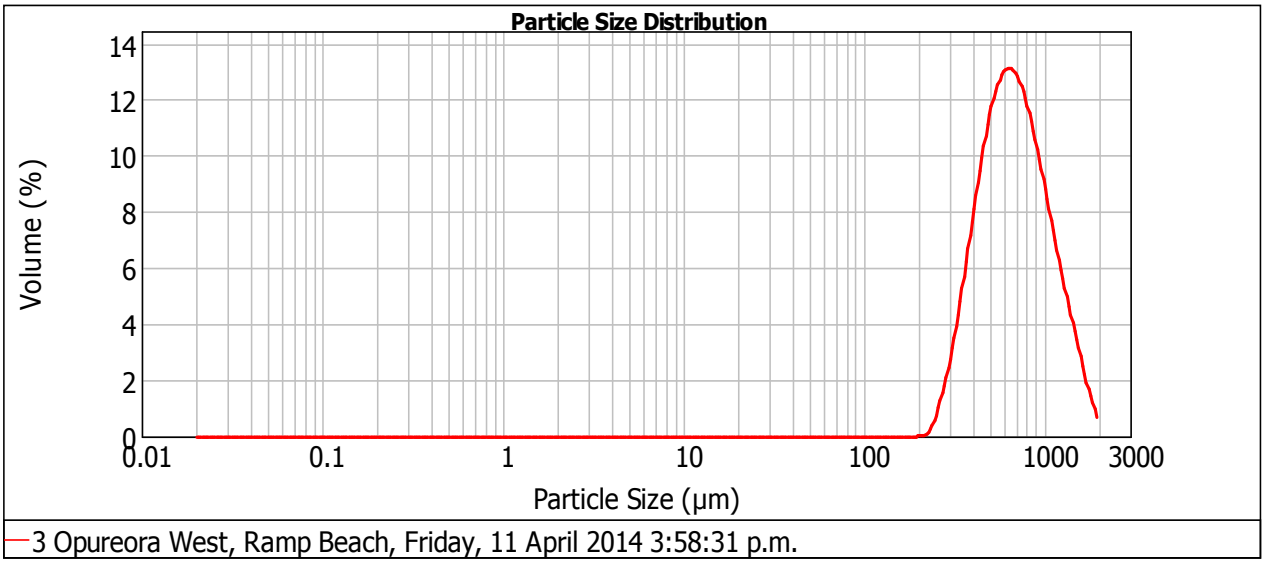
Vol. Weighted Mean D[4,3]:
745.812 um

Standard Deviation
334.966 um

---

d(0.1): 386.681 um **d(0.5):** 669.293 um **d(0.9):** 1225.032 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	0.980	0.00	37.000	0.00	105.000	0.00	300.000	2.11	840.000	68.41
0.060	0.00	2.000	0.00	44.000	0.00	125.000	0.00	350.000	6.01	1000.000	80.03
0.120	0.00	3.900	0.00	53.000	0.00	149.000	0.00	420.000	14.25	1190.000	88.81
0.240	0.00	7.800	0.00	63.000	0.00	177.000	0.00	500.000	25.80	1410.000	94.74
0.490	0.00	15.600	0.00	74.000	0.00	210.000	0.00	590.000	39.18	1680.000	98.47
0.700	0.00	31.000	0.00	88.000	0.00	250.000	0.20	710.000	55.02	2000.000	100.00

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
4 Opureora East sandbank

SOP Name:
Marine Sediment

Measured:
Friday, 11 April 2014 4:03:54 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Friday, 11 April 2014 4:03:56 p.m.

Sample bulk lot ref:
2014052/4

Result Source:
Measurement

Particle Name:
Marine 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:
18.90 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.870 %

Result Emulation:
Off

Concentration:
0.5620 %Vol

Span :
1.468

Uniformity:
0.471

Result units:
Volume

Specific Surface Area:
0.031 m²/g

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

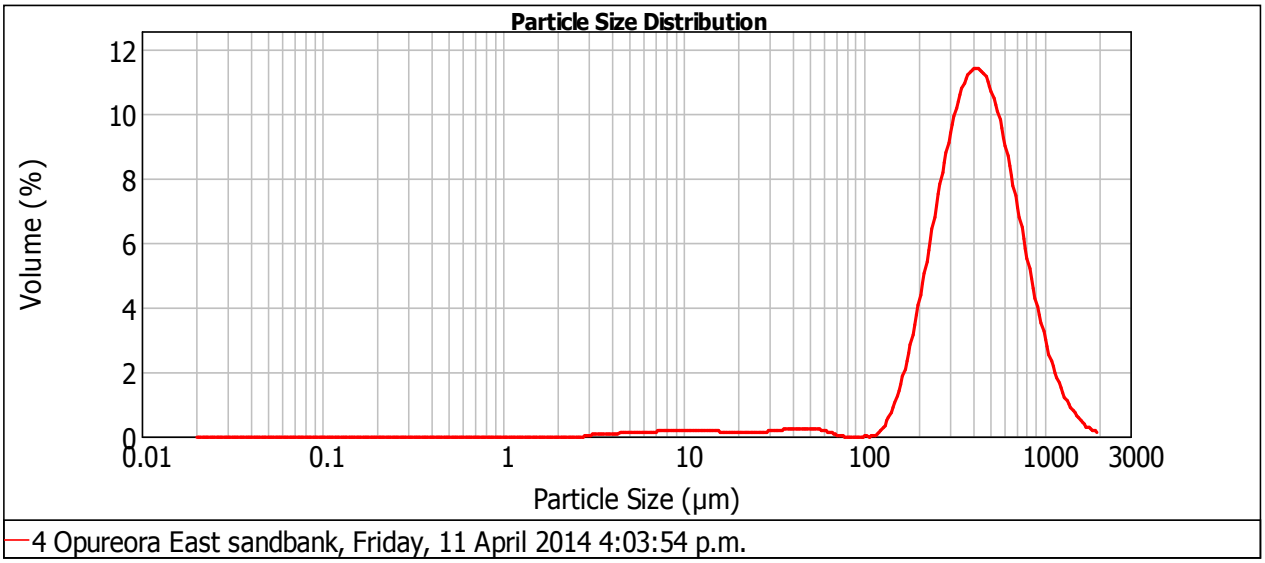
Vol. Weighted Mean D[4,3]:
478.478 um

Standard Deviation
271.668 um

---

d(0.1): 211.493 um **d(0.5):** 420.950 um **d(0.9):** 829.610 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	0.980	0.00	37.000	2.32	105.000	3.20	300.000	26.21	840.000	90.41
0.060	0.00	2.000	0.00	44.000	2.59	125.000	3.23	350.000	36.43	1000.000	94.98
0.120	0.00	3.900	0.13	53.000	2.89	149.000	3.87	420.000	49.83	1190.000	97.67
0.240	0.00	7.800	0.70	63.000	3.12	177.000	5.83	500.000	62.67	1410.000	99.06
0.490	0.00	15.600	1.48	74.000	3.20	210.000	9.79	590.000	73.71	1680.000	99.76
0.700	0.00	31.000	2.11	88.000	3.20	250.000	16.40	710.000	83.76	2000.000	100.00

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
5 Opureora West, old wharf beach

SOP Name:
Marine Sediment

Measured:
Friday, 11 April 2014 4:09:45 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Friday, 11 April 2014 4:09:47 p.m.

Sample bulk lot ref:
2014052/5

Result Source:
Measurement

Particle Name:
Marine 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:
14.00 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
2.852 %

Result Emulation:
Off

Concentration:
1.3754 %Vol

Span :
1.367

Uniformity:
0.418

Result units:
Volume

Specific Surface Area:
0.00934 m²/g

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

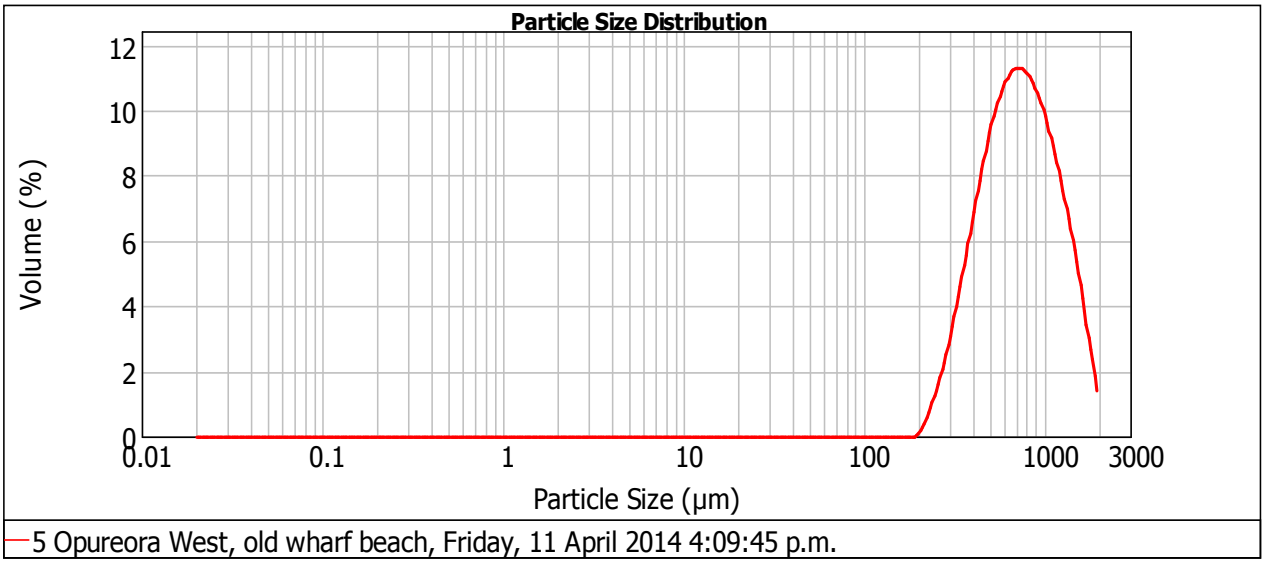
Vol. Weighted Mean D[4,3]:
806.385 um

Standard Deviation
381.956 um

---

d(0.1): 377.971 um **d(0.5):** 725.704 um **d(0.9):** 1370.282 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	0.980	0.00	37.000	0.00	105.000	0.00	300.000	3.35	840.000	60.71
0.060	0.00	2.000	0.00	44.000	0.00	125.000	0.00	350.000	7.30	1000.000	72.69
0.120	0.00	3.900	0.00	53.000	0.00	149.000	0.00	420.000	14.54	1190.000	83.09
0.240	0.00	7.800	0.00	63.000	0.00	177.000	0.00	500.000	24.04	1410.000	91.21
0.490	0.00	15.600	0.00	74.000	0.00	210.000	0.01	590.000	34.95	1680.000	97.10
0.700	0.00	31.000	0.00	88.000	0.00	250.000	0.86	710.000	48.38	2000.000	100.00

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
6 BH5A 150 -500 mm

SOP Name:
Marine Sediment

Measured:
Friday, 11 April 2014 4:14:58 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Friday, 11 April 2014 4:14:59 p.m.

Sample bulk lot ref:
2014052/6

Result Source:
Measurement

Particle Name:
Marine 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:
22.64 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.550 %

Result Emulation:
Off

Concentration:
0.4846 %Vol

Span :
1.504

Uniformity:
0.498

Result units:
Volume

Specific Surface Area:
0.0439 m²/g

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

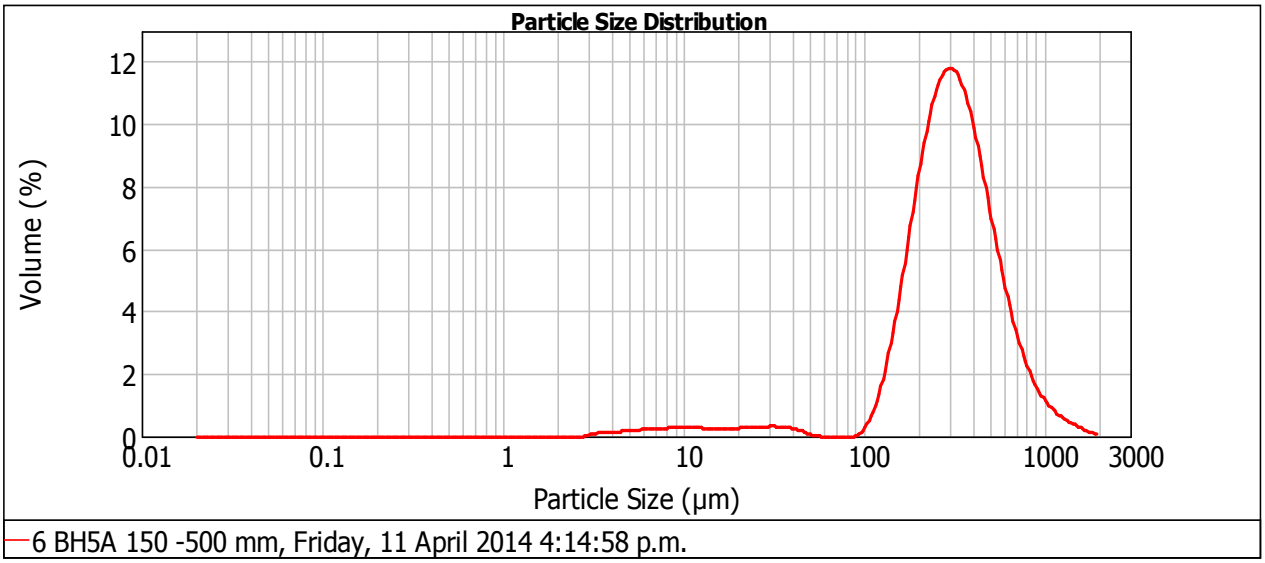
Vol. Weighted Mean D[4,3]:
359.213 um

Standard Deviation
227.059 um

---

d(0.1): 158.048 um **d(0.5):** 308.708 um **d(0.9):** 622.193 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	0.980	0.00	37.000	3.91	105.000	4.45	300.000	47.79	840.000	96.08
0.060	0.00	2.000	0.00	44.000	4.19	125.000	5.49	350.000	59.52	1000.000	97.82
0.120	0.00	3.900	0.19	53.000	4.33	149.000	8.42	420.000	72.03	1190.000	98.87
0.240	0.00	7.800	1.09	63.000	4.33	177.000	13.99	500.000	81.64	1410.000	99.49
0.490	0.00	15.600	2.29	74.000	4.33	210.000	22.55	590.000	88.32	1680.000	99.86
0.700	0.00	31.000	3.55	88.000	4.33	250.000	34.03	710.000	93.30	2000.000	100.00

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
7 BH5B 0 - 150 mm

SOP Name:
Marine Sediment

Measured:
Friday, 11 April 2014 4:21:06 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Friday, 11 April 2014 4:21:08 p.m.

Sample bulk lot ref:
2014052/7

Result Source:
Measurement

Particle Name:
Marine 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:
19.13 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.840 %

Result Emulation:
Off

Concentration:
0.3979 %Vol

Span :
1.195

Uniformity:
0.386

Result units:
Volume

Specific Surface Area:
0.0443 m²/g

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

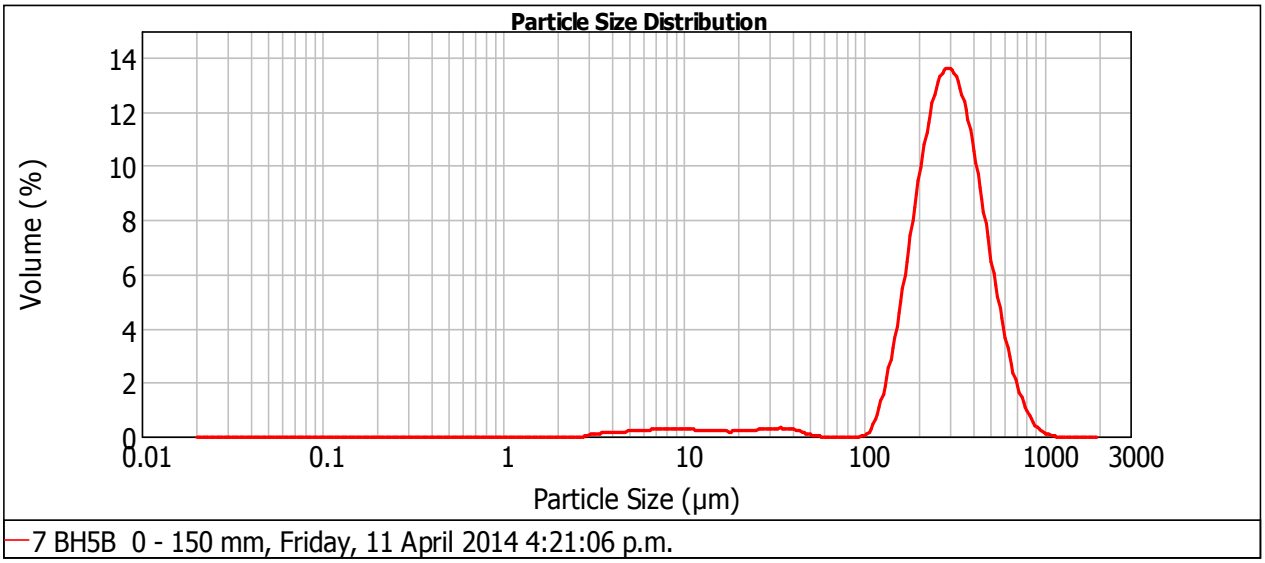
Vol. Weighted Mean D[4,3]:
316.451 um

Standard Deviation
150.387 um

---

d(0.1): 163.075 um **d(0.5):** 293.117 um **d(0.9):** 513.484 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	0.980	0.00	37.000	3.57	105.000	4.01	300.000	52.07	840.000	99.56
0.060	0.00	2.000	0.00	44.000	3.87	125.000	4.64	350.000	65.48	1000.000	99.95
0.120	0.00	3.900	0.20	53.000	4.01	149.000	7.37	420.000	79.17	1190.000	100.00
0.240	0.00	7.800	1.14	63.000	4.01	177.000	13.25	500.000	88.84	1410.000	100.00
0.490	0.00	15.600	2.23	74.000	4.01	210.000	22.84	590.000	94.74	1680.000	100.00
0.700	0.00	31.000	3.21	88.000	4.01	250.000	36.10	710.000	98.24	2000.000	100.00

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
8 BH4 0-500 mm

SOP Name:
Marine Sediment

Measured:
Tuesday, 15 April 2014 1:57:59 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Tuesday, 15 April 2014 1:58:01 p.m.

Sample bulk lot ref:
2014052/8

Result Source:
Measurement

Particle Name:
Marine 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:
22.09 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.741 %

Result Emulation:
Off

Concentration:
0.4828 %Vol

Span :
1.271

Uniformity:
0.41

Result units:
Volume

Specific Surface Area:
0.0427 m²/g

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

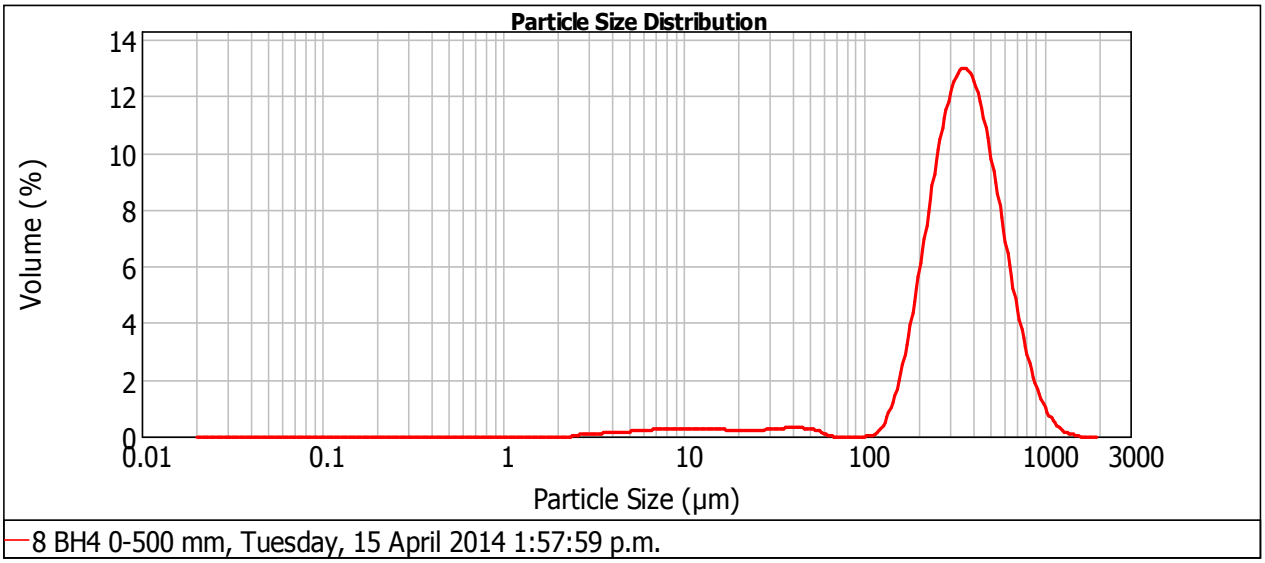
Vol. Weighted Mean D[4,3]:
387.763 um

Standard Deviation
196.603 um

---

d(0.1): 189.435 um **d(0.5):** 356.181 um **d(0.9):** 642.051 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	0.980	0.00	37.000	3.70	105.000	4.56	300.000	35.75	840.000	97.15
0.060	0.00	2.000	0.00	44.000	4.04	125.000	4.64	350.000	48.51	1000.000	99.04
0.120	0.00	3.900	0.27	53.000	4.38	149.000	5.51	420.000	63.80	1190.000	99.78
0.240	0.00	7.800	1.14	63.000	4.56	177.000	8.20	500.000	76.73	1410.000	99.98
0.490	0.00	15.600	2.38	74.000	4.56	210.000	13.68	590.000	86.28	1680.000	100.00
0.700	0.00	31.000	3.39	88.000	4.56	250.000	22.76	710.000	93.44	2000.000	100.00

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
9 BH3A 0-400 mm

SOP Name:
Marine Sediment

Measured:
Tuesday, 15 April 2014 2:03:20 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Tuesday, 15 April 2014 2:03:22 p.m.

Sample bulk lot ref:
2014052/9

Result Source:
Measurement

Particle Name:
Marine 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:
18.81 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.573 %

Result Emulation:
Off

Concentration:
0.4615 %Vol

Span :
1.590

Uniformity:
0.508

Result units:
Volume

Specific Surface Area:
0.0376 m²/g

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

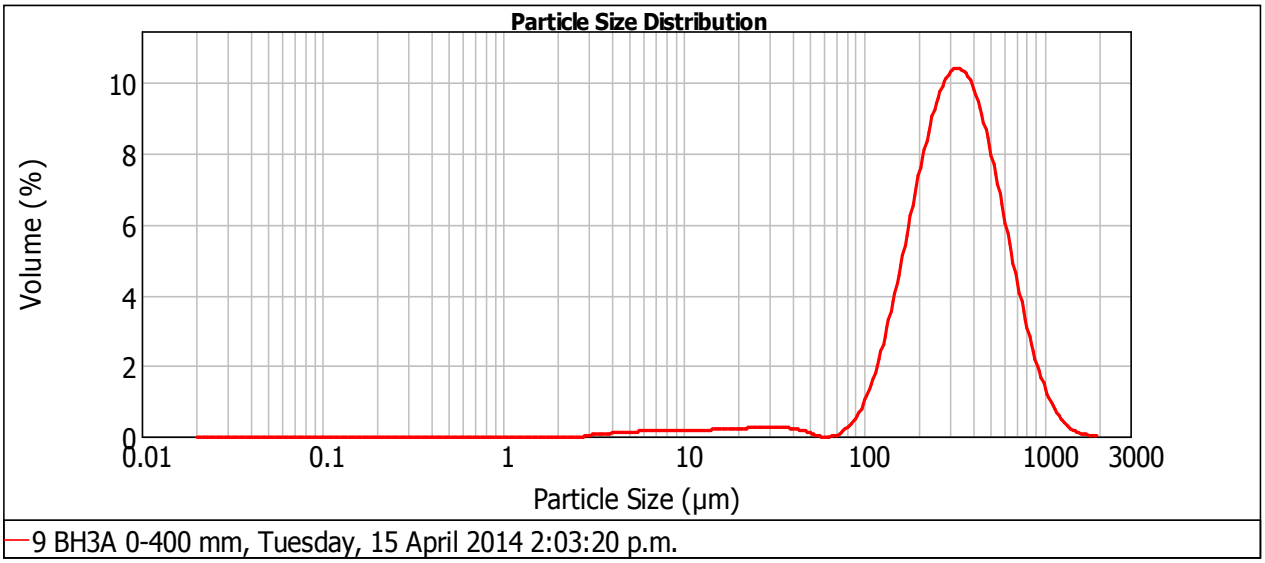
Vol. Weighted Mean D[4,3]:
370.071 um

Standard Deviation
221.944 um

---

d(0.1): 148.183 um **d(0.5):** 322.544 um **d(0.9):** 660.899 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	0.980	0.00	37.000	2.92	105.000	4.48	300.000	45.08	840.000	96.02
0.060	0.00	2.000	0.00	44.000	3.17	125.000	6.47	350.000	55.57	1000.000	98.30
0.120	0.00	3.900	0.13	53.000	3.33	149.000	10.14	420.000	67.61	1190.000	99.40
0.240	0.00	7.800	0.75	63.000	3.33	177.000	15.76	500.000	77.82	1410.000	99.84
0.490	0.00	15.600	1.58	74.000	3.35	210.000	23.46	590.000	85.73	1680.000	99.97
0.700	0.00	31.000	2.61	88.000	3.60	250.000	33.28	710.000	92.21	2000.000	100.00

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
10 BH3B 400-700 mm

SOP Name:
Marine Sediment

Measured:
Tuesday, 15 April 2014 2:08:56 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Tuesday, 15 April 2014 2:08:58 p.m.

Sample bulk lot ref:
2014052/10

Result Source:
Measurement

Particle Name:
Marine 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:
22.79 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.657 %

Result Emulation:
Off

Concentration:
0.5707 %Vol

Span :
1.654

Uniformity:
0.527

Result units:
Volume

Specific Surface Area:
0.0378 m²/g

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

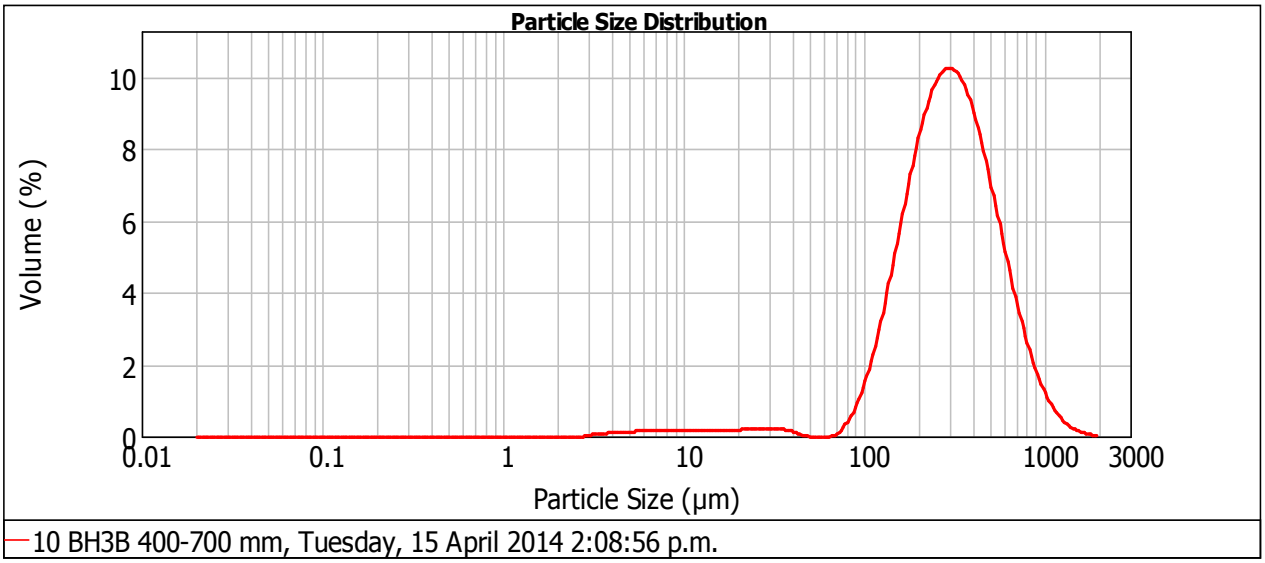
Vol. Weighted Mean D[4,3]:
351.208 um

Standard Deviation
220.78 um

---

d(0.1): 139.624 um **d(0.5):** 298.933 um **d(0.9):** 634.170 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	0.980	0.00	37.000	2.53	105.000	4.50	300.000	50.24	840.000	96.30
0.060	0.00	2.000	0.00	44.000	2.69	125.000	7.27	350.000	60.45	1000.000	98.28
0.120	0.00	3.900	0.14	53.000	2.70	149.000	12.00	420.000	71.65	1190.000	99.31
0.240	0.00	7.800	0.75	63.000	2.70	177.000	18.79	500.000	80.77	1410.000	99.77
0.490	0.00	15.600	1.44	74.000	2.73	210.000	27.57	590.000	87.60	1680.000	99.95
0.700	0.00	31.000	2.29	88.000	3.16	250.000	38.17	710.000	93.09	2000.000	100.00

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
11 BH2A 0-450 mm

SOP Name:
Marine Sediment

Measured:
Tuesday, 15 April 2014 2:20:36 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Tuesday, 15 April 2014 2:20:38 p.m.

Sample bulk lot ref:
2014052/11

Result Source:
Measurement

Particle Name:
Marine 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:
13.23 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.440 %

Result Emulation:
Off

Concentration:
0.0291 %Vol

Span :
2.837

Uniformity:
0.911

Result units:
Volume

Specific Surface Area:
0.448 m²/g

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

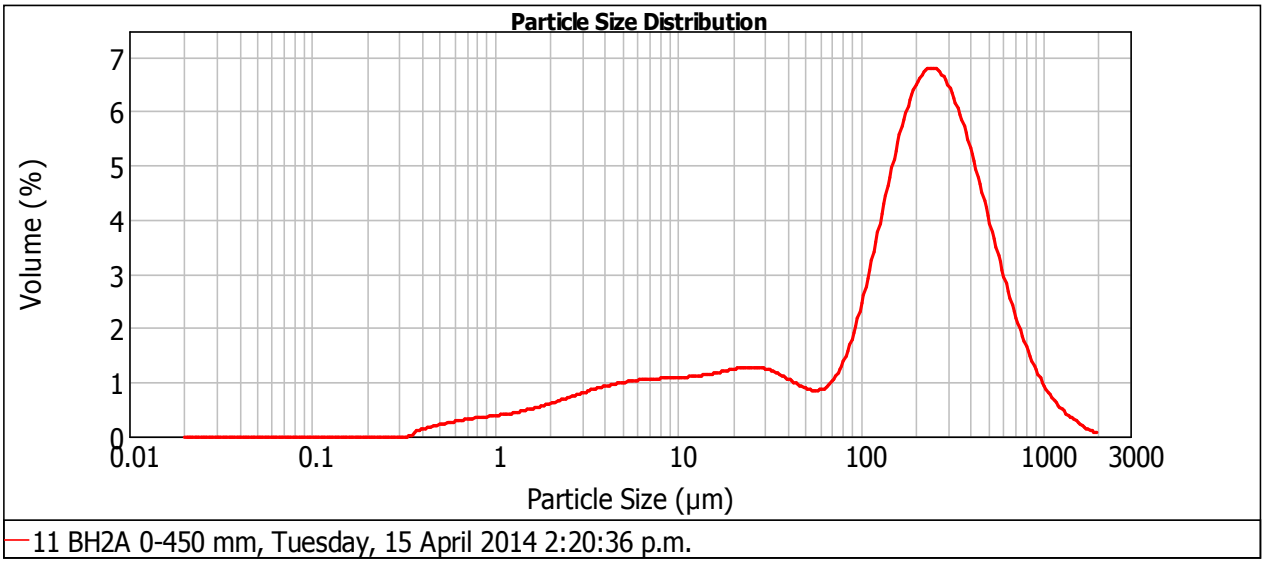
Vol. Weighted Mean D[4,3]:
245.509 um

Standard Deviation
249.445 um

---

d(0.1): 5.992 um **d(0.5):** 191.343 um **d(0.9):** 548.890 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	0.980	1.70	37.000	23.73	105.000	32.04	300.000	69.61	840.000	96.78
0.060	0.00	2.000	3.91	44.000	24.93	125.000	35.67	350.000	75.92	1000.000	98.17
0.120	0.00	3.900	7.24	53.000	26.04	149.000	40.69	420.000	82.50	1190.000	99.05
0.240	0.00	7.800	11.81	63.000	27.00	177.000	46.87	500.000	87.69	1410.000	99.56
0.490	0.31	15.600	16.80	74.000	28.02	210.000	53.94	590.000	91.57	1680.000	99.87
0.700	0.94	31.000	22.36	88.000	29.58	250.000	61.62	710.000	94.77	2000.000	100.00

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
12 BH2B 400-750 mm

SOP Name:
Marine Sediment

Measured:
Tuesday, 15 April 2014 2:26:43 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Tuesday, 15 April 2014 2:26:45 p.m.

Sample bulk lot ref:
2014052/12

Result Source:
Measurement

Particle Name:
Marine 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:
18.43 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.550 %

Result Emulation:
Off

Concentration:
0.0236 %Vol

Span :
4.738

Uniformity:
1.56

Result units:
Volume

Specific Surface Area:
0.816 m²/g

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

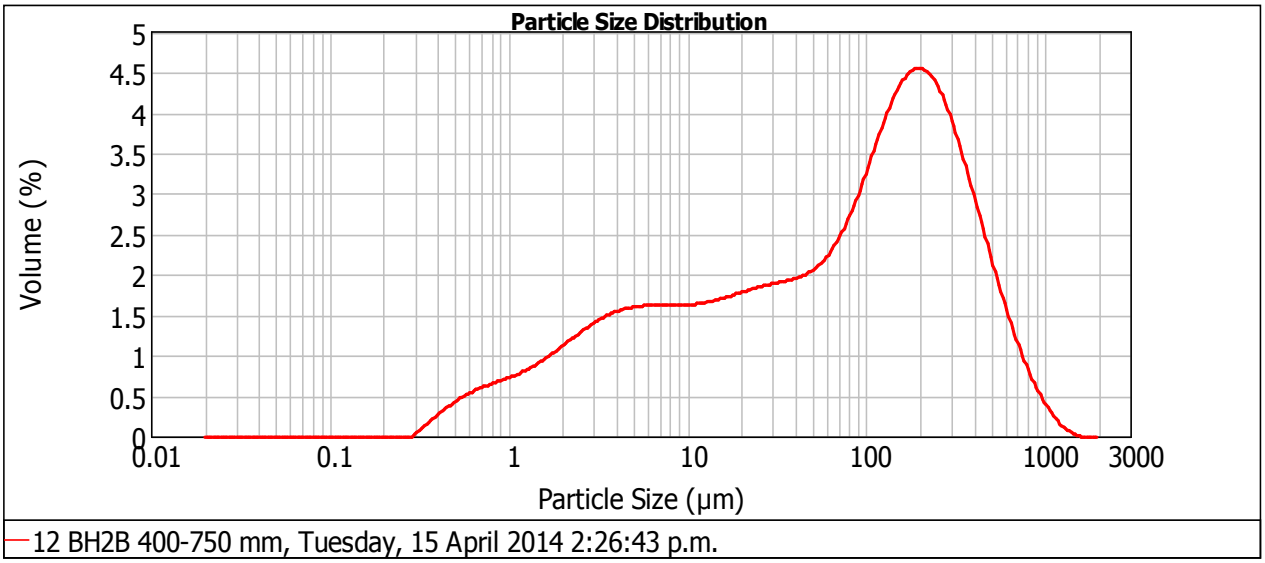
Vol. Weighted Mean D[4,3]:
150.103 um

Standard Deviation
188.177 um

---

d(0.1): 2.712 um **d(0.5):** 82.404 um **d(0.9):** 393.170 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	0.980	3.39	37.000	38.46	105.000	54.87	300.000	83.82	840.000	98.91
0.060	0.00	2.000	7.55	44.000	40.68	125.000	59.03	350.000	87.53	1000.000	99.54
0.120	0.00	3.900	13.43	53.000	43.15	149.000	63.73	420.000	91.26	1190.000	99.87
0.240	0.00	7.800	20.69	63.000	45.61	177.000	68.70	500.000	94.12	1410.000	99.99
0.490	0.73	15.600	28.14	74.000	48.14	210.000	73.79	590.000	96.21	1680.000	100.00
0.700	1.94	31.000	36.25	88.000	51.22	250.000	78.88	710.000	97.90	2000.000	100.00

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
13 BH1

SOP Name:
Marine Sediment

Measured:
Tuesday, 15 April 2014 2:46:23 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Tuesday, 15 April 2014 2:46:25 p.m.

Sample bulk lot ref:
2014052/13

Result Source:
Measurement

Particle Name:
Marine 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:
13.52 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.258 %

Result Emulation:
Off

Concentration:
0.0482 %Vol

Span :
4.417

Uniformity:
1.38

Result units:
Volume

Specific Surface Area:
0.267 m²/g

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

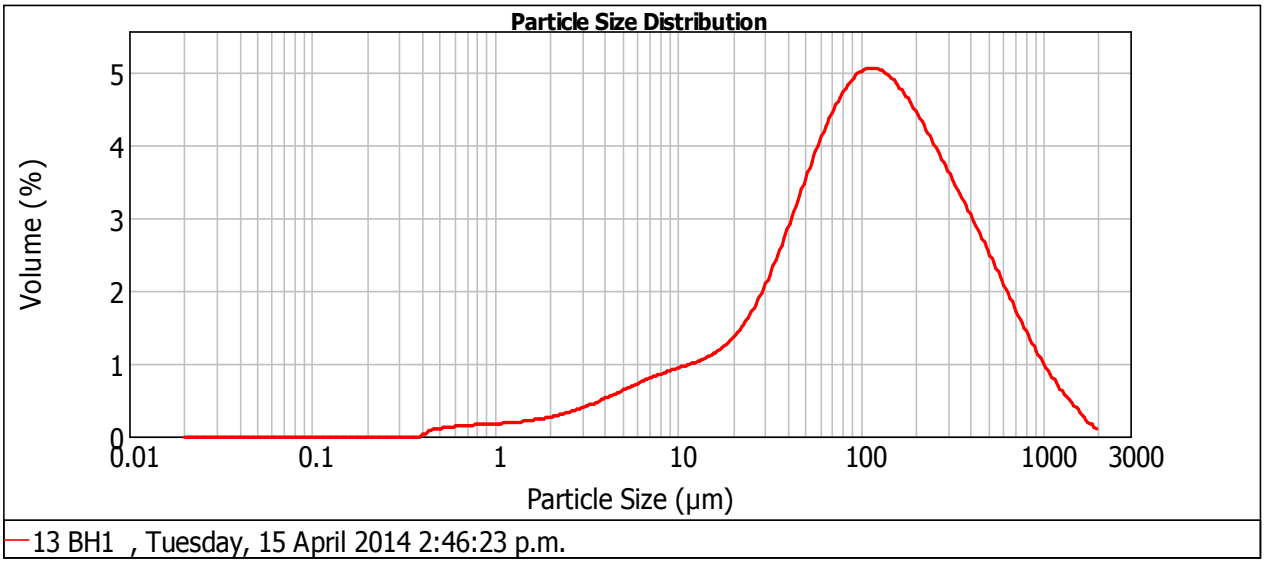
Vol. Weighted Mean D[4,3]:
202.511 um

Standard Deviation
255.71 um

---

d(0.1): 13.803 um **d(0.5):** 111.384 um **d(0.9):** 505.768 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	0.980	0.77	37.000	20.47	105.000	48.05	300.000	79.43	840.000	96.40
0.060	0.00	2.000	1.74	44.000	23.73	125.000	53.81	350.000	82.95	1000.000	97.74
0.120	0.00	3.900	3.38	53.000	27.89	149.000	59.55	420.000	86.69	1190.000	98.71
0.240	0.00	7.800	6.45	63.000	32.35	177.000	64.96	500.000	89.81	1410.000	99.37
0.490	0.10	15.600	10.88	74.000	36.96	210.000	70.03	590.000	92.36	1680.000	99.80
0.700	0.41	31.000	17.73	88.000	42.32	250.000	74.84	710.000	94.71	2000.000	100.00

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
14 Opureora East Beach Berm

SOP Name:
Marine Sediment

Measured:
Tuesday, 15 April 2014 2:52:17 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Tuesday, 15 April 2014 2:52:19 p.m.

Sample bulk lot ref:
2014052/14

Result Source:
Measurement

Particle Name:
Marine 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:
14.63 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.177 %

Result Emulation:
Off

Concentration:
1.0990 %Vol

Span :
0.978

Uniformity:
0.309

Result units:
Volume

Specific Surface Area:
0.0123 m²/g

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

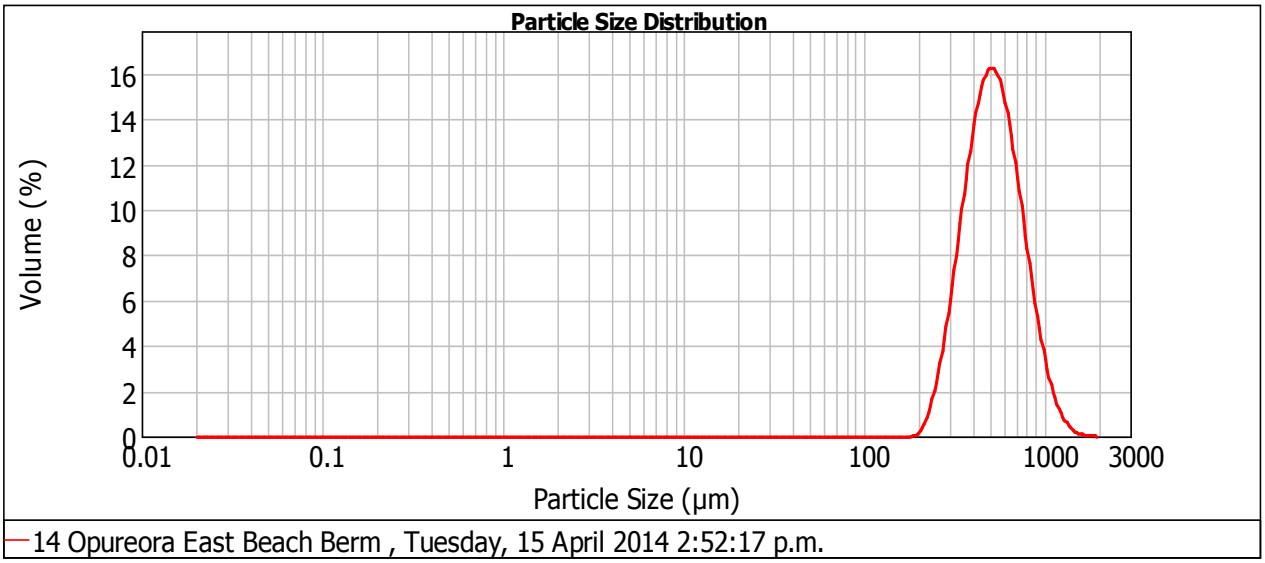
Vol. Weighted Mean D[4,3]:
556.173 um

Standard Deviation
208.002 um

---

d(0.1): 327.885 um **d(0.5):** 517.643 um **d(0.9):** 834.035 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	0.980	0.00	37.000	0.00	105.000	0.00	300.000	5.92	840.000	90.34
0.060	0.00	2.000	0.00	44.000	0.00	125.000	0.00	350.000	13.87	1000.000	96.35
0.120	0.00	3.900	0.00	53.000	0.00	149.000	0.00	420.000	28.53	1190.000	98.97
0.240	0.00	7.800	0.00	63.000	0.00	177.000	0.00	500.000	46.30	1410.000	99.81
0.490	0.00	15.600	0.00	74.000	0.00	210.000	0.05	590.000	63.65	1680.000	99.98
0.700	0.00	31.000	0.00	88.000	0.00	250.000	1.32	710.000	80.07	2000.000	100.00

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
15 Opureora West Old Wharf Berm

SOP Name:
Marine Sediment

Measured:
Tuesday, 15 April 2014 4:07:07 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Tuesday, 15 April 2014 4:07:09 p.m.

Sample bulk lot ref:
2014052/15

Result Source:
Measurement

Particle Name:
Marine 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:
12.02 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
1.119 %

Result Emulation:
Off

Concentration:
0.8879 %Vol

Span :
0.986

Uniformity:
0.312

Result units:
Volume

Specific Surface Area:
0.0123 m²/g

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

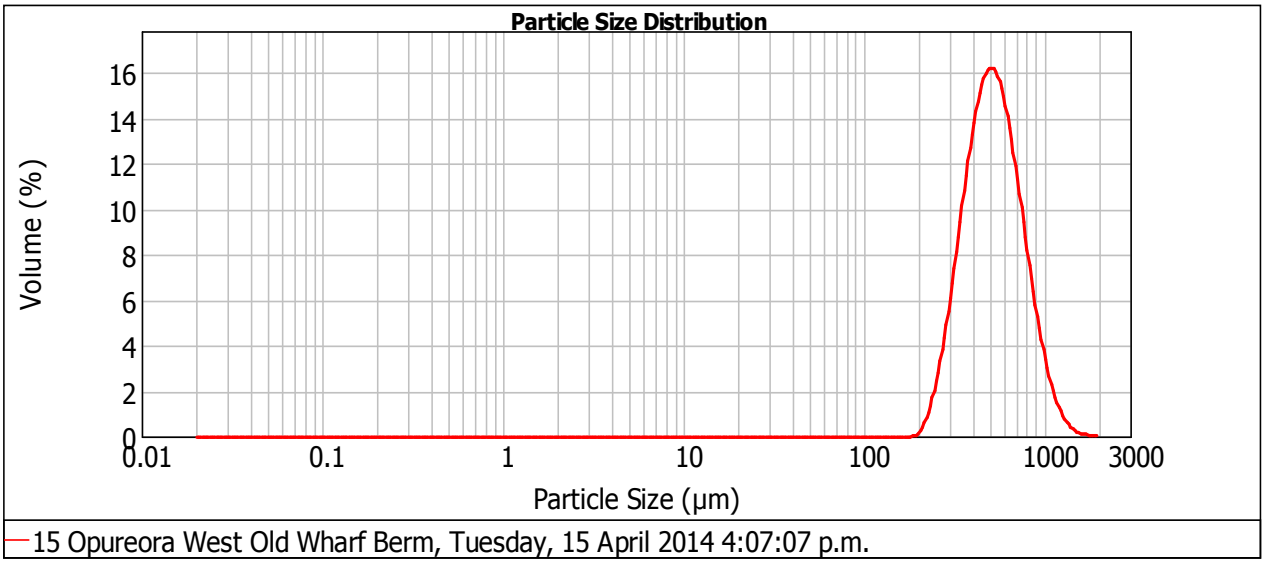
Vol. Weighted Mean D[4,3]:
556.360 um

Standard Deviation
210.902 um

---

d(0.1): 327.163 um **d(0.5):** 516.365 um **d(0.9):** 836.144 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	0.980	0.00	37.000	0.00	105.000	0.00	300.000	5.99	840.000	90.22
0.060	0.00	2.000	0.00	44.000	0.00	125.000	0.00	350.000	14.03	1000.000	96.18
0.120	0.00	3.900	0.00	53.000	0.00	149.000	0.00	420.000	28.79	1190.000	98.84
0.240	0.00	7.800	0.00	63.000	0.00	177.000	0.00	500.000	46.57	1410.000	99.74
0.490	0.00	15.600	0.00	74.000	0.00	210.000	0.05	590.000	63.83	1680.000	99.96
0.700	0.00	31.000	0.00	88.000	0.00	250.000	1.33	710.000	80.08	2000.000	100.00

Operator notes:

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MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
17 Opureora West ramp toe

SOP Name:
Marine Sediment

Measured:
Tuesday, 15 April 2014 4:12:40 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Tuesday, 15 April 2014 4:12:42 p.m.

Sample bulk lot ref:
2014052/16

Result Source:
Measurement

Particle Name:
Marine 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:
14.34 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.561 %

Result Emulation:
Off

Concentration:
0.5301 %Vol

Span :
1.237

Uniformity:
0.389

Result units:
Volume

Specific Surface Area:
0.0246 m²/g

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

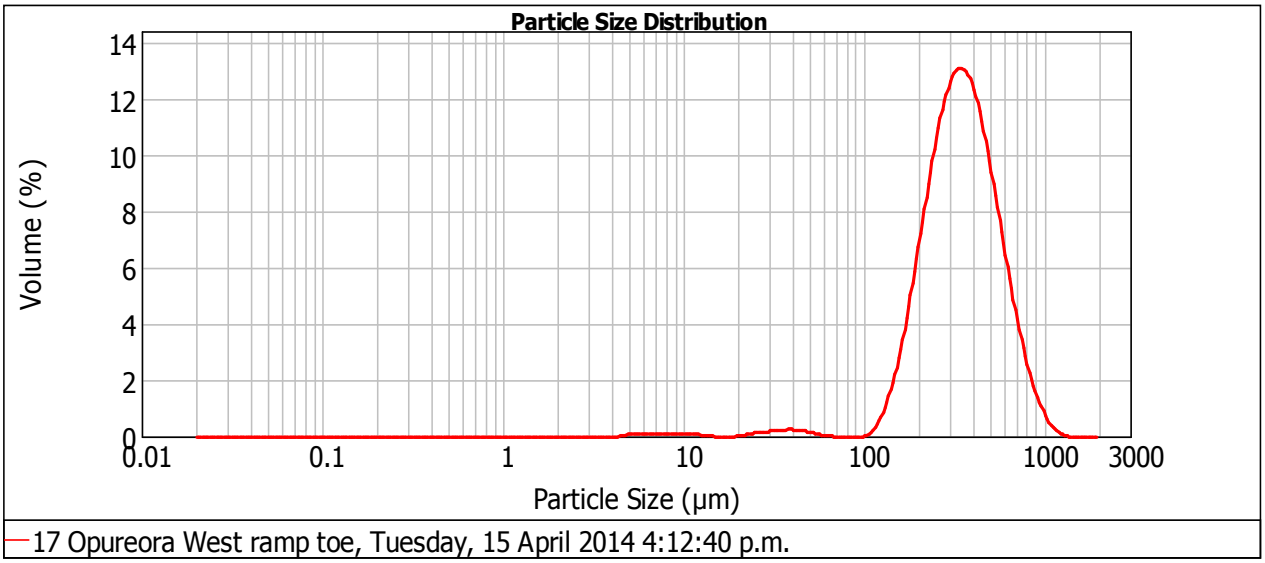
Vol. Weighted Mean D[4,3]:
379.934 um

Standard Deviation
178.635 um

---

d(0.1): 192.254 um **d(0.5):** 345.700 um **d(0.9):** 620.057 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	0.980	0.00	37.000	1.09	105.000	1.64	300.000	37.99	840.000	97.88
0.060	0.00	2.000	0.00	44.000	1.36	125.000	1.95	350.000	51.06	1000.000	99.47
0.120	0.00	3.900	0.00	53.000	1.58	149.000	3.49	420.000	66.25	1190.000	99.94
0.240	0.00	7.800	0.27	63.000	1.64	177.000	7.18	500.000	78.78	1410.000	100.00
0.490	0.00	15.600	0.53	74.000	1.64	210.000	13.86	590.000	87.86	1680.000	100.00
0.700	0.00	31.000	0.84	88.000	1.64	250.000	24.12	710.000	94.54	2000.000	100.00

Operator notes:

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Private Bag 3105
Hamilton, New Zealand

MALVERN INSTRUMENTS

MASTERSIZER 2000

Result Analysis Report

Sample Name:
18 Opureora Old Warf toe

SOP Name:
Marine Sediment

Measured:
Tuesday, 15 April 2014 4:18:02 p.m.

Sample Source & type:

Measured by:
rodgers

Analysed:
Tuesday, 15 April 2014 4:18:04 p.m.

Sample bulk lot ref:
2014052/17

Result Source:
Measurement

Particle Name:
Marine 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:
16.60 %

Dispersant Name:
Water

Dispersant RI:
1.330

Weighted Residual:
0.909 %

Result Emulation:
Off

Concentration:
0.3893 %Vol

Span :
1.282

Uniformity:
0.413

Result units:
Volume

Specific Surface Area:
0.0385 m²/g

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

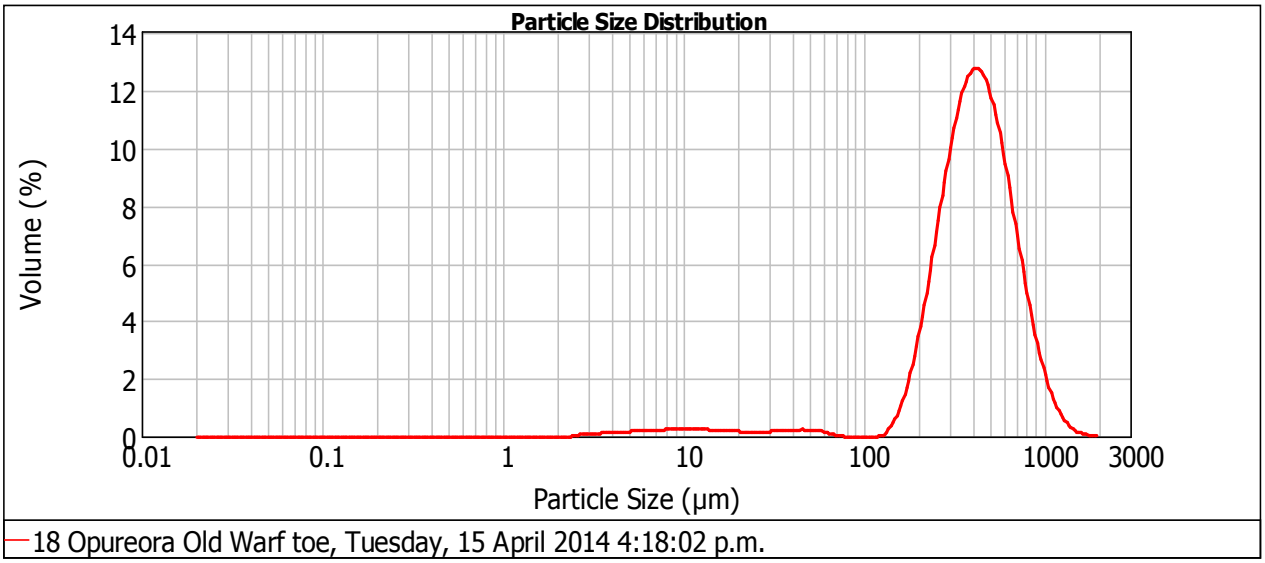
Vol. Weighted Mean D[4,3]:
453.061 um

Standard Deviation
230.221 um

---

d(0.1): 219.288 um **d(0.5):** 414.936 um **d(0.9):** 751.195 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	0.980	0.00	37.000	3.18	105.000	3.98	300.000	25.01	840.000	93.77
0.060	0.00	2.000	0.00	44.000	3.43	125.000	3.98	350.000	36.09	1000.000	97.43
0.120	0.00	3.900	0.28	53.000	3.70	149.000	4.23	420.000	51.02	1190.000	99.14
0.240	0.00	7.800	1.10	63.000	3.90	177.000	5.53	500.000	65.34	1410.000	99.79
0.490	0.00	15.600	2.18	74.000	3.98	210.000	8.76	590.000	77.32	1680.000	99.96
0.700	0.00	31.000	2.96	88.000	3.98	250.000	14.95	710.000	87.61	2000.000	100.00

Operator notes:

Appendix E: Contamination Samples

Hill Laboratories
BETTER TESTING BETTER RESULTS

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

Tel +64 7 858 2000
Fax +64 7 858 2001
Email mail@hill-labs.co.nz
Web www.hill-labs.co.nz

ANALYSIS REPORT

Client:	Tonkin & Taylor	**Lab No:**	1258709	SPv1
Contact:	Mark Ivamy	**Date Registered:**	04-Apr-2014	
	C/- Tonkin & Taylor	**Date Reported:**	14-Apr-2014	
	PO Box 317	**Quote No:**		
	TAURANGA 3140	**Order No:**	851786	
		Client Reference:	851786	
		Submitted By:	Mark Ivamy	

Sample Type: Soil

Sample Name:		BH2 - Opureora 450-750 28-Mar-2014				
Lab Number:		1258709.2				
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	4	-	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	0.17	-	-	-	-
Total Recoverable Chromium	mg/kg dry wt	11	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	6	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	14.8	-	-	-	-
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-	-	-	-
Total Recoverable Nickel	mg/kg dry wt	5	-	-	-	-
Total Recoverable Zinc	mg/kg dry wt	44	-	-	-	-
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	< 0.010	-	-	-	-
alpha-BHC	mg/kg dry wt	< 0.010	-	-	-	-
beta-BHC	mg/kg dry wt	< 0.010	-	-	-	-
delta-BHC	mg/kg dry wt	< 0.010	-	-	-	-
gamma-BHC (Lindane)	mg/kg dry wt	< 0.010	-	-	-	-
cis-Chlordane	mg/kg dry wt	< 0.010	-	-	-	-
trans-Chlordane	mg/kg dry wt	< 0.010	-	-	-	-
Total Chlordane [(cis+trans)* 100/42]	mg/kg dry wt	< 0.04	-	-	-	-
2,4'-DDD	mg/kg dry wt	< 0.010	-	-	-	-
4,4'-DDD	mg/kg dry wt	< 0.010	-	-	-	-
2,4'-DDE	mg/kg dry wt	< 0.010	-	-	-	-
4,4'-DDE	mg/kg dry wt	< 0.010	-	-	-	-
2,4'-DDT	mg/kg dry wt	< 0.010	-	-	-	-
4,4'-DDT	mg/kg dry wt	< 0.010	-	-	-	-
Dieldrin	mg/kg dry wt	< 0.010	-	-	-	-
Endosulfan I	mg/kg dry wt	< 0.010	-	-	-	-
Endosulfan II	mg/kg dry wt	< 0.010	-	-	-	-
Endosulfan sulphate	mg/kg dry wt	< 0.010	-	-	-	-
Endrin	mg/kg dry wt	< 0.010	-	-	-	-
Endrin aldehyde	mg/kg dry wt	< 0.010	-	-	-	-
Endrin ketone	mg/kg dry wt	< 0.010	-	-	-	-
Heptachlor	mg/kg dry wt	< 0.010	-	-	-	-
Heptachlor epoxide	mg/kg dry wt	< 0.010	-	-	-	-
Hexachlorobenzene	mg/kg dry wt	< 0.010	-	-	-	-
Methoxychlor	mg/kg dry wt	< 0.010	-	-	-	-

Sample Type: Sediment

Sample Type: Sediment						
Sample Name:		BH1 - Opureora 28-Mar-2014				
Lab Number:		1258709.1				
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg						
Total Recoverable Arsenic	mg/kg dry wt	< 2	-	-	-	-
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	-	-	-	-
Total Recoverable Chromium	mg/kg dry wt	< 2	-	-	-	-
Total Recoverable Copper	mg/kg dry wt	< 2	-	-	-	-
Total Recoverable Lead	mg/kg dry wt	3.1	-	-	-	-
Total Recoverable Mercury	mg/kg dry wt	< 0.10	-	-	-	-
Total Recoverable Nickel	mg/kg dry wt	< 2	-	-	-	-
Total Recoverable Zinc	mg/kg dry wt	12	-	-	-	-
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	< 0.010	-	-	-	-
alpha-BHC	mg/kg dry wt	< 0.010	-	-	-	-
beta-BHC	mg/kg dry wt	< 0.010	-	-	-	-
delta-BHC	mg/kg dry wt	< 0.010	-	-	-	-
gamma-BHC (Lindane)	mg/kg dry wt	< 0.010	-	-	-	-
cis-Chlordane	mg/kg dry wt	< 0.010	-	-	-	-
trans-Chlordane	mg/kg dry wt	< 0.010	-	-	-	-
Total Chlordane [(cis+trans)* 100/42]	mg/kg dry wt	< 0.04	-	-	-	-
2,4'-DDD	mg/kg dry wt	< 0.010	-	-	-	-
4,4'-DDD	mg/kg dry wt	< 0.010	-	-	-	-
2,4'-DDE	mg/kg dry wt	< 0.010	-	-	-	-
4,4'-DDE	mg/kg dry wt	< 0.010	-	-	-	-
2,4'-DDT	mg/kg dry wt	< 0.010	-	-	-	-
4,4'-DDT	mg/kg dry wt	< 0.010	-	-	-	-
Dieldrin	mg/kg dry wt	< 0.010	-	-	-	-
Endosulfan I	mg/kg dry wt	< 0.010	-	-	-	-
Endosulfan II	mg/kg dry wt	< 0.010	-	-	-	-
Endosulfan sulphate	mg/kg dry wt	< 0.010	-	-	-	-
Endrin	mg/kg dry wt	< 0.010	-	-	-	-
Endrin aldehyde	mg/kg dry wt	< 0.010	-	-	-	-
Endrin ketone	mg/kg dry wt	< 0.010	-	-	-	-
Heptachlor	mg/kg dry wt	< 0.010	-	-	-	-
Heptachlor epoxide	mg/kg dry wt	< 0.010	-	-	-	-
Hexachlorobenzene	mg/kg dry wt	< 0.010	-	-	-	-
Methoxychlor	mg/kg dry wt	< 0.010	-	-	-	-

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%.	-	1-2
Heavy metals, screen As,Cd,Cr,Cu,Ni,Pb,Zn,Hg	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	1-2
Organochlorine Pesticides Screening in Soil	Sonication extraction, SPE cleanup, dual column GC-ECD analysis (modified US EPA 8082).. Tested on dried sample	0.010 - 0.04 mg/kg dry wt	1-2
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-2

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

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

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