FACTUAL REPORT OF GEOTECHNICAL INVESTIGATIONS

Port Otago – Project Next Generation



Factual Report of Geotechnical Investigations

Port Otago - Project Next Generation



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Executive Summary

The following report outlines the factual data related to the geotechnical investigation completed for the dredging portion of Port Otago Ltd's "Next Generation" infrastructure development. Geotechnical investigation included subsurface investigation and laboratory testing. The two main objectives of the proposed geotechnical site investigation and laboratory testing were to (1) achieve a detailed description and characterisation of the materials to be dredged, (2) determine whether or not the sediment will be contaminated.

The subsurface investigation consisted of drilling at a total of 43 locations within the existing channel from Port Chalmers past Taiaroa Head. Investigations largely encountered sand, silt, and clay as well as basalt rock at Acheron Head and Rocky Point.

Laboratory testing was completed to determine both the soil and rock mechanical and chemical properties of the sediments. Mechanical testing involved particle size analysis, atterberg limits, water content, shear strength (cohesive), solid density, and unconfined compressive strength (rock). Chemical testing included a screen level analysis for heavy metals, inorganic compounds PCB, PAH and TPH as well as the inorganic compounds cyanide and total nitrogen.

With regard to chemical testing, none of the parameters analysed exceeded the guideline values used and based on these results, the materials to be dredged are not contaminated.

The field investigation and mechanical laboratory testing allowed us to characterise the materials into 4 main units that include (1) SAND (2) clayey SILT (3) silty CLAY and (4) ROCK.

The sand unit was most commonly encountered in the channel sections near the entrance to the harbour and beyond, namely from the Harington Bend to the Entrance sections. Sand was generally described as loosely packed in cores and had a water content between $\sim 20 - 30\%$.

The clayey silt was the most commonly encountered sediment type and was most prominent from the Swinging Basin to the Cross Channel sections. This unit's behaviour is dominated by a high silt content. These sediments were generally soft to very soft and non-plastic. Water content was between $\sim 30 - 40\%$ and had a measured shear strength between 14 - 24kPa.

Silty clay was the least common sediment type encountered and was most prominent in the area around Acheron Head. This unit had a relatively high clay content and sediments were generally soft to very soft, had a high plasticity and water content ~ 60%. The shear strength of these materials was measured to be between 12 - 22kPa.

Rock was the least common unit and was only encountered at Rocky Point and Acheron Head. This unit consisted of completely weathered basalt (cobbles and boulders) near surface and moderately weathered basalt at depth. A third borehole (B5) off Pulling Point encountered basalt cobbles but the borehole was terminated due to bad weather. It is likely that bedrock is also present at Pulling Point. Rock strength ranged from extremely weak to weak within the upper 2 to 4m and became moderately strong to very strong below this. Laboratory testing returned uniaxial rock strength values of 101 and 62MPa for B3 and B4, respectively.



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1 Introduction and Scope of Work

The following report outlines the factual data related to the geotechnical investigation completed for the dredging portion of Port Otago Ltd's "Next Generation" infrastructure development. The purpose of this development is to enable larger container vessels to be serviced at Port Chalmers. The project includes the provision of new plant and container handling equipment as well as the widening and deepening of the shipping channel. The channel is to be deepened along various sections from Port Chalmers past Taiaroa Head as shown in Figure 1 below as well as in Appendix A.



Figure 1 – Aerial photograph of the shipping channel.

The main objectives of the proposed geotechnical site investigation and laboratory testing were:

- to achieve a detailed description and characterisation of the material to be dredged
- to determine whether or not these materials will be contaminated.

In order to achieve these objectives subsurface investigation and laboratory testing were completed and the methodology and results of these investigations are outlined in this report.



2 Subsurface Investigation

The subsurface investigation consisted of using two different methods to extract the geological units for characterisation. The method depended on the materials that we expected to encounter and included:

- Vibrocoring This method is particularly used for investigations for dredging works and involves vibrating a tube into soft sediments to obtain a fully cored sample. We were limited to a maximum core length of 3m which restricted the use of this method to locations within the existing channel. A total of 37 vibrocore holes were completed to an average depth of 2.7m with minimum and maximum depths of 0.65 and 3.16m, respectively.
- Rotary Borehole Drilling This method was used in locations where materials of interest had a thickness greater than ~ 3m or where rock and more heavily consolidated materials were expected (eg. areas targeted for channel widening). A total of 6 rotary drilled boreholes were completed to an average depth of 8.6m with minimum and maximum depths of 2.5 and 12.1m, respectively.

Both methods were completed from a stable barge platform operated by Port Otago Ltd. Vibrocoring was completed by Quaternary Resources Ptl Ltd and rotary borehole drilling by Downer EDI Works Ltd. In total, investigations were completed at 43 locations along the sections targeted for deepening. These locations, along with their grid locations, are shown in Appendix A. Complete core logs and example photographs are presented in Appendix B.

A geological description based on logging of cores received from all 43 investigation locations is presented in Table 1. Results are summarised according to the channel sections that each hole was completed in. These channel sections are indicated in Appendix A.

Both, vibrocore and borehole drilling largely encountered sand and clayey silt with increasing plasticity being directly related to the quantity of clay present. The only boreholes that encountered bedrock were B3 and B4 at Rocky Point and Acheron Head, respectively. However, B5 at Pulling Point encountered a rounded basalt cobble at 2.4m but had to be terminated because of bad weather. It is therefore possible that bedrock could also be present at this point as well.



Section Name	Geological Description of Materials	Boreholes & Vibrocores in Section
Swinging Basin	Grey, sandy SILT and fine SAND. Silt is soft to very soft and non- plastic. Sand is loosely packed	B1, B2, VC1, VC1c, VC5, VC6, VC8
Deborah Bend with Rocky Point	SILT in the southern part close to Carey's Bay and silty CLAY closer to Acheron Head. Sediments soft to very soft and plastic where clay present. Completely to moderately weathered basalt in borehole 3 along the north side of the existing channel.	B3, VC9, VC10, VC12 - 14
Hamilton Bend with Acheron Head and Pulling Point	Clayey SILT with some sand, soft to very soft, non-plastic to slightly plastic. Silty CLAY, soft to very soft and plastic close to Acheron Head. Completely to moderately weathered basalt in boreholes 4 at Acheron Head. Basalt cobbles at Pulling Point	B4, B5, VC15, VC17, VC18, VC21, VC22
Taylors Bend	Clayey SILT at Dowling Bay end of section and sandy SILT at Waipuna Bay, soft to very Soft, plastic where clay content high.	VC23, VC26, VC27, VC29, VC32
Cross Channel	Clayey SILT, soft to very soft, slightly plastic sand content increasing toward eastern end of section.	VC34, VC36, VC39
Harington Bend	Fine SAND near Otakou changing to clayey SILT near Harrington Point and the Spit.	B6, VC41, VC42, VC44 - 46
Howletts	Fine SAND with some Silt near the eastern side around Pilot Beach.	VC47 - 50
Entrance	Fine SAND	VC54, VC56, VC57, VC59

Table 1 – Overview of geological description of materials found in borehole grouped by channel section.

3 Laboratory Testing

Laboratory testing was completed to determine the soil and rock mechanical properties of the sediments, as well as to determine the chemical contents in the sediments to be dredged. Mechanical testing was completed by the Opus Materials Testing Laboratory in Green Island, Dunedin. Chemical testing was completed by Hill's Laboratories in Hamilton. Complete laboratory tests results are presented in full in Appendix C. A summary of the type of tests and results are presented in the following sections.

3.1 Soil and Rock Mechanical Testing

The results of the mechanical testing completed at various boreholes and vibrocore holes is shown in Table 2. Testing included:

- Particle Size Analysis Used to determine the distribution of such things as clay, silt and sand fractions in the various sediments sampled. Where sediments contained a substantial amount of fines an additional step using a hydrometer was required to separate the finer silt and clay fractions.
- Atterberg Limits Used to describe the plasticity and liquid limits of sediments.
- Water Content Although these sediments were all saturated, this value gives an indication of the water held within void spaces and thus gives an indication of porosity. In addition, for most types of clays and silts there are relationships between water content, shear strength and consistency. If these relationships have been established by a number of paired tests (eg. atterberg limits), then water content can be used as an indicator for shear strength and consistency.
- Unconfined Compressive Strength Used to describe the strength of rock.
- Shear Vane Used to test the strength of cohesive sediments.
- Solid Density Used to describe weight and density for each of the three sediments encountered (silt, clay, sand).



	Pa Dist	rticle \$ ributio	Size on (%)		A	tterberg L	imits	Peak Stre (k	Shear ength Pa)	ensity 1 ³)	fined essive igth 'a)
Sample (Depth in m below seabed)	СLAY	SILT	SAND	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Min	Мах	Solid D (t/m	Uncon Compre Stren (MP
silty CLAY											
VC14 (0.8)	21	73	6	58.1	50	28	22	12	22	2.75	
Clayey SIL1											
VC1 (0.8)	12	60	28	38.1							
VC8 (0.6)	12	78	10	35.3	37	NP	NA	14	24		
VC12 (0.7)	13	73	14	38.1						2.76	
VC23 (1.6)	19	69	12	42.4							
VC45 (2.2)	18	74	8	42.5							
VC46 (1.6)				37.6	42	NP	NA				
VC49 (2.3)	10	50	40	31.3							
SAND											
VC6 (0.6)	0	0	100	26.7							
VC29											
(2.15)	0	1	99	25.0							
VC41 (2.0)	0	1	99	27.9							
VC50 (1.6)	0	0	100	26.4						2.68	
VC54 (1.8)	0	0	100	22.9							
VC59 (1.4)	0	0	100	26.1							
BASALT BE	DRO	CK	,								
B3 (-14m below											
Chart											
Datum)											101.5
B4											
(-12.75m											
Delow											
Datum)											62.9

Table 2 - Summary of Mechanical Testing Results for Port Otago's "Next Generatio	n" Dredging
Project	

Notes:

-- indicates "no value" because this analysis was not completed for the sample

NP - indicates that the sample was "Non-Plastic"

NA - indicates a plastic index could not be calculated because the sample was non-plastic



3.2 Chemical Testing

Because dredged material will be removed from the shipping channel and disposed elsewhere, information regarding the presence or absence of contaminants within the dredged material is essential.

Samples were submitted from 5 different locations along the length of shipping channel where material is proposed to be dredged. These locations were selected to be representative samples of material to be dredged and included sites VC5, VC12, VC21, VC34 and VC47.

Samples were taken through the full depth of the material to be dredged and 3 composite or mixed samples were submitted from each location. The three composites included combining sediment from 0 - 500mm, 500 - 1000mm and 1000 - 1500mm depth below the existing seabed. The upper 0 - 500mm composite was analysed first and based on the results from this level, further testing of the deeper composite samples was deemed unnecessary.

The sampling, sample handling and preservation procedures for marine sediments were followed in accordance to the New Zealand Guidelines for Sea Disposal of Waste and the New Zealand Contaminated Sites Guidelines (1999).

Samples were analysed for the following parameters:

- Heavy Metals and Metalloids As,Cd,Cr,Cu,Ni,Pb,Zn
- **Organic Compounds** PCB, PAH, TPH
- Inorganic Compounds CN, TN

The guideline values used for comparison are from the "Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000)" and are listed along with a summary of results in Table 3.

None of the parameters analysed exceeded the guideline values.



	Detection limit	Guidelines	Sample Concentrations (mg/kg)									
Parameter	(mg/kg)	ANZECC ¹	VC5	VC12	VC21	VC34	VC47					
Metals												
Arsenic	2	20	7.1	7.9	<2.0	<2.0	3.3					
Cadmium	0.1	1.5	<0.10	<0.10	<0.10	<0.10	<0.10					
Chromium (Total)	2	80	17	16	2.5	2.6	8.9					
Copper	2	65	6.7	6	<2.0	<2.0	4.4					
Lead	2	50	7.1	6.7	0.79	0.81	4.3					
Nickel	0.4	21	11	10	2.2	2.1	7.2					
Zinc	4	200	44	42	8.1	6.8	27					
Organic Compounds												
PCB (Total)	0.02	0.023	<0.001	<0.001	<0.001	<0.001	<0.001					
TPH (Total C7 - C36)	60		<60	<60	<60	<60	<60					
PAH												
Anthracene	0.0020	0.085	0.002	<0.0020	<0.0020	<0.0020	<0.0020					
Fluroanthene	0.0020	0.6	0.0021	<0.0020	<0.0020	0.002	<0.0020					
Phenanthrene	0.0020	0.24	<0.0020	0.0025	<0.0020	<0.0020	0.0049					
Inorganic Compounds												
Cyanide (Total)	0.1		<0.1	<0.1	<0.1	<0.1	<0.1					
Nitrogen (Total)	0.051		<0.051	<0.051	<0.051	<0.051	0.082					

Table 3 - Summary of Chemical Testing for Port Otago's "Next Generation" Dredging Project

Notes:

- all concentrations are in mg/kg (ppm) unless otherwise stated

- nv indicates that a guideline value does not exist for the quoted reference

- only those PCB, TPH, and PAH compounds above detection limit are listed, otherwise only the total will be listed.

¹ Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000), low trigger value



4 Characterisation Summary

With regard to chemical testing, none of the parameters analysed exceeded the guideline values.

Based on the field investigation and mechanical laboratory testing the materials to be dredged during the widening and deepening of the shipping channel can be roughly characterised into 4 main units that include (1) SAND (2) clayey SILT (3) silty CLAY and (4) ROCK.

4.1 SAND

This unit was most commonly encountered in the channel sections near the entrance to the harbour and beyond, namely from the Harington Bend to the Entrance sections and in the eastern part of the Swinging Basin. Although sand is found in both of the other sediment types, grain size distribution curves for this sediment type were between 99 - 100% sand. In addition, the vast majority of this sand fell with the "fine" sand designation (0.06 - 2mm).

Sand was generally described as loosely packed in cores and has a water content between $\sim 20 - 30\%$.

4.2 Clayey SILT

This unit was the most commonly encountered sediment type in the upper reaches of the harbour and was most prominent from the Swinging Basin right out to the Cross Channel. The unit is dominated by the silt grain size fraction and on average had a grain size distribution of 14% clay, 67% silt, and 19% sand.

These sediments were generally soft to very soft. Samples submitted for atterberg limits showed these sediments as non-plastic. Comparison with the silty clay unit shows the importance of clay content in plasticity. As mentioned above a slightly higher clay content can influence the material properties. Water content ranged between $\sim 30 - 40\%$ and a shear strength between 14 - 24kPa was measured.

4.3 Silty CLAY

This unit was the least common sediment type and was most prominent in the area around Acheron Head. The tested sample had a grain size distribution of 21% clay, 73% silt and 6% sand. Although the largest fraction is silt, the clay percentage influences material properties. When clay content rises it dominates material behaviour and therefore this unit has clay as its dominant fraction.

The sediments in this unit were generally soft to very soft with a high plasticity and high water content ~ 60%. The shear strength of these materials is estimated to be between 12 - 22kPa.

NOTE: Strength and density qualitative descriptions described above (eg. soft to very soft) are generalisations. It is possible that vibrocoring has resulted in a slight modification of the consistency and the denseness of the materials.



4.4 ROCK

This was the least common unit and was only encountered at Rocky Point and Acheron Head. This unit consisted of completely weathered basalt near surface and moderately weathered basalt at depth. Borehole B5 encountered basalt cobbles off Pulling Point but the borehole was terminated due to bad weather. It is likely that this unit is also present at Pulling Point. Rock strength ranged from extremely weak to weak within the upper 2 to 4m and became moderately strong to very strong below this. The spacing of defect or discontinuities ranged from closely spaced to very closely spaced. Laboratory testing returned uniaxial rock strength values of 101 MPa and 62 MPa for B3 and B4, respectively.



APPENDIX A

Site Locations Geotechnical Investigations

(Note - Refer to "Geotech	nical Investi	gations - Pr	oposed Vibrocor	re Positions" fo	r details on mis	sing numbers.)	
				Acti	al Position		
Area - Desription	VC No	Date	Local Grid (N	orth Taieri)	l at/l ong	<u>.</u> (WGS84)	Denth(m)
Area - Desription	VO NO.	Date	Northing	Easting	Lat	Long	Seabed
Port Chalmers Inner Basin	VC c	14/05/08	705110	326778	45°48.805'S	170°37.633'E	13.5
	VC01	14/05/08	705199	327062	45°48.756'S	170°37.852'E	13.3
Port Chalmers Swinging Basin	VC05	14/05/08	705563	326889	45°48.560'S	170°37.717'E	13.1
	VC06	14/05/08	705510	327194	45°48.588'S	170°37.953'E	13.0
	VC08	17/05/08	705874	326985	45°48.392'S	170°37.790'E	13.4
	VC09	14/05/08	706134	327263	45°48.251'S	170°38.004'E	14.0
	VC10	17/05/08	706236	327178	45°48.196'S	170°37.938'E	13.2
Deborah Bend	VC12	14/05/08	706455	327427	45°48.077'S	170°38.129'E	13.4
-	VC13	14/05/08	706519	327738	45°48.042'S	170°38.369'E	13.3
	VC14	17/05/08	706674	327742	45°47.958'S	170°38.372'E	13.6
	VC15	16/05/08	706753	328055	45°47,915'S	170°38.613'E	13.8
1	VC17	16/05/08	706788	328334	45°47.895'S	170°38.828'E	13.5
Hamilton Bend	VC18	16/05/08	706648	328568	45°47.970'S	170°39.009'E	12.7
	VC21	13/05/08	706836	329215	45°47.867'S	170°39.508'E	10.8
	VC22	16/05/08	707000	329103	45°47.779'S	170°39.421'E	12.9
	VC23	13/05/08	707210	320378	15°17 665'S	170°30 632'E	12 /
	VC26	13/05/08	707210	329672	45°47 633'S	170°39 859'E	12.4
Taylors Bend	VC27	13/05/08	707508	330042	45°47 502'S	170°30.003°E	13.2
	VC29	13/05/08	707334	330477	45°47 595'S	170°40 480'E	11.5
	VC32	16/05/08	707494	331012	45°47.507'S	170°40.892'E	10.6
		17/05/08	707121	331/185	15º17 707'9	1700/1 266'5	12.1
	VC36	17/05/08	707121	331701	45°47 637'S	170 41.200 L	12.1
Cross Channel	VC39	17/05/08	706983	332173	45°47 780'S	170 41.494E	10.0
	VC40	17/05/08	707140	332565	45°47.694'S	170°42.092'E	11.0
		16/05/08	707149	333025	15°17 688'S	170°42 447'E	11.8
	VC41	16/05/08	707149	333512	45°47 602'S	170 42.447 L	11.0
Harrington Point	VC44	16/05/08	707518	334023	45°47 486'S	170 42.022 L	11.5
	VC45	15/05/08	707897	334024	45°47 281'S	170°43 215'E	13.2
	VC46	15/05/08	707737	334145	45°47.367'S	170°43.309'E	12.4
		40/05/00	700070	00.400.4			10.0
4	VC47	16/05/08	708879	334021	45°46.751'S	170°43.208'E	13.8
Howletts	VC48	15/05/08	709227	334081	45°46.563'S	170°43.253'E	13.3
+	VC49	15/05/08	708943	334183	45°46./165	170°43.333E	13.5
	v C50	13/03/08	109402	554257	40 40.400 3	170 43.300 E	11.0
	VC54	15/05/08	710635	334362	45°45.802'S	170°43.464'E	-14.4
Entrance Channel	VC56	15/05/08	711110	334207	45°45.546'S	170°43.342'E	-14.4
	VC57	15/05/08	711061	334447	45°45.572'S	170°43.528'E	-12.0



APPENDIX B

Borehole and Vibrocore Logs and Core Photographs

		Opus International Consultants Duredin Office							Boreho	le No: B 1			
	OP	US	Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gi El In	o-ordi rid: La evatic clinat	inates: 45° 48 atitude / Long on: - 3.1m ion: Vertical	636'S 170° 38.0 jitude (WGS84) Datum: C Azimuth:	18'E hart Datum N/A		
				Ground Profile		1		Sa	mples	-			
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test △ kPa △ 0 20 60 100 SPT ■ N ■ 0 10 30 50	Additional Lab Tests/Notes	Piezometer Installation		
- 0 - -			SAND with s black, homoger organic rich wit	Ground Surface ome silt and trace shells hous. Loose; saturated; dilatant; sand, fine, h a strong sulphur smell.		-3.10 0.00 -3.70 0.60	HQ	67%					
- 1 - -			SAND with s as at 0 to 0.6m	from drillers comments. ome silt and trace shells		-4.00	НQ	67%	-				
-2			Lost core (inferred SAND	from drillers comments).		-5.50							
- - -3			SAND with m grey to light gre Loose; saturate	unor shells y, homogenous. d; dilatant; sand, fine to medium.	>	-6.10 3.00							
	λ.		(inferred SAND	from drillers comments).	×××		HQ	40%			alled -		
-4 - -	Tube Wireline Rota		SAND with m as at 2.4 to 3.0	inor shells m.		-7.00	HQ	60%			No Piezometer Inst		
-5	HQ Triple		Lost core (inferred SAN	D from drillers comments).	××	4.80							
			SAND with m as at 2.4 to 3.0	inor shells ^{m.}		-8.50 5.40 -9.10	0 0 0					Drillers comment: becoming firmer below 5.4m.	
			Lost core (inferred SAND	from drillers comments).	× × ×	6.00	HQ	40%					
-7			SAND with m as at 2.4 to 3.0 Lost core (inferred SAND	inor shells m. from drillers comments).	×××	-10.40 7.30	HQ	27%					
-			SAND with m as at 2.4 to 3.0	inor shells ^{m.}	×××	-11.50 8.40 -11.70 8.60							
-9			(Inferred SAND	from drillers comments).	$\times \times \times \rangle$		HQ	Q 13%					
- 10 F	ema	marks: HQ clay coring bit used for full length of borehole.							ed: Tim Jowe	ett Date	e: 21/4/2008		
							Checked: Markus Hanz Drill Rig: Longyear 38 Rotary (Driller: G. Brown) Start Date: 10/4/2008 Finish Date: 10/4/2008						
								Scale	e: As Shown				

	Opus International Consultants Dunedin Office		Opus International Consultants	Page: 2 of 2				Borehole No: B 1						
•	DPI	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01	÷		Co Gr Ele Inc	Co-ordinates: 45° 48.636'S170° 38.018'EGrid: Latitude / Longitude(WGS84)Elevation: - 3.1mDatum: Chart DatumInclination: VerticalAzimuth: N/A						
				Ground Profile			Samples							
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation			
- - - -11					× × × × × ×	-14.50	HQ	0%						
-				End of Log		11.40								
											oposed Design Deput			
I	Rem	arks	: HQ clay coring	bit used for full length of borehole.				Logg Chee	ged: Tim Jow cked: Markus	ett Dat Hanz	te: 21/4/2008			
								Drill Star	Rig: Longyea t Date: 10/4/2	ar 38 Rotary (Drille 008 Finish Da	er: G. Brown) ate: 10/4/2008			
								Scal	e: As Shown					

		Opus International Consultants						Borehole No: B 2						
OP	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP001.001			Co Gr Ele Inc	Co-ordinates: 45° 48.479'S170°37.962'EGrid: Latitude / Longitude(WGS84)Elevation: - 4.1mDatum: Chart DatumInclination: VerticalAzimuth: N/A							
			Ground Profile		1		Sa	mples						
Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	A kPa A 0 20 60 100 SPT N 0 10 30 50	Additional Lab Tests/Notes	Piezometer Installation				
		SAND with tr grey, homogen medium. Lost core (inferred SAND	Ground Surfa ous. Loose; saturated; dilatant; sand, fine-	S 0.00 saturated; dilatant; sand, fine- 4.60 s comments) X S -5.70 S 1.60		HQ	31%							
e Wireline Rotary		SAND with trace shells as at 0 to 0.5m. X Lost core (inferred SAND from drillers comments). X SAND with trace shells greenish grey, homogenous. Loose; saturated; dilatant; sand, medium to fine. X Lost core (inferred SAND from drillers comments). X X X	race shells from drillers comments).	× × × ×	-6.20 2.10	5.70 1.60 6.20 2.10 HQ .7.20 3.10 .7.70 3.60 HQ	33%							
HQ Triple Tub				-7.20 3.10 -7.70 3.60	HQ	33%			⊳ Piezometer Installed [—]					
				×××××		HQ	0%			ž				
		SAND with trace as at 3.1m to 3.6m. Lost core (inferred SAND from	t race shells .6m. 9 from drillers comments).	× × ×	-10.20 6.10 -10.70 6.60	<u>о</u> но	33%							
	SAND with trace shells as at 3.1 to 3.6m. Lost core (inferred SAND from drillers comments).	× × × ×	-11.70 7.60 -12.20 8.10	но	33%									
þ			End of Log	X.	9.10									
Rem	narks	: HQ clay coring Proposed D	bit used for full length of borehole esign Depth 10.9m				Logg Cheo Drill Star	ged: Tim Jow cked: Markus Rig: Longyea t Date: 11/4/08	ett Da Hanz Ir 38 Rotary (Drill 3 Finish Da	te: 21/4/08 er: G. Brown) ate: 11/4/08				

1			Opus International Consultants	Page: 1 of 1		Borehole No: B 3							
C	DP	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr Ele Inc	Co-ordinates: 45° 48.282'S170° 37.818'EGrid: Latitude / Longitude(WGS84)Elevation: - 9.1mDatum: Chart DatumInclination: VerticalAzimuth: N/A					
				Ground Profile	1	1		Sa	mples				
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation		
- 0 - - - - -		2	Highly weath grey-orange bro joints, typical bl fine-medium Gl Lost core (inferred basalt	Ground Surface Thered BASALT Down, weak (material), extremely closely spaced ock size 5 to 20mm; behaves as an interlocked, RAVEL with minor coarse gravel.).		-9.10 0.00 -9.60 0.50	HQ	50%		Occasional seam of red-brown, moderately plastic silty CLAY, wet, very soft, up to 30mm thick.			
-					× × ×	-11.10	HQ	0%		Drillers comment: core loss due to core dropping from catcher.			
-2	Wire line Rotary		Basalt as at 0.0 to 0.5 Lost core (inferred basalt	m/	× × ×	-12.10	HQ	10%		Drillers comment: core loss due to mismatch of inner	ır Installed –		
	HQ Triple Tube		Basalt as at 0.0 to 0.5 Lost core (inferred basalt	m.).	が が X X	-12.50 3.40	HQ	40%		tube.	No Piezomete		
-4 - - - -5		-	Moderately V dark grey with s with some weal weathering, clo	Veathered BASALT some orange-brown zones, moderately strong k zones associated with more intense sely to very closely spaced joints.	では学校では学校では	4.00	HQ	100%	-	Joints typically planar, rough, open, dipping at between 10 to 20°, with some dipping at 60 to 70°			
-							НО	100%		Calcite veins up to 5mm thick Pro	posed Design Depth		
									-				
-7						-16.50	НQ	100%		14.0m: Sample UCS			
- 8				End of Log		7.40							
- - - -													
-10													
R	tem	arks	: HQ Diamono	l impregnated drill bit used for full length of bo	rehole	э.		Logg Chee Drill	ged: Tim Jow cked: Markus Rig: Longyea	ett Date Hanz ar 38 (Driller: G. Br	e: 21/4/2008 own)		
				-				Star Scal	t Date: 16/4/2 e: As Shown	ບບຮ Finish Da	te: 16/4/2008		

	Opus International Consultants Dunedin Office						Boreho	le No: B 4			
	DP	US	Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr Ele Inc	o-ordi id: La evatic clinati	nates: 45° 47 atitude / Long on: - 4.0m ion: Vertical	884'S 170° 38.73 itude (WGS84) Datum: Cl Azimuth:	0'E nart Datum N/A
				Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test ^ kPa ^ 0 20 60 100 SPT • N • 0 10 30 50	Additional Lab Tests/Notes	Piezometer Installation
		Ground Surface Cobbles						0%		Drillers comment: loose sediments washed away.	
- -2 - - - -			Cobbles loose; sub rour Completely v orange-brown, Weathered to S silt, very stiff; g Lost core	nded. weathered BASALT extremely weak, very closely spaced joints SILT to silty GRAVEL with some cobbles. ravel, medium to fine, loose.		-6.10 2.10 -7.10	HQ	33%	-		
- - 	e Rotary		Extremely to grey-orange br extremely weal	Lost core (inferred basalt). Basalt as at 1.65 to 2.1m. Extremely to highly weathered BASALT grey-orange brown, weak to moderately strong with some extremely weak zones, very closely to closely spaced joints. Joints generally dipping at 10 to 20°, planar, rough, open. Moderately weathered, BASALT greenish to purplish grey, moderately strong, closely spaced joints. Joints generally dipping at 20 to 30°, planar, rough, open. Joint at 40° infilled (5mm) with soft, moderately plastic, orange- brown SILT	なができたがないできた。	-8.05	HQ	100%	6		o Piezometer Installed [–]
- 	HQ Triple Tube Wire lin		extremely wea Joints general Moderately greenish to pu				HQ	100%		RQD: 31% (-8.6 to -10.1m)	Z
- - - - 7 -			greenish to pur joints. Joints ge open. Joint at 40° infi		行為が設定が行うない	-11.45	HQ	100%	-	RQD: 77% (-10.1 to -11.6m)	
- - - - - - - 9			brown SILT.		語で語を語で語で語で語		HQ	100%		RQD: 80% (-11.6 to -13.1m) -12.75m: Sample UCS	
- - - -10					がなながな		HQ	100%		RQD: 100% (-13.1 to -14.6m)	
I	Rem	ark	s: HQ Diamono	d impregnated bit used for full length of boreho	le			Logg Chee Drill	ged: Tim Jow cked: Markus Rig: Longyea	ett Dat Hanz ar 38 Rotary (Drille	e: 21/4/2008 r: G. Brown)
							8	Star Scal	t Date: 14/4/2 e: As Shown	008 Finish Da	te: 14/4/2008

		Opus International Consultants Durandia Office							Boreho	le No: <mark>B</mark> 4	
	OP	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01		×	Co Gri Ele Inc	o-ordii id: La evatio clinati	nates: 45° 47 atitude / Long on: - 4.0m ion: Vertical	.884'S 170° 38.73 itude (WGS84) Datum: C Azimuth:	30'E hart Datum N/A
-				Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Craphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
- - - -11		E					но	100%		Pr Pr	pposed Design Depth
- - -12				End of Log		<u>-16.10</u> 12.10				(-14.6 to -16.1m)	
	3 9 Rem	nark	s: HQ Diamor	nd impregnated bit used for full length of bor	rehole			Log	ged: Tim Jow cked: Markus	vett Da	te: 21/4/2008
	Drill Rig: Longyear 38 Rotary (Driller: G. Brown) Start Date: 14/4/2008 Finish Date: 14/4/2008 Scale: As Shown							Drill Star Sca	Rig: Longye t Date: 14/4/2 le: As Shown	ar 38 Rotary (Drill 2008 Finish Da	er: G. Brown) ate: 14/4/2008

			Opus International Consultants	Page: 1 of 1					Boreho	le No: B 5	
•	JPI OPI	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordii d: La vatio linati	nates: 45° 47. titude / Long n: - 10.0m on: Vertical	.763'S 170° 39.40 itude (WGS84) Datum: C Azimuth:	00'E hart Datum N/A
				Ground Profile				Sa	mples		
Depth	re title Rollary hod	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
-0-	HQ Triple Tube W		Lost core (inferred SAND	Ground Surface	× × × ×	<u>-10.00</u> 0.00	HQ	0%			
	SAND with minor shells dark grey, homogenous. Loose; saturated; dilatant; sand, medium to fine. End of Log					<u>-11.58</u> 1.58	HQ	39%		Rounded basalt COBBLE at 2.4m.	No Piezometer Installed
-				End of Log		2.50					
-3 - - - - - - - - - - - - - - - - - -										Pr	oposed Design Depth
- - - - - - 7 - - - 7											
- - - - - - - - - - -											
	Rem	arks	s: HQ Clay Coring	g bit used for full length of borehole.				Log Che Drill	ged: Tim Jow cked: Markus Rig: Longye	vett Da s Hanz ar 38 Rotary (Drill	te: 21/4/2008 er: G. Brown) ate: 15/4/2008
								Star	t Date: 15/4/2	2008 Finish D	ate: 15/4/2008
						_		Sca	ie. As Shown		

			Opus International Consultants	Page: 1 of 1				Boreho	le No: B 6		
•	DPU	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordii d: La vatio linati	nates: 45° 47. titude / Long n: - 7.0m on: Vertical	466'S 170° 42.9 itude (WGS84) Datum: C Azimuth:	56'E hart Datum N/A
				Ground Profile				Sa	nples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test kPa 0 20 60 100 SPT N 0 10 30 50	Additional Lab Tests/Notes	Piezometer Installation
			Lost core (inferred SAND	Ground Surface	××××××	-7.00 0.00 -8.40	HQ	0%		Drillers comment: core loss due to loose sediments being washed	
- 	le Tube Wire line Rotary		SAND with tr light grey, homo medium to fine. Lost core (inferred SAND	r ace shells ogenous. Loose; saturated; dilatant; sand, from drillers log).	××××	- <u>8.90</u> 1.90	HQ	33%		away.	
-3 - - -4 -	HQ Trip		SAND with ti as at 1.5 to 1.9 Lost core (inferred sand f	r ace shells m. from drillers log).	××××	2.90 -10.40 3.40 -11.40	HQ	33%			:zometer installed [–]
- - -5 -			SAND with tr as at 1.5 to 1.9 Lost core (inferred SAND	race shells m.) from drillers log).	× × × ×	4.40 -11.90 4.90	HQ	33%			а ОД
			SAND with to as at 1.5 to 1.9 Lost core (inferred SAND	race shells Im.) from drillers log).	××××××	-12.50 5.90 -13.10 6.10	HQ	13%			
- - - 8 -			SAND with t as at 1.5 to 1.9 Lost core (inferred SANE	race shells Jm. D from drillers log).	×××××	-14.60 7.60	HQ	13%		Pr	oposed Design Depth
-9 - - - -				End of Log					¥		
	Rem	arks	:: HQ Clay Coring	g bit used for full length of borehole.		Logged: Tim Jowett Date: 21/4/2008 Checked: Markus Hanz					
						Start Date: 12/4/2008 Finish Date: 12/4/2008			ate: 12/4/2008		
1					Scale: As Shown						

1			Opus International Consultants	Page: 1 of 1				i K	Vibroco	re No: VC	1
0	DPI	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordi id: La evatic :linat	nates: 45° 48. atitude / Long on: -13.3m ion: Vertical	756'S 170° 37.8 itude (WGS84) Datum: C Azimuth:	52'E :hart Datum N/A
				Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
	Vibro Core	Vibro Core Aluminium Casing	SAND with s light grey, home gravel, fine. SILT with so dark brown, len sand, fine; lens depth. Clayey SILT dark brown, ho	Ground Surface ome gravel and silt ogenous. Loosely packed; moist; sand, course; me clay and minor sand soidal. Soft to very soft; saturated; plastic; of shelly Silt. Sand percentage decreases with mogenous. Soft to very soft; saturated; plastic.		-13.30 0.00 -13.40 0.10 -15.00 1.70			SPT not carried out	0.8m: Sample PSD	roposed Design Depth
F - -	Rem Qui Full	marks: uick, firm and steady penetration of core barrel ull core catcher					Logged: James GrindleyDate: 15 May 2008Checked: Markus HanzDrill Rig: Vibro CoreStart Date: 14/5/2008Finish Date: 14/5/2008				te: 15 May 2008 ate: 14/5/2008
								Sca	le: As Shown		

			Opus International Consultants	Page: 1 of 1			2	Vibroco	ore No: VC	1c	
•	DPI	US	Dinedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordi d: La vatio linati	nates: 45° 48. Ititude / Long In: -12.9m Ion: Vertical	805'S 170° 37.6 itude (WGS84) Datum: C Azimuth:	33'E hart Datum N/A
				Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
-	Vibro Core	Vibro Core Aluminium Casirig	SAND with s light grey, home sand, fine.	Ground Surface ome silt ogenous. Loosely packed; moist; poorly graded; End of Log		<u>-12.90</u> 0.00 <u>-13.55</u> 0.65			SPT not carried out		No Piezometer Installed [–]
								ged; James G	P Srindley Da	roposed Design Depth	
	Rem Hard Full b	ark: , slow out pa	S: penetration of core barr rtially inverted core catcl	rel her				Che Drill Star	cked: Markus Rig: Vibro Co t Date: 14/5/2	s Hanz ore 008 Finish D	ate: 14/5/2008
						Sca	e: As Shown				

			Opus International Consultants	Page: 1 of 1				1	Vibrocc	ore No: VC	5
	DP	us	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr Ele Inc	o-ordi id: La evatic clinat	nates: 45° 48 atitude / Long on: -13.1m ion: Vertical	560'S 170° 37.71 itude (WGS84) Datum: Cl Azimuth:	I7'E hart Datum N/A
				Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
	Vibro Core	Vibro Core Aluminium Casing	SILT with so grey, homogen Sand percenta Trace sand	In the clay and of trace sand hous. Soft to very soft; saturated; non plastic. ge decrease with depth. The clay hous. Soft to very soft; moist to saturated; plastic. End of Log		-14.58 0.00 -14.58 1.48		98%	SPT not carried out	Mixed sample for contamination testing Mixed sample for contamination testing Mixed sample for contamination testing Pro	poosed Design Depth ▼
Remarks: - Quick, then firm and steady penetration of core barrel Logged: James Grindley Date: 15 May - Full, almost inverted core catcher Drill Rig: Vibro Core Start Date: 14/5/2008 Finish Date: 14/5/2 Scale: As Shown						te: 15 May 2008 hte: 14/5/2008					

1			Opus International Consultants	Page: 1 of 1			1	Vibroco	re No: VC	6	
0) PI	JS	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01		D.	Co Gri Ele Inc	-ordi d: La vatic linat	nates: 45° 48. atitude / Longi on: -12.4m on: Vertical	588'S 170° 37.9 itude (WGS84) Datum: C Azimuth:	53'E hart Datum N/A
-	T	Т		Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
	1 Organization 1 SILT with minor sand and clay black, homogenous. Soft to very soft; moist; plastic. Becomes less sandy with depth 2 SILT with minor clay black, homogenous. Soft to very soft; moist; plastic. 3 SILT with minor clay black, homogenous. Soft to very soft; moist; plastic.							94%	SPT not carried out	0.6m: Sample PSD	roposed Design Depth
-0				End of Log		3.04					
لــــــــــــــــــــــــــــــــــــ	tem Qui Full	arks ck, ti	s: hen firm and stead erted core catche	dy penetration of core barrel		1	1	Log Che	ged: James G cked: Markus	Grindley Da Hanz	te: 15 May 2008
		.,						Stai Sca	t Date: 14/5/2	008 Finish D	ate: 14/5/2008

1			Opus International Consultants	Page: 1 of 1			Y	Vibroco	re No: VC	8	
•	DPU	JS	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordii id: La evatio clinati	nates: 45° 48. titude / Long n: -13.2m on: Vertical	392' S 170° 37.79 itude (WGS84) Datum: C Azimuth:	90' E hart Datum N/A
				Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	, Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
0	Core	minium Casirig	Sandy SILT of grey, homogen	with some clay and shells ous. Soft ; wet to saturated.		-13.20 0.00					istalled [–]
	Vibro	Vibro Core Alur	Clayey SILT grey, homogen	with some sand ous. Soft; wet; slightly plastic.				36%	SPT not carried out	0.6m: Sample PSD, Atterberg, Shear Strength	No Piezometer In
				End of Log		0.80					
-0						-				F	
- -3											
_,											
	Rem Quick Full c	k, the	S: en firm and steady penetr catcher, inverted on reco	ration of core barrel very leading to lost core		Logged: Markus Hanz Date: 24 May 2008 Checked: Markus Hanz Drill Rig: Vibro Core Start Date: 14/5/2008 Finish Date: 14/5/2008 Scale: As Shown					

Number of a set of the s				Opus International Consultants	Page: 1 of 1					Vibroco	ore No: VC	9
Bit of the second profile Samples 9 0 Description 0	OI	νU	JS	Dinedin Onice Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr Ele Inc	o-ordi id: La evatic clinat	nates: 45° 48. Ititude / Long In: -14.0m Ion: Vertical	251'S 170° 38 itude (WGS84) Datum Azimut	.004'E Chart Datum h: N/A
Image: Second		T	T		Ground Profile				Sa	mples		
SAND with minor Shells groy, homogenous. Loosely packed; moist; poorly graded. 1000 Image: Construct on the state of t	Depth Drilling Method	Cacine	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
SILT with some sand and minor clay 000 000 000 000 Back, homogenous. Soft to very soft; saturated; slightly plastic; 1 1 1 1 SILT with some clay 1588 1 1 1 1 1 SILT with some clay 1588 1	-		sing	SAND with m grey, homogen	Ground Surface ninor Shells ous. Loosely packed; moist; poorly graded.		-14.00			SPT not carried out		
- - <td>-1</td> <td>VIDIO COLE</td> <td>Core Aluminium Cas</td> <td>SILT with so black, homoger smells of organ</td> <td>me sand and minor clay nous. Soft to very soft; saturated; slightly plastic; ics.</td> <td></td> <td>-14.80</td> <td></td> <td></td> <td></td> <td></td> <td>Proposed Design Depth</td>	-1	VIDIO COLE	Core Aluminium Cas	SILT with so black, homoger smells of organ	me sand and minor clay nous. Soft to very soft; saturated; slightly plastic; ics.		-14.80					Proposed Design Depth
- -			Vibro (SILT with so black, homoger	me clay nous. Soft to very soft; moist; plastic.		- <u>-15.62</u> 1.62		95%			No Piezometer Installed [–]
Remarks: Logged: James Grindley Date: 15 May - Quick penetration of core barrel Checked: Markus Hanz Drill Rig: Vibro Core - Full but partially inverted core catcher Drill Rig: Vibro Core Start Date: 14/5/2008	-											
Start Date: 14/5/2006 Finish Date: 14/5/20	Rer - Qı - Fu	nar uick	r ks: c per out pa	netration of core t artially inverted c	parrel ore catcher				Logg Chec Drill	jed: James G :ked: Markus Rig: Vibro Co	rindley [Hanz pre	Date: 15 May 2008
Scale: As Shown									Star	Date: 14/5/20	no Finish	Date: 14/5/2008

1			Opus International Consultants	Page: 1 of 1			8	Vibroco	re No: VC	10	
•) OP	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	o-ordi id: La evatio clinati	nates: 45° 48. atitude / Longi on: -13.1m ion: Vertical	946' S 170° 37.9 tude (WGS84) Datum: C Azimuth:	38' E hart Datum N/A
				Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
-		asing	SAND with s grey, homogen Silty SAND w	Ground Surface ome shells ous. Sand, medium to fine. vith some shells		- <u>13.80</u> 0.70			SPT not carried out		
- 1	Vibro Core	Vibro Core Aluminium C	grey, homogen CLAY with so black, homogen	ous. ome silt nous. Soft to stiff; plastic		-14.30		63%			No Piezometer Installed [–]
				End of Log		1.65				Pr	oposed Design Depth
-2 - - 											
-											
F - 1 - 1	Rem Quick Full, i	arks: , then nvertee	steady and firm penetra I core catcher	tion of core barrel				Logg Chec Drill	ged: Markus H sked: Markus Rig: Vibro Co	anz Dat Hanz re	e: 24 May 2008
					Start Date: 17/5/2008 Finish Date: 17/5/2008 Scale: As Shown			ite: 17/5/2008			

1			Opus International Consultants	Page: 1 of 1					Vibroco	re No: VC	12
	DP	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr Ele Inc	o-ordi id: La evatic clinat	nates: 45° 48. atitude / Longi on: -13.3m ion: Vertical	077'S 170° 38.12 tude (WGS84) Datum: C Azimuth:	29'E hart Datum N/A
		-		Ground Profile		1		Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane fest	Additional Lab Tests/Notes	Piezometer Installation
-			SILT with mi dark grey, homo non plastic.	Ground Surface nor sand and clay ogenous. Soft to very soft; moist to saturated;		-13.30 0.00			SPT not carried out	Mixed Sample for Contamination Testing	
- -1	Vibro Core	ore Aluminium Casing								Mixed Sample for Contamination Testing 0.7m: Sample PSD, SD	neter Installed -
		Vibro C	SILT with mi dark grey, hom non plastic; cor	nor clay ogenous. Soft to very soft; moist to saturated; itains vesicles.		- <u>14.40</u> 1.10				Mixed Sample for Contamination Testing	No Piezon
-		-				-14.95 1.65		98%		Pro	pposed Design Depth Ş
-2			Clayey SILT black, homoger	nous. Soft to very soft; moist; plastic.		-16.46					
-				Life of Log							
- -	Rem Qui Full	arks ck, si but j	: teady and firm per partially inverted c	netration of core barrel ore barrel				Logg Che Drill Star	ged: James G cked: Markus Rig: Vibro Co t Date: 14/5/20	rindley Dat Hanz ore 08 Finish Da	e: 15 May 2008 ite: 14/5/2008
								Scal	e: As Shown		

1			Opus International Consultants	Page: 1 of 1	15			13	Vibroco	re No: VC	13
C	DP1	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr El Inc	o-ordi id: La evatic clinat	nates: 45° 48. atitude / Long on: -13.3m ion: Vertical	042'S 170° 38.3 itude (WGS84) Datum: (Azimuth	369'E Chart Datum : N/A
			-	Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane rest	Additional Lab Tests/Notes	Piezometer Installation
	Vibro Core	Vibro Core Aluminium Casing C	SILT with so grey, homogen Changes with c minor clay. Nor Clayey SILT black, homoge	Ground Surf me clay and trace sand ous. Soft to very soft; saturated; plastic. depth to become SILT with some sand and n plastic nous. Soft to very soft; moist; plastic End of Log		-14.73 0.00		93%	SPT not carried out		roposed Design Depth ▼
- - -	Rem Qui Full	arks ck, st l, part	eady penetration	of core barrel e catcher				Log Che Drill Star Sca	ged: James G cked: Markus Rig: Vibro Co t Date: 14/5/2 le: As Shown	rindley Da Hanz Dre 008 Finish D	ate: 15 May 2008 Date: 14/5/2008

Project Name: Project Name: Project Name: Conversion December 2010 (WSSA) Co-ordinates: 457 479 58: 51 107 33.372 E Contentions: 477 498: 51 107 33.372 E December 2010 (WSSA) Image: Section Chapse Markow Project Na CG2P0.01 Co-ordinates: 457 4798: 51 107 33.372 E December 2010 (WSSA) Datamit Water Level Admit Value Image: Section Chapse Markow Project Na CG2P0.01 Growund Profile Control Section Chapse Markow Project Na CG2P0.01 Datamit Water Level Admit Value Image: Section Chapse Markow Project Na CG2P0.01 Growund Profile Section Chapse Markow Project Na CG2P0.01 Section Chapse Markow Project Na CG2P0.01 Datamit Water Level Admit Markow Project Na CG2P0.01 Image: Section Chapse Markow Project Na CG2P0.01 Growund Profile Section Chapse Markow Project Na CG2P0.01 Section Chapse Markow Project Na CG2P0.01 Section Chapse Markow Project Na CG2P0.01 Image: Section Chapse Markow Project Na CG2P0.01 Growund Schwart Project Na CG2P0.01 Section Chapse Markow Project Na CG2P0.01 Section Chapse Markow Project Na CG2P0.01 Project Na CG2P0.01 Image: Section Chapse Markow Project Na CG2P0.01 Growund Schwart Project Na CG2P0.01 Section Chapse Markow Project Na CG2P0.01 Section Chapse Markow Project Na CG2P0.01 Project Na CG2P0.01 Image: Section Chapse Markow Project Na CG2P0.01 Growund Chapse Markow Project Na CG2P0.01 Section Chapse Markow Project Na CG2P0.01 Section Chapse Markow Project Na C				Opus International Consultants	Page: 1 of 1				1	Vibroco	re No: VC	14
Ground Profile Samples gg gg gg gg <th></th> <th>DPI</th> <th>US</th> <th>Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995</th> <th>Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01</th> <th></th> <th></th> <th>Co Gri Ele Inc</th> <th>-ordi id: La evatio :linati</th> <th>nates: 45° 47. atitude / Long on: -13.7m ion: Vertical</th> <th>958' S 170° 38.3 itude (WGS84) Datum: W Azimuth:</th> <th>72' E /ater Level N/A</th>		DPI	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordi id: La evatio :linati	nates: 45° 47. atitude / Long on: -13.7m ion: Vertical	958' S 170° 38.3 itude (WGS84) Datum: W Azimuth:	72' E /ater Level N/A
Remarks: CLAY with minor silt Description Ref					Ground Profile			_	Sa	mples		
0 CLAY with some sit and shells 1330 1330 1330 0 CLAY with some sit and shells 1330 1330 1330 0 CLAY with minor sit 1330 1330 1330 0 Diack, homogenous. Soit, woit, plastic, becomes silf 1330 1330 0 Diack, homogenous. Soit, moist to wet; plastic; becomes silf 1330 1330 1 Diack, homogenous. Soit, moist to wet; plastic; becomes silf 1330 1330 1 Diack, homogenous. Soit, moist to wet; plastic; becomes silf 1330 1330 1 Diack, homogenous. Soit, moist to wet; plastic; becomes silf 1330 1330 1 Diack, homogenous. Soit, moist to wet; plastic; becomes silf 1330 1330 1 Diack, homogenous. Soit, moist to wet; plastic; becomes silf 1330 1330 1 Diack, homogenous. Soit, moist to wet; plastic; becomes silf 1330 1330 1 Diack, homogenous. Soit, moist to wet; plastic; becomes silf 1330 1330 1 Diack, homogenous. Soit, moist to wet; plastic; becomes silf 1330 1340 1 Diack, homogenous. Soit, moist to wet; plastic; becomes silf 1340 1340 1 Diack, homogenous. Soit, moist to wet; plastic; becomes 1340 1340	Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
Image: Solution in a solution with plastic: Image: Solution in a solut	0			CLAV with a	Ground Surface		-13.70					
CLAY with minor silt				black, homoger	nous. Soft; wet; plastic.							
CLAY with minor silt Image: State of the second s	1	Vibro Core	Vibro Core Aluminium Casing	CLAY with m black, homoger with depth	ninor silt nous. Soft; moist to wet; plastic; becomes stiff		-13.90 0.20			SPT not carried out	0.8m: Sample PSD, Atterberg, SD, Shear Strength	
- - <td>-</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>Pr</td> <td>l oposed Design Depth</td>	-										Pr	l oposed Design Depth
grey - brown. Soft; moist; plastic. End of Log Remarks: - Quick, steady, firm penetration of core barrel - Full by partially inverted core catcher Drill Rig: Vibro Core Start Date: 17/5/2008 Scale: As Shown	-2		-	CLAY with n	ninor silt		-16.80		98%			No Piczometer Installed [–]
End of Log End of Log Remarks: - - Quick, steady, firm penetration of core barrel - - Full by partially inverted core catcher Date: 24 May 200 Checked: Markus Hanz Date: 24 May 200 Checked: Markus Hanz Date: 24 May 200 Start Date: 17/5/2008 Finish Date: 17/5/2008 Scale: As Shown Scale: As Shown	-			grey - brown. S	Soft; moist; plastic.	\wedge						
Remarks: Logged: Markus Hanz Date: 24 May 200 - Quick, steady, firm penetration of core barrel Checked: Markus Hanz Date: 24 May 200 - Full by partially inverted core catcher Drill Rig: Vibro Core Start Date: 17/5/2008 Scale: As Shown Scale: As Shown					End of Log							
- Quick, steady, firm penetration of core barrel - Full by partially inverted core catcher Checked: Markus Hanz Drill Rig: Vibro Core Start Date: 17/5/2008 Scale: As Shown		201							Log	ued: Markus	Hanz Da	te: 24 May 2008
Drill Rig: Vibro Core Start Date: 17/5/2008 Finish Date: 17/5/2008 Scale: As Shown	-	Qui	ck, s	eady, firm penetra	ation of core barrel				Che	cked: Markus	Hanz	
Scale: As Shown		1. UI	ру р						Drill Star	Rig: Vibro Co t Date: 17/5/2	ore 008 Finish Da	ate: 17/5/2008
									Sca	e: As Shown		

			Opus International Consultants	Page: 1 of 1		Vibrocore No: VC 15							
OPUS		US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995 Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01				Co-ordinates: 45° 47.915' S170° 36.613' EGrid: Latitude / Longitude(WGS84)Elevation: -13.7mDatum: Chart DatumInclination: VerticalAzimuth: N/A						
	Ground Profile							Samples Vana Tast					
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev		Type	Recovery	vane fest △ kPa △ 0 20 60 100 SPT N ■ 0 10 30 50	Additional Lab Tests/Notes	Piezometer Installation	
	Vibro Core	Vibro Core Aluminium Casing	CLAY with so grey, homogene	Ground Store silt and minor shells bus. Soft; wet; plastic.	unface		80	9	96%	SPT not carried out	F	Proposed Design Depth ¥ I Pairetsu Jajietsu V Zajie Q	
3				End of Log		2.1			000	ed: Markus F	lanz D	ate: 24 May 2008	
Remarks: - Quick, steady, firm penetration of core barrel - Full and inverted core catcher								L C D S S	Cogged, markus Hanz Date: 24 may 2000 Checked: Markus Hanz Drill Rig: Vibro Core Start Date: 16/5/2008 Finish Date: 16/5/2008 Scale: As Shown Scale Shown				
Description: Project Name: Project Next Generation Dilem: Por Ottopo Pre. N3 37 Project Next Generation Dilem: Por Ottopo Pre. N3 37 Project Next Generation Dilem: Por Ottopo Pre. N3 37 Project Next Generation Project Next G				Opus International Consultants	Page: 1 of 1				1	Vibroco	ore No: VC	17	
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Ground Profile Samples:	OP	י ט	JS	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co- Gri Ele Inc	-ordii d: La vatio linati	nates: 45° 47. titude / Long n: -13.4 on: Vertical	.895' S 170° 38. itude (WGS84) Datum: Azimuth	828' E Chart Datum : N/A	
Normalization Secretation		T			Ground Profile				Sa	mples			
Control Sitty SAND Greate Suffice 10.00 Image: Control of Contr	Depth Drilling Method		Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation	
Sandy SILT with some clay grey, homogenous. Soft. 93% 93% Property 93% 93% 93% Property	0			Silty SAND grey, homogen Sandy SILT grey, homogen	ous. Saturated.		-13.40 0.00 -13.80 0.40			SPT not carried out	7		
	- J Core	VIDIO COLE	Vibro Core Aluminium Casing	Sandy SILT ogrey, homogen	with some clay ous. Soft.		<u>-14.10</u> 0.70					No Piezometer Installed [–]	
- - <td>-2</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>93%</td> <td></td> <td></td> <td>Proposed Design Depth</td>	-2								93%			Proposed Design Depth	
-3 End of Log 2.95 Image: Constraint of Log - - Image: Constraint of Log Image: Constraint of Log - - Image: Constraint of Log Image: Constraint of Log - - Image: Constraint of Log Image: Constraint of Log - - - Image: Constraint of Log Image: Constraint of Log - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -	-						-16.35						
Remarks: Logged: Markus Hanz Date: 24 - Quick, steady, smooth penetration of core barrel Checked: Markus Hanz Date: 24 - Fully Inverted core catcher Drill Rig: Vibro Core	-3	T			End of Log		2.95						
		ma	arks sk, s	: teady, smooth per erted core catche	netration of core barrel				Logg	ged: Markus cked: Markus Rig: Vibro C	Hanz D Hanz D	ate: 24 May 2008	
Start Date: 16/5/2008 Finish Date: 1 Scale: As Shown		,						Start Date: 16/5/2008 Finish Date: 16/5/2008 Scale: As Shown					

1			Opus International Consultants	Page: 1 of 1				Vibroco	re No: VC	18	
0	PI	JS	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr Ele Inc	-ordi id: La evatic clinat	nates: 45° 47. atitude / Long on: -12.9m ion: Vertical	970' S 170° 39.0 itude (WGS84) Datum: C Azimuth:	09' E hart Datum N/A
				Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
	Vibro Core	Vibro Core Aluminium Casing	CLAY with some silt grey, homogenous. Soft; wet; plastic.					98%	SPT not carried out	Pr	oposed Design Depth
- - -3				End of Log		2.45					
- R(- (- E	ema Quio Emp	marks: uick, steady penetration of core barrel npty and partially inverted core catcher						Logg Chei Drill Star Scal	ged: Markus H cked: Markus Rig: Vibro Co t Date: 16/5/20 e: As Shown	lanz Da Hanz Dre D08 Finish Da	te: 24 May 2008 ate: 16/5/2008

1			Opus International Consultants	Page: 1 of 1			2	Vibroco	re No: VC 2	21	
	DPI	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordii id: La evatio :linati	nates: 45° 47. htitude / Long on: -10.6m ion: Vertical	867'S 170° 39.50 itude (WGS84) Datum: Cl Azimuth:	8'E nart Datum N/A
				Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
-0-				Ground Surface	1.000	-10.60					
			Course to mo	edium SAND ogenous. Loosely packed; moist.					SPT not	Mixed sample for contamination testing	
-	ibro Core	e Aluminium Casing				-11.60			carried out	Mixed sample for contamination testing	er Installed -
-1	^	Vibro Core	Becomes progr	ressively more sandy with depth.		1.00		91%		Mixed sample for contamination testing	No Piezomet
			Bocomes a Sh	elly SAND	9.0	-12.50 1.90					
-2 -			SILT with so grey; homogen	me sand mes. Loosely packed; moist; non plastic.	8 00	-12.59 1.99 -12.88					
-	SILT with minor clay grey, homogenous. Soft to very soft; moist to saturated; slightly plastic.										
	End of Log										
-3	-3 Proposed design depth at 4.4m										
-											
	Rem - Initi - Em	n ark s ially ipty,	s: hard, then firm, ste inverted core catcl	eady and even penetration of core barrel her			Logged: James Grindley Date: 15 May 2008 Checked: Markus Hanz Drill Rig: Vibro Core				
								Start Date: 13/5/2008Finish Date: 13/5/2008Scale: As Shown			

1			Opus International Consultants	Page: 1 of 1					Vibroco	re No: VC	22
	DPU	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordii id: La evatio :linati	nates: 45° 47. atitude / Long on: -12.8m ion: Vertical	779' S 170° 39. itude (WGS84) Datum: Azimuth	421' E Chart Datum n: N/A
				Ground Profile	1	1		Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane fest	Additional Lab Tests/Notes	Piezometer Installation
-0-			Sandy SILT v grey, homogen	Ground Surface with trace clay and shells ous. Soft; wet to saturated.		-12.80 0.00			SPT not carried out		
	Vibro Core	Vibro Core Aluminium Casing	Sandy SILT v grey. Soft; plas	with some clay tic.		0.50		88%			No Piezometer Installed [–]
			SILT with so grey. Soft; sligh	me sand, clay and shells htly plastic.		1.50					Proposed Design Depth
-						-15.45					
- —3											
-											
	Rem Quick Full a	arks	S: ady, smooth penetration mpletely inverted core c	of core barrel atcher		1		Logg	ged: Markus I cked: Markus Rig: Vibro C	Hanz D Hanz	l vate: 24 May 2008
								Star	t Date: 16/5/2 e: As Shown	008 Finish I	Date: 16/5/2008

			Opus International Consultants	Page: 1 of 1				Vibroco	ore No: VC	23	
	DP	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr El Inc	o-ordi rid: La evatic clinat	nates: 45° 47. atitude / Long on: -12.1m ion: Vertical	.665'S 170° 39.6 itude (WGS84) Datum: C Azimuth:	32'E hart Datum N/A
				Ground Profile		1		Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
0			SILT with so dark brown, ho	Ground Surface me sand, clay and minor shells mogenous. Soft to very Soft; moist; plastic.		-12.10					
	evolution of the sand and shells decrease with depin								SPT not carried out		· Installed
-1	Vibro	No sand, minor shells			seine eine seine eine eine seine eine seine eine	-13.10		98%		1.6m: Sample PSD	
-3				End of Log		2.85					*
-	Rem Slov Em	əmarks: Slow and steady penetration of core barrel Empty core catcher					Logged: James Grindley Date: 15 May 2008 Checked: Markus Hanz Drill Rig: Vibro Core Start Date: 13/5/2008 Finish Date: 13/5/2008				
								Scale: As Shown			

1			Opus International Consultants	Page: 1 of 1					Vibroco	re No: VC	26
0	Pl	JS	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr Ele Inc	o-ordi id: La evatio clinat	nates: 45° 47. atitude / Long on: -13.2m ion: Vertical	633'S 170° 39 itude (WGS84) Datum: Azimut	.859'E Chart Datum h: N/A
	1			Ground Profile				Sa	mples		
Depth Deiling Mathod	noinaw Billing	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
	Vibro Core	Vibro Core Aluminium Casing	Gravely SAN grey, homogene graded; sand, or Clayey SILT grey, homogene plastic. SAND with m grey, homogene graded; sand, n Lenses of silty s	Cround Surface D Outs. Loosely packed; moist to saturated; poorly course to fine; gravel, angular broken shells. with minor sand outs. Soft to very soft; moist to saturated; slightly ninor shells Outs. Loosely packed; moist to saturated; poorly nedium to fine. Sand End of Log		- <u>13.20</u> 0.000 -13.355 0.15 -15.44 -15.58 -16.30 3.10			SPT not carried out		Proposed Design Depth
- S - E	ma low mp	arks: /, firr ity co	n and steady pene pre catcher	etration of core barrel		<u> </u>	Logged: James Grindley Date: 15 May 2008 Checked: Markus Hanz Drill Rig: Vibro Core Start Date: 13/5/2008 Finish Date: 13/5/2008				
					_	Scale: As Shown					

			Opus International Consultants	Page: 1 of 1				Vibroco	re No	: VC 2	27	
	DPU	US	Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordi id: La vatio linati	nates: 45° 47.4 titude / Longi n: -13.1m on: Vertical	502'S 1 tude (WC E A	70° 40.14 GS84) Datum: CH Azimuth: I	4'E nart Datum N/A
				Ground Profile				Sa	mples			
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test △ kPa △ 0 20 60 100 SPT ■ N ■ 0 10 30 50	Additional Lab	I ests/Notes	Piezometer Installation
-0			Shelly SAND grey with white	Ground Surface shells, homogenous. Loosely packed; moist too		-13.10 0.00 -13.20 0.10						
	Vibro Core	Vibro Core Aluminium Casing	SILT with mi grey; lensoidal. medium to fine	A, angular. nor sand; Soft; moist to saturated; non plastic. Lenses, SAND with some silt and broken shells I become lenses of silt and shells		<u>-14,30</u> 1.20		90%	SPT not carried out			No Piezometer Installed –
-2 - - - - - - - -				End of Log		- <u>-15.45</u> 2.35						¥ ₽
	Rem	ark	5:	parrel	<u> </u>	<u></u>	Logged: James Grindley Date: 14 May 200 Checked: Markus Hanz				e: 14 May 2008	
8-	Full	cor	e catcher			Drill Rig: Vibro Core Start Date: 13/5/2008 Finish Date: 13/5/200			te: 13/5/2008			
							Scale: As Shown					

1	Opus International Consultants Duration Office							Vibrocore No: VC 29					
•	DPU	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordi id: La evatio ilinati	nates: 45° 47. Ititude / Longi on: -11.5m ion: Vertical	595'S 170° 40.48 tude (WGS84) Datum: Cl Azimuth:	80'E hart Datum N/A		
				Ground Profile				Sa	mples				
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation		
	Vibro Core	Vibro Core Aluminium Casing	SAND with s light grey, lense graded; sand, beds).	End of Log		- <u>11.50</u> 0.00 14.30		138%	SPT not carried out	2.15m: Sample PSD	No Piezometer Installed [–]		
0	Rem Slo Em	narks w an opty c	: d steady penetrat ore catcher	tion of core barrel, then hit something hard				Log Che Dril Star	ged: James G cked: Markus I Rig: Vibro C t Date: 13/5/2	Frindley Da Hanz Ore 008 Finish Da	te: 15 May 2008 ate: 13/5/2008		
									Scale: As Shown				

1			Opus International Consultants	Page: 1 of 1			Y	Vibroco	re No: VC	32	
(DP	us	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co- Gri Ele Inc	-ordii d: La vatio linati	nates: 45° 47. titude / Long n: -10.8m on: Vertical	507' S 170° 40. itude (WGS84) Datum: Azimuth	892' E Chart Datum ı: N/A
		ļ		Ground Profile	1			Sa	nples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test kPa Δ 0 20 60 100 SPT N = 0 10 30 50	Additional Lab Tests/Notes	Piezometer Installation
	Vibro Core	Vibro Core Aluminium Casing	SAND with s light grey - brow SAND light grey - brow	Ground Surface ome shells vn, homogenous. Moist; sand, medium to fine. vn. Moist; sand, medium to fine.		-11.60 0.80 13.80 0.80		91%	SPT not carried out		No Piezometer Installed
-											
 - -	Rem Smo Em	emarks: Smooth, even and steady penetration of core barrel Empty core catcher						Logg Chec Drill	jed: Markus H ked: Markus Rig: Vibro Co	lanz D Hanz D pre	ate: 24 May 2008
									Start Date: 16/5/2008Finish Date: 16/5/2008Scale: As Shown		

			Opus International Consultants	Page: 1 of 1			Vibrocore No: VC 34					
•	DP	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr El In	o-ordi rid: La evatic clinat	nates: 45° 47 atitude / Long on: -12.2m ion: Vertical	707' S 170° 41.26 itude (WGS84) Datum: C Azimuth:	66' E hart Datum N/A	
				Ground Profile		1		Sa	mples			
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation	
-			SAND with s grey, homogene	ome shells ous. Moist; sand, medium to fine.		1-12.20			SPT not carried out	Mixed sample for contamination testing	x	
-	Vibro Core Gree Aluminium Casing Casi			with minor sand ous. Slightly plastic; sand, fine.		-12.85	<u>,</u>			Mixed sample for contamination testing	ometer Installed [–]	
		Vibro (ייניים באור היא מייני באור היא	-14.84		98%		Mixed sample for contamination testing	No Piezor	
	End of Log 2.									Pro	posed Design Depth	
- 3											7	
 	em: Quic Full	n arks: ick, then firm, steady penetration of core barrel Il but partially inverted core catcher						Logg Chec Drill Start Scale	ged: Markus H cked: Markus Rig: Vibro Co t Date: 17/5/20 e: As Shown	lanz Dat Hanz ore 008 Finish Da	e: 24 May 2008 te: 17/5/2008	

			Opus International Consultants	Page: 1 of 1				Vibroco	ore No: VC	36	
) DP	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr Ele Inc	o-ordi id: La evatio clinat	nates: 45° 47. atitude / Long on: -13.3m ion: Vertical	637' S 170° 41.4 itude (WGS84) Datum: C Azimuth:	94' E Chart Datum N/A
\square				Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
	green, homogenous. Loosely packed work pool y graded, sand, medium to fine; grains of gravel and sand are primarily broken shells. Clayey SiLT with trace sand green, homogenous. Soft to very soft; moist to saturated; slightly plastic. SILT with some clay and minor sand green, homogenous. Soft; moist; non plastic; sand, angular, course to fine. SAND with some silt, minor shells, and trace clay green, homogenous. Loosely packed; moist; well graded; shells, broken and angular. SAND with some silt, minor shells, and trace clay green, homogenous. Loosely packed; moist; well graded; shells, broken and angular. End of Log							93%	SPT not carried out	Pr	Poposed Design Depth
-											
F	em	arks	•				Logged: James Grindley Date: 21 May 2008				
-	Quio Full	Suick then slow penetration of core barrel Full with partial Invert of core catcher				Checked: Markus Hanz Drill Rig: Vibro Core Start Date: 17/5/2008 Finish Date: 17/5/2008					
							Scale: As Shown				
	_										

SAND with some silt and sholls group. Location. Sand with some silt and sholls group. Location. <th< th=""><th></th><th></th><th>Opus International Consultants</th><th>Page: 1 of 1</th><th></th><th></th><th></th><th>1</th><th>Vibroco</th><th>re No: VC</th><th>39</th></th<>			Opus International Consultants	Page: 1 of 1				1	Vibroco	re No: VC	39
Ground Profile Samples ugg Description With Stription 0 Council Sufficience 0 0 Counci 0 0 Counci	OP	PUS	Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordi id: La evatic ilinat	nates: 45° 47. atitude / Long on: -12.4m ion: Vertical	780' S 170° 41. itude (WGS84) Datum: (Azimuth	790' E Chart Datum : N/A
Note: Note: <th< th=""><th></th><th></th><th></th><th>Ground Profile</th><th></th><th></th><th></th><th>Sa</th><th>mples</th><th></th><th></th></th<>				Ground Profile				Sa	mples		
Benarks: SAND with some shells - -	Depth Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test ^ kPa ^ 0 20 60 100 	Additional Lab Tests/Notes	Piezometer Installation
SAND with some silt and shells 1330 1 1 1 1 1 SAND with some silt and shells 1430 94% 94% 94% 94% SAND with silt and trace clay 1430 94% 94% 94% SAND with silt and trace clay 1430 94% 94% SAND with silt and trace clay 1430 94% 94% SAND with silt and trace clay 1430 94% 94% Homogenous. Sand, fine 1430 94% 94% Sand, fine 1430 1440 1440 Sand, fine 1456 94% 94% Sand, fine 1456 94% 94% Sand, fine 1456 1440 1440 Sand, fine 1456 1440	-	asing	SAND with s grey, homogen	Ground Surface come shells ous. Wet to saturated; sand, medium.		12.40			SPT not carried out		
- -		Vibro Core Aluminium Ca	SAND with s grey. Loosely p	ome silt and shells vacked wet; sand, fine.		-13.30		94%			No Piezometer Installed [—]
-3 End of Log 3.05 Proposed Design D - 3.05 3.05 3.05 3.05 - 3.05 3.05 3.05 3.05 - - 1 1 1 1 - - 1 1 1 1 1 - - 1 1 1 1 1 1 - - 1			SAND with s Homogenous.	ilt and trace clay Sand, fine		1.80					
Remarks: - Firm and steady, then hard penetration of core barrel Logged: Markus Hanz Date: 24 May 24 - Full, but partially invert core catcher Drill Rig: Vibro Core Start Date: 17/5/2008 Finish Date: 17/5/2008	-3			End of Log		3.05				F	Proposed Design Depth₋ ▼
Start Date: 17/5/2008 Finish Date: 17/5/200	Ren - Fin - Ful	narks m an II, bu	I s: d steady, then hard t partially invert cor	d penetration of core barrel e catcher				Logg Chec Drill	ged: Markus H cked: Markus Rig: Vibro Co	lanz Da Hanz pre	1 ate: 24 May 2008
Scala: As Chown							-	Start	Date: 17/5/20	008 Finish D	ate: 17/5/2008

1			Opus International Consultants	Page: 1 of 1				1	Vibroco	re No: VC	40
01	PL	JS	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordii id: La evatio :linati	nates: 45° 47. titude / Longi n: -12.0m on: Vertical	694' S 170° 42. tude (WGS84) Datum: Azimuth	092' E Chart Datum : N/A
				Ground Profile				Sa	mples		
Depth Drilling Method	Bonnou Rumo	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
	Vibro Core	Vibro Core Aluminium Casing	SAND with s grey, homogen SAND with s grey. Wet; sand SAND with s grey. Moist to v SAND with s grey. Moist to v	Cround Surface orea shells ous. Saturated; sand, medium. ome shells d, medium to fine. come silt and shells vet; sand, fine. come silt and shells vet; sand, fine. End of Log depth 3.5m		-12.00 0.00 -12.30 0.30 -13.10 1.10 1.70		109%	SPT not carried out		No Piezometer Installed -
Re - Q - F	emarks: Quick, then firm and steady penetration of core barrel Full but partially Inverted core catcher					Logged: Markus Hanz Date: 24 May 2008 Checked: Markus Hanz Drill Rig: Vibro Core					
								Scal	le: As Shown		

			Opus International Consultants	Page: 1 of 1					Vib	roco	ore No: VC	41
 	DP	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordi id: La evatic :linat	nates: atitude on: -11 ion: Ve	45° 47 / Long I.7m ertical	.688' S 170° 42.44 jitude (WGS84) Datum: C Azimuth:	ŧ7' Ε hart Datum N/A
				Ground Profile				Sa	mples		-	
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Van	e lest Pa ▲ 60 100 PT N ■ 30 50	Additional Lab Tests/Notes	Piezometer Installation
-			SAND grey - brown. S	aturated; sand, medium.		0.00						
	Vibro Core	Vibro Core Aluminium Casing	SAND with tr grey - black, ho	race silt and shells mogenous. Wet; sand, medium to fine.		-12.20		100%	SPT n carriec	ot Jout		No Piezometer Installed –
- <u>2</u> - - 			SAND with m grey, homogene	ninor silt and shells ous. Wet; sand, medium to fine.		-14.20 2.50					2.0m: Sample PSD	
-			Proposed design o	End of Log depth 4.8m								
F - -	tem Stea Emp	marks: teady, even, firm penetration of core barrel mpty core catcher						Logged: Markus Hanz Date: 24 May 2008 Checked: Markus Hanz Drill Rig: Vibro Core Start Date: 16/5/2008 Finish Date: 16/5/2008 Scale: As Shown				

			Opus International Consultants	Page: 1 of 1					Vibroco	re No: VC	42
	ОР ОР	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr Ele Inc	o-ordi id: La evatio clinat	nates: 45° 47. atitude / Long on: -12.5m ion: Vertical	602' S 170° 42.8 itude (WGS84) Datum: (Azimuth	322' E Chart Datum : N/A
				Ground Profile	1			Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
	Vibro Core	Vibro Core Aluminium Casing	SAND with se grey - brown, he shelly SAND grey - brown. W SAND with se grey. Moist to w	Ground Surface ome shells mogenous. Wet; sand, medium. ////////////////////////////////////		-13.90 1.40 -14.05 1.530 2.80		99%	SPT not carried out		No Piezometer Installed [–]
R	lem	arks	:					Logg	jed: Markus H	lanz Da	te: 24 May 2008
-	Quio Emp	ck, s oty, p	teady penetration o partially Inverted co	of core barrel re catcher				Cheo Drill Starf	ked: Markus Rig: Vibro Co Date: 16/5/20	Hanz re 108 Finish Da	ate: 16/5/2008
							-	Start	. Jac. 10/0/20		
								Juan			

			Opus International Consultants	Page: 1 of 1					Vibroco	re No: VC	44
0	PL	JS	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr Ele Inc	o-ordi id: La evatic clinat	nates: 45° 47. atitude / Longi on: -13.5m ion: Vertical	486' S 170° 43. itude (WGS84) Datum: Azimuth	216' E Chart Datum :: N/A
		_		Ground Profile	1	1		Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test ^ kPa ^ 0 20 60 100 	Additional Lab Tests/Notes	Piezometer Installation
0			Shells with s	ome sand	000 000 000 000	0.00					
	Vibro Core	Vibro Core Aluminium Casing	Clayey SILT of grey, homogene	with some sand bus. Wet; slightly plastic; sand, fine.	에는 아파			128%	SPT not carried out		No Piezometer Installed [—]
-	_	_		End of Log	ġĘ.	-16.15 2.65					
- 3										F	Proposed Design Depth
_											
Re - H	ma ard	i rks: I pen	etration of core ba	arrel				Logg Chec	led: Markus H ked: Markus I	anz Da Hanz	ate: 24 May 2008
- Pi	arti	al Inv	verted core catche	ar -				Drill Start	Rig: Vibro Co Date: 16/5/20	re 08 Finish D	ate: 16/5/2008
								Scale	e: As Shown		

1			Opus International Consultants	Page: 1 of 1		Vibrocore No: VC 45					
	DP	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordi id: La evatic clinat	nates: 45° 47. atitude / Long on: -13.2m ion: Vertical	281' S 170° 43.2′ tude (WGS84) Datum: C Azimuth:	15' E hart Datum N/A
				Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
- 0 - 	Vibro Core	ore Aluminium Casing	SAND with m grey - black. Mo Silty SAND w grey - black. Mo	vith some clay bist to saturated; slightly plastic; sand, fine.		-13.20 0.00 -13.80 0.60			SPT not carried out		neter Installed [—]
-		Vibro C	Clayey SILT grey - black. Mo	pist to saturated; slightly plastic.		<u>-14.80</u> 1.60		80%			No Piezon
-2						-15.75				2.2m: Sample PSD	
				End of Log		2.30					
-		-								Pro	pposed Design Depth ¥
F - -	tem Har Full	arks d, slo y invo	w - steady penetr erted core catcher	ation of core barrel				Logg Chec Drill Start	ged: Markus H cked: Markus Rig: Vibro Co t Date: 15/5/20	lanz Dat Hanz re 108 Finish Da	e: 18 May 2008 te: 15/5/2008
						Scale: As Shown					

			Opus International Consultants	Page: 1 of 1					Vibroco	re No: VC	46
OP	יט	JS	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr Ele Inc	o-ordii id: La evatio clinati	nates: 45° 47. atitude / Longi on: -12.8m ion: Vertical	465' S 170° 43.30 itude (WGS84) Datum: M Azimuth:	97' E ean Sea Level N/A
	Т			Ground Profile				Sa	mples		
Depth Drilling Method		Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test ^ kPa ^ 0 20 60 100 	Additional Lab Tests/Notes	Piezometer Installation
0			SAND with m grey, homogene	Ground Surface ninor Shells ous. Saturated; sand, medium to fine.		-12.80					
			Silty SAND w grey - black. W	vith minor shells et.		-13.40			SPT not carried out		
-1 -2	VIDIO COLE	Vibro Core Aluminium Casing	Clayey SILT grey. Moist to w	with some shells vet; plastic.				100%		1.6m: Shear Strength	No Piezometer Installed [–]
-3			Proposed desigr	End of Log n depth 3.7m							
Ren	na	rks:	adu popotration a	of core barrel				Log	ged: Markus I cked: Markus	Hanz Dat Hanz	e: 18 May 2008
- Ha - Fu	ill b	, ste out ii	nverted core catc	her				Drill Star	Rig: Vibro Co t Date: 15/5/20	ore 008 Finish Da	te: 15/5/2008
								Scal	e: As Shown		

			Opus International Consultants	Page: 1 of 1			n (j	Vibroco	re No: VC	47	
	OP	US	Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr Ele Ine	o-ordi id: La evatic clinati	nates: 45° 46. atitude / Long on: -12.7m ion: Vertical	751' S 170° 43.20 itude (WGS84) Datum: Cl Azimuth:	98' E hart Datum N/A
		-		Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test ^ kPa ^ 0 20 60 100 	Additional Lab Tests/Notes	Piezometer Installation
- 0 -			SAND dark green, ler fine; lenses, bl	Ground Surface nsoidal. Loosely packed; moist; sand, coarse to lack sand, smells of organics.		-12.70 0.00			SPT not carried out	Mixed sample for contamination testing	
	ro Core	Aluminium Casino	Shelly SAND graded; sand, c Clayey SANE			10.70				Mixed sample for contamination testing	Installed -
-1	Vit	Vihro Core	Shelly SANI graded; sand, Clayey SAN grey, homoger course to fine.	D grey homogenous. Loosely packed; moist; gap course to fine; shells, whole, 40mm diameter. D nous. Loosely packed; moist; well graded; sand,	• 5 • 5 • 5 • 6 • 6 • 6 • 6 • 6 • 6 • 6 • 6 • 6 • 6	-13.95		100%		Mixed sample for contamination testing	No Piezomete
-2											
-3			Proposed desig	End of Log n depth 3.8m		2.90					
	Rem Firr	nark	s: teady and even pe	enetration of core barrel			<u> </u>	Log Che	ged: James G cked: Markus	rindley Dat Hanz	e: 5 June 2008
	- Em	ipty	core catcher					Drill Star	Rig: Vibro Co t Date: 16/5/20	ore 008 Finish Da	te: 16/5/2008
								Juga	C. As Showi		

1			Opus International Consultants	Page: 1 of 1				2	Vibroco	re No: VC	48
	DP	US	Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordii id: La evatio :linati	nates: 45° 46. titude / Long n: -12.9m on: Vertical	563' S 170° 43.2 itude (WGS84) Datum: C Azimuth:	253' E Chart Datum : N/A
				Ground Profile				Sa	nples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
	Vibro Core	Vibro Core Aluminium Casing	SAND with se grey - brown, he SAND grey, homogene SAND with se grey - black. We	ome shells omogenous. Moist; sand, medium. ous. Moist to wet; sand, medium to fine. ous. Moist to wet; sand, medium to fine.		-12.90 0.00 -14.10 1.20 -15.70 2.80 15.95 3.05		110%	SPT not carried out		No Piezometer Installed
- F	tem Quie Emp	emarks: Quick, firm - steady penetration of core barrel Empty core catcher						Logged: Markus Hanz Date: 18 May 2008 Checked: Markus Hanz Drill Rig: Vibro Core			
								Start Date: 15/5/2008Finish Date: 15/5/2008Scale: As Shown			

		Opus International Consultants Durandia Offica							Vibrocore No: VC 49							
	ЭP	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	o-ordi id: La evatio clinat	nates: 45° 46. atitude / Long on: -13.6m ion: Vertical	.716' S 170° 43.3 itude (WGS84) Datum: C Azimuth:	33' E Chart Datum N/A					
				Ground Profile	-	1		Sa	mples							
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane lest	Additional Lab Tests/Notes	Piezometer Installation					
	Vibro Core	Vibro Core Aluminium Casing	SAND with s grey - black, ho SAND with s grey - black, ho Clayey SILT grey - black. Sli	Ground Surface ome shells mogenous. Wet; sand, medium to fine. ome silt and minor shells mogenous. Wet. with minor shells ghtly plastic. End of Log		-13.60 0.00 14.40 0.80 15.30		98%	SPT not carried out	2.3m: Sample PSD	voposed Design Depth					
-	lem	arks						Log	ged: Markus H	lanz Da	te: 18 May 2008					
-	lniti Em	ally h pty, p	ard, steady penet artially Inverted o	ration of core barrel core catcher				Cheo Drill Star	cked: Markus Rig: Vibro Co t Date: 15/5/20	Hanz ore 008 Finish Da	ate: 15/5/2008					
								Scal	e: As Shown							
	_						-									

1			Opus International Consultants	Page: 1 of 1				1	Vibroco	re No: VC 🗄	50
•	DPI	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co- Gri Ele Inc	-ordin d: La vatio linati	nates: 45° 46. titude / Long n: -13.0m on: Vertical	468' S 170° 43.38 itude (WGS84) Datum: Cl Azimuth: I	8' E nart Datum N/A
				Ground Profile			_	Sa	nples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
	Vibro Core	Vibro Core Aluminium Casing C	SAND greyish brown, uniform. SAND grey - black, ho Proposed design	End of Log		-13.65		107%	SPT not carried out	1.6m: Sample PSD, SD	No Piezometer Installed [–]
	Rem	narks	5:					Log	ged: Markus	Hanz Dat	e: 18 May 2008
-	Qu Em	ick, f ipty c	irm - steady penet core catcher	tration of core barrel				Che Drill Stor	Rig: Vibro C	Hanz ore 008 Finish Da	te: 15/5/2008
								Star	L Date: 15/5/2	vuo Finish Da	ne. 19/9/2008
						-	_	Scal	e: As Shown		

1			Opus International Consultants	Page: 1 of 1				1	Vibroco	re No: VC	54
•	DP	US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gri Ele Inc	-ordii id: La evatio :linati	nates: 45° 45 atitude / Long an: -13.8m an: Vertical	802' S 170° 23.44 itude (WGS84) Datum: C Azimuth:	64' E hart Datum N/A
				Ground Profile				Sa	mples		
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
0			SAND with s brown, homoge	Ground Surface ome shells enous. Wet; sand, medium to fine.	9 	0.00			SPT not		
-1	Vibro Core	Vibro Core Aluminium Casing	SAND with s grey, homogen	ome shells ous. Wet; sand, medium, uniform.		-14.45		107%		1.8m: Sample PSD	No Piezometer Installed [–]
-2		-	SAND grey. Wet; sand	d, medium to fine; lenses of shells at 2.2m.		-15.95 2.15					
- 3			Proposed design	End of Log depth 3.7m		3.00					
-	Rem Qui Em	ick, s pty c	: teady - firm peneti ore catcher	ration of core barrel				Logg Chec Drill Star	ged: Markus I cked: Markus Rig: Vibro Co t Date: 15/5/2	Hanz Dat Hanz Dre 008 Finish Da	te: 18 May 2008 ate: 15/5/2008
								Scal	e: As Shown		, and a second second

			Opus International Consultants	Page: 1 of 1				ű,	Vibroco	re No: VC	56
OF	PL	JS	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995	Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01			Co Gr Ele Inc	-ordi id: La evatic :linat	nates: 45° 45. atitude / Longi on: -14.4m ion: Vertical	546' S 170° 43.3 tude (WGS84) Datum: (Azimuth	342' E Chart Datum : N/A
	Т			Ground Profile				Sa	mples		
Depth Drilling Method	2000	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation
	Vibro Corre	Vibro Core Aluminium Casing	SAND with s brown, homogen SAND with s grey, homogen	ome shells anous. Moist; sand, medium to fine.	3	-15.15 0.75		105%	SPT not carried out		No Piezometer Installed [–]
-3				End of Log		- <u>17.35</u> 2.95					Proposed Design Depth
- Rei - Qu - Er	ma uic mp	arks: k pe ty c	netration of core ore catcher	barrel				Logg Chee Drill Star	ged: Markus H cked: Markus Rig: Vibro Co t Date: 15/5/20	łanz Da Hanz Dre D08 Finish D	ate: 18 May 2008 Date: 15/5/2008

OPUS			Opus International Consultants	Page: 1 of 1 Vibrocore No: VC 57							57	
			Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995 Project Name: Project Next Generation Client: Port Otago Location: Otago Harbour Project No. 6CGP00.01					Co-ordinates: 45° 45.572' S170° 43.528' EGrid: Latitude / Longitude(WGS84)Elevation: -11.9mDatum: Chart DatumInclination: VerticalAzimuth: N/A				
	Ground Profile						Samples					
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane Test	Additional Lab Tests/Notes	Piezometer Installation	
	Vibro Core	Vibro Core Aluminium Casing	SAND brownish , hom SAND grey - brown, h	Ind of Log		- <u>11.90</u> 0.00 - <u>13.60</u> 1.70		82%	SPT not carried out		No Piezometer Installed	
R - 1	Remarks: - Quick, steady - firm penetration of core barrel - Empty core catcher							Logged: Markus Hanz Date: 18 May 2008 Checked: Markus Hanz Drill Rig: Vibro Core Start Date: 15/5/2008 Finish Date: 15/5/2008				
								Scale: As Shown				

			Opus International Consultants					Vibrocore No: VC 59					
OPUS		US	Dunedin Office Private Bag 1913 Dunedin New Zealand Tel. 64 3 471 5500 Fax 64 3 471 8995 Location: Otago Location: Otago Project No. 6CGP00.01			Co Gr Ele Ine	Co-ordinates: 45° 45.263' S 170° 43.354' E Grid: Latitude / Longitude (WGS84) Elevation: -15.4m Datum: Chart Datum Inclination: Vertical Azimuth: N/A						
		Ground Profile						Sa	mples				
Depth	Drilling Method	Casing		Description	Graphic Log	Depth/Elev	Type	Recovery	Vane lest ^ kPa ^ 0 20 60 100 SPT • N • 0 10 30 50	Additional Lab Tests/Notes	Piezometer Installation		
	Vibro Core	Vibro Core Aluminium Casing	SAND grey - brown, he SAND with s grey, homogene	omogenous. Moist to wet; sand, medium.		-16.35	<u>i</u>		SPT not carried out	1.4m: Sample PSD	No Piezometer Installed [—]		
						يليا المراجع		93%		Pr	oposed Design Depth ¥		
-						-18,40							
-				End of Log		3.00							
F	Remarks:							Logged: Markus Hanz Date: 18 May 2008					
-	- Firm steady penetration							Checked: Markus Hanz					
- Empty Core catcher								Drill Rig: Vibro Core Start Date: 15/5/2008 Finish Date: 15/5/2008					
								Scale: As Shown					
								Scale: AS Shown					



VC18 – Silty CLAY



VC1 – clayey SILT



VC12 – clayey SILT





VC46 - clayey SILT Port Otago Vibracore VC 46



VC50 - SAND



VC54 - SAND Port Otago Vibracore VC 54 This Man Manada

VC32 - SAND





B3 – Basalt Cobbles and Highly Weathered Basalt

B3 – Moderately Weathered Basalt



B4 – Completely Weathered Basalt



B4 – Moderately Weathered Basalt



APPENDIX C

Soil/ Rock Mechanical and Chemical Laboratory Testing Results

Soil and Rock Mechanical

Particle Size Distribution


IANZ Approved Signatory Denys Searls Designation : Laboratory Manager 07/07/08

csf 2100 (8/02)

Date :

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131 Main South Rd Green Island, PO Box 13128 Dunedin, New Zealand

Sampled by: E. Burgers B. Burgers B. Sampled by: Bargers B. Sampled by: B. Burgers B. Sample description: Marine Sediments Lukers B. Burgers B.	Project : Location : Client : Client/Sam Contractor	nple Ref : :		Project Ne Deep Wat Port Otago VC6 - 0.6n N/A	ext Generat er Channe o n below sea	tion l abed level				OPUS
Water Content (as received.): 26.7 % Sieve Size Passing Sieve Size Passing Formation (%) Image: Content (As received.): Passing Formation (%) Image: Content (As received.): Passing Passing <td>Sampled by Date receiv Sampling n Sample con Sample des Solid Partic</td> <td>y : ed : nethod : ndition : scription : :le Density</td> <td>(t/m³):</td> <td>Quaternar 5/04/08 Vibro Cor Moist Marine Se</td> <td>y Resource e diments assumed</td> <td>es Ptl Ltd (B</td> <td>obby)</td> <td>Project No: Lab Ref No: Client Ref:</td> <td>6-CGP00.0 OPU.D8-07</td> <td>1 015LD 7</td>	Sampled by Date receiv Sampling n Sample con Sample des Solid Partic	y : ed : nethod : ndition : scription : :le Density	(t/m ³):	Quaternar 5/04/08 Vibro Cor Moist Marine Se	y Resource e diments assumed	es Ptl Ltd (B	obby)	Project No: Lab Ref No: Client Ref:	6-CGP00.0 OPU.D8-07	1 015LD 7
Sieve Size Passing Further Size	Water Cont	tent (as rec	eived):	26.7	%			TT 1 .		
Sieve Size Prassing Sieve Size Prassing Passing Practice Size Prassing Practice Size			Sieve A	nalysis				Hydromet	er Analysis	
(mm) (x) (mm) (x) (mm) (x) (mm) (x) (3.0) 4.75 10 0.200 97 (3.0) 1.18 100 0.150 18 </td <td>Sieve Size</td> <td>Passing</td> <td>Sieve Size</td> <td>Passing</td> <td>Sieve Size</td> <td>Passing</td> <td>Particle Size</td> <td>Passing</td> <td>Particle Size</td> <td>Passing</td>	Sieve Size	Passing	Sieve Size	Passing	Sieve Size	Passing	Particle Size	Passing	Particle Size	Passing
03.0 4.7.3 100 0.200 97	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)	(mm)	(%)
373 2.30 100 0.212	63.0		4.75	100	0.300	97				
13.2 1.18 100 0.130 18	37.5		2.30	100	0.212					
13.2 0.000 99 0.003 2	19.0		1.18	100	0.150	18				
Note: "-" denotes sieve not used and/or hydrometer analysis not tested	13.2		0.600	99	0.075	2				
Note: 2 deboes sieve hot discussion of regulation injustication injustended injustende injustication injustication injustica	9.5 Note:	 donatas si	0.425	 d/or hudromo	tor analysis no	t tactad				
Sieve Aperture Size (mm)	Indie.		eve not used and	1701 Hyurome	ter analysis no	t testeu				
100 1	0					Sieve A	perture Size	e (mm)		
Test Methods Notes Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve) Fraction Tested:Whole soil Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer) Fraction Tested:Whole soil Date Tested: 12/06/08 11/07/08 Sampling is not covered by IANZ Accreditation Interpretent may only be reproduced in full All tests reported herein have been performed in accordance with the laboratory Manager Date : 7/07/08	100 90 80 60 50 50 20 10 0 0 0	0)	0.010	m coarse	6000 000 000 000 000 000 000 000 000 00	ticle Size (mm) 1.	000	10.000	00 10 10 10 10 10 10 10 10 10	100.000
Particle Size Analysis: NZS 4402 1986 Test 2.8.1 (Wet Sieve) Particle Size Analysis: NZS 4402 1986 Test 2.8.4 (Hydrometer) Date Tested: 12/06/08 11/07/08 ANZ Approved Signatory Denys Searls Designation : Laboratory Manager Date : 7/07/08 ANZ Approved Signatory Denys Searls Designation : Laboratory Manager Date : 7/07/08 All tests reported herein have been performed in accordance with the laboratory's scope of accreditation Page 1 of 1	Test Methods					Notes				
Date Tested: 12/06/08 Sampling is not covered by IANZ Accreditation 11/07/08 This report may only be reproduced in full IANZ Approved Signatory Denys Searls All tests reported herein have been performed in accordance with the laboratory's scope of accreditation Date : 7/07/08	Particle Size A Particle Size A	analysis: NZS analysis: NZS	5 4402 1986 Te 5 4402 1986 Te	st 2.8.1 (Wet S st 2.8.4 (Hydr	Sieve) ometer)	Fraction Test	ed:Whole soil			
11/07/08 This report may only be reproduced in full ANZ Approved Signatory Denys Searls It ests reported herein have been performed in accordance with the laboratory's scope of accreditation Date : 7/07/08	Date Tested	:	12/06/08			Sampling is	not covered b	y IANZ Accre	editation	
C laboratory Page 1 of 1	IANZ Appr Designation Date :	roved Sign a : Laborate	11/07/08 atory Deny ory Manager 7/07/08	s Searls	ð	This report n	nay only be re All tests repor have been per accordance w laboratory's s accreditation	eproduced in rted herein rformed in ith the cope of	full	
Lange and the second seco			6	TO		Laboratory			Page 1 of 1	

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IANZ Approved Signatory Denys Searls Designation : Laboratory Manager Date : 7/07/08

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7/07/08

Designation : Laboratory Manager

Date :

csf 2100 (8/02)



Designation : Laboratory Manager 7/07/08

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Date :

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Designation : Laboratory Manager Date : 7/07/08

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Atterberg Limits

PLASTICITY INDEX TEST REPORT

Project :	Project Next Generation
Location :	VC 8 - 0.6m below seabed level
Client :	Port Otago
Contractor :	N/A
Sampled by :	Quaternary Resources Ptl Ltd (Bobby)
Date sampled :	5/04/08
Sample condition :	Moist
Sample description :	Marine Sediment
Sampling method:	Vibro Core
Tested by:	Jon



 Project No:
 6-CGPOO.01 015LD

 Lab Ref No:
 OPU.D8/07

 Client Ref No
 OPU.D8/07



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PLASTICITY INDEX **TEST REPORT**

Project :	Project Next Generation
Location :	VC 14 - 0.8m below seabed level
Client :	Port Otago
Contractor :	N/A
Sampled by :	Quaternary Resources Ptl Ltd (Bobby)
Date sampled :	5/04/08
Sample condition :	Moist
Sample description :	Marine Sediment
Sampling method:	Vibro Core
Tested by:	Jon



6-CGPOO.01 015LD Project No : Lab Ref No : OPU.D8/07 **Client Ref No**



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PLASTICITY INDEX TEST REPORT

Project :	Project Next Generation
Location :	VC 46 - 1.6m below seabed level
Client :	Port Otago •
Contractor :	N/A
Sampled by :	Quaternary Resources Ptl Ltd (Bobby)
Date sampled :	5/04/08
Sample condition :	Moist
Sample description :	Marine Sediments
Sampling method:	Vibro Core
Tested by:	Jon



 Project No:
 6-CGPOO.01 015LD

 Lab Ref No:
 OPU.D8/07

 Client Ref No
 OPU.D8/07



Note: Liquid Limit is the water content value corresponding to 25 blows on the graph.

Date tested : 12/06/08

IANZ Approved Signatory

Denys Searls Designation : Date :

Laboratory Manager 7/07/08 Testing is covered by IANZ Accreditation This report may only be reproduced in full



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Unconfined Compressive Strength

UCS REPORT

Project :	Project Next Generation
Location :	Otago Harbour
Client :	Port Otago Ltd
Contractor :	Downer EDI Works Ltd
Sampled by :	Downer EDI Works Ltd
Date sampled :	25/05/08
Sampling method :	Taken from core
Sample description :	60mm Core Sample
Sample condition :	Moist
Bore Number:	3
Test Depth:	14.0m below chart datum



6-CGP00.01 015LD Project No : Lab Ref No: OPU.D8/06 **Client Ref No:**

Depth	(m)	14.15			
Height	(mm)	121.6	Area (mm	2941.66	
Diameter	(mm)	61.2	Volume (co	357.71	
Height/Diameter R	atio	1.99	Correction	0.943	
Mass in Air	(g)	938			
Mass in Water	(g)	586			
Volume	(cc)				
Wet Density	(t/m^{3})	2.62			
Dry Density	(t/m^{3})	2.62			
Failure Load	(N)	319827			
Failure Stress	(kPa)	108723.24			
Corrected Stress	(kPa)	101472.1			
Deformation	(mm)	1.3			
Strain	(AL/Lo)	0.0103			

Test Results

Nater Content

Before Test

After Test



Rate of axial Compression: 1mm/min

Mode of Failure

Г

Brittle/explosive

Test Method: NZS 4402: 1986 Test 6.3.1



5/05/08 Date tested : Date reported : 5/05/08

Authorised Signatory: Laboratory Manager **Denys** Searls 11/07/08

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UCS WORKSHEET

Project :	Project Next Generation
Location :	Otago Harbour
Client :	Port Otago Ltd
Contractor :	Downer EDI Works Ltd
Sampled by :	Downer EDI Works Ltd
Date sampled :	25/05/08
Sampling method :	Taken from core
Sample description :	60mm Core Sample
Sample condition :	Moist
Bore Number:	4
Test Depth:	12.75m below chart datum



Project No : 6-CGP00.01 015LD Lab Ref No : OPU.D8/06 Client Ref No :

				Test R	esults	
Depth	(m)	14.15			Water Content	
Height	(mm)	121.6	Area (mm	2941.66	Third Content	
Diameter	(mm)	61.2	Volume (co	357.71		
Height/Diameter I	Ratio	1.99	Correction	007/01	Before Test	After Test
Mass in Air	(g)	938				
Mass in Water	(g)	586				
Volume	(cc)					
Wet Density	(t/m^{3})	2.62				
Dry Density	(t/m^3)	2.62				
Failure Load	(N)	185000				
Failure Stress	(kPa)	62889.62				
Corrected Stress	(kPa)	0.0				
Deformation	(mm)	1.3				
Strain	(AL/Lo)	0.0103				
Mode of Failure Test Method: NZ	ZS 4402: 198	Brittle 36 Test 6.3.	Į			
Date tested : 5 Date reported : 5	5/05/08 5/05/08		Ν		This report may o	nly be reproduced in full

Authorised Signatory: Denys Searls *Laboratory Manager* 11/07/08

CSF 2004 (22/08/03)

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Shear Strength – Cohesive Sediments

TEST	REPORT							Project No : Lab Ref No :	6-CGPOO.01 (OPU.D8/07	DISLD
Project . Project	Novt Cone	notion		Data camp	Jod.	05/04/00		Client Ref No :		
Location : Dunedi Client : Port Ot	n ago Ltd	Tation		Sampling : Sample De	method : scription:	Vibrating Silt-clay	Core			
Contractor : N/A Sampled by : Quatern	ıary Resou	trces Ptl Lt	d (Bobby	Sample co	ndition :	Moist-wet			0	PUS
				T	est Results					
Chand Chand Participal Control P	- 1 - 1 - 1 - 1		0 0011					F		<u>venter e constante</u> 4
Shear Stress Kesults (IN.2 Geo	technical 50	007/9 JUT 20	1) VC8-0.	om below s	eabed level					
Pilcon shear vane number		CL-600								
Peak vane reading		1.5	2.0	2.0	2.5					
Peak shear strength	kPa	14	0.1	10		,	3			
Remoulded shear strength	kPa	7	10	10	12 -	,	ā.			
Shear Stress Results (N.Z Geo	technical So	c. Inc 8/2001) VC14-(.8m helow	seahed level					
Pilcon shear vane number		CL-600								
Peak vane reading		1.3	1.5	1.5	2.3					
Remoulded vane reading	5	0.8	0.8	0.8	1.0					
Leak shear strength	kl'a	12	14	14	- 22	1	ĩ			
Remoulded shear strength	kPa	7	7	7	10 -	1	ĩ			
Date tested : 10/06/08 11/07/08 Approved Denys Searls Designation : 23/06/08	y Manager					L	'his report	may only be reproduced	l in full	
CSF 2006 (13/09/2006)									Pag	re 1 of 1
Opus International Consultants Dunedin Laboratory	: Limited			81 Main South Teen Island, P(Rd D Box 13128			Telephone (03) 488 05 Facsimile (03) 488 143	80	
Quality Management Systems Certified to	ISO 9001		<u>а</u>	ınedin, New Z	ealand			Website www.opus.co.	zu	

Solid Density

DETERMINATION OF SOLID DENSITY REPORT

Project No : 6-CGPOO.01 015LD Lab Ref No: OPU D8/07 Client Ref No

Project :	Project Next Generation
Location :	Dunedin
Client / Contractor :	Port Otago
Client Ref :	VC 12, VC 14, VC 50
Sampled By :	Quaternary Resources Ptl Ltd (Bobby)
Date Received :	5/04/08
Sampling Method	not stated
Sample Description :	Marine Sediments
Sample Condition :	moist - wet
Tested By	Jon
Date Tested	17/06/08

dillo	10	4 4
	No.	Z Z
		- F
		4 7 7
		αn
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			IESI RESULIS
	Value	2.76 t/m ³	
VC 12 - 0.7m below seabed level	Material Used	SILT	
	History	Oven Dried	
	Value	2.75 t/m ³	
VC 14 - 0.8m below seabed level	Material Used	CLAY	
	History	Oven Dried	
	Value	2.68 t/m ³	
VC50 - 1.6m below seabed level	Material Used	SAND	
	History	Oven Dried	
Testing carried out in accordance wit	h: NZS 4402	2 : 1986 Test 2.7.2	

	e laboratory's scope of accreditation. Page 1 o	Telephone (03) 48805	Facsimile (03) 488143	Website www.opus.co
Testing is covered by IANZ Accreditation This report may only be reproduced in full	All tests reported herein have been performed in accordance with the	131 Main South Rd	PO Box 13128, Green Island,	Dunedin, New Zealand
Checked By: Denys Date Checked: 17/06/08 Date Reported: 11/07/08 IANZ Approved Signatory - Denys Searls	Designation : Laboratory Manager	Opus International Consultants Limited	Dunedin Laboratory	Quality Management Systems Certified To ISO 9001

CHEMICAL



R J Hill Laboratories Limited11 Clyde StreetFPrivate Bag 3205FHamilton 3240, New ZealandN

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 mail@hill-labs.co.nz

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ANALYSIS REPORT

Client:	Opus International Consultants Ltd
Contact:	Greene, Shane
	c/o Opus International Consultants Ltd
	Private Bag 1913
	DUNEDIN

Lab No:	643983	SPv1
Date Registered:	29-May-2008	
Date Reported:	12-Jun-2008	
Quote No:	32850	
Order No:		
Client Reference:	Port Otago Ltd, Port	
Submitted By:	Hanz, Markus	

Sample Type: Sediment						
Sa	mple Name:	VC05 0-0.5m 27-May-2008 7:00	VC21 0-0.5m 27-May-2008 6:30	VC12 0-0.5m 27-May-2008 6:45	VC34 0-0.5m 27-May-2008 4:50	VC47 0-0.5m 27-May-2008
		pm	pm	pm	pm	11:40 am
L	ab Number:	643983.1	643983.4	643983.7	643983.10	643983.13
Individual Tests					· · · ·	
Total Cyanide*	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Nitrogen	g/100g dry wt	< 0.051	< 0.051	< 0.051	< 0.051	0.082
Heavy metal screen level As,Cd,	Cr,Cu,Ni,Pb,Zn				· · · ·	
Total Recoverable Arsenic	mg/kg dry wt	7.1	< 2.0	7.9	< 2.0	3.3
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Chromium	mg/kg dry wt	17	2.5	16	2.6	8.9
Total Recoverable Copper	mg/kg dry wt	6.7	< 2.0	6.0	< 2.0	4.4
Total Recoverable Lead	mg/kg dry wt	7.1	0.79	6.7	0.81	4.3
Total Recoverable Nickel	mg/kg dry wt	11	2.2	10	2.1	7.2
Total Recoverable Zinc	mg/kg dry wt	44	8.1	42	6.8	27
Polycyclic Aromatic Hydrocarbon	s Trace in Soil					
Acenaphthene	mg/kg dry wt	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Acenaphthylene	mg/kg dry wt	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Anthracene	mg/kg dry wt	0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Benzo[a]anthracene	mg/kg dry wt	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Benzo[k]fluoranthene	mg/kg dry wt	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Chrysene	mg/kg dry wt	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Fluoranthene	mg/kg dry wt	0.0021	< 0.0020	< 0.0020	0.0020	< 0.0020
Fluorene	mg/kg dry wt	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Naphthalene	mg/kg dry wt	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Phenanthrene	mg/kg dry wt	< 0.0020	0.0025	< 0.0020	< 0.0020	0.0049
Pyrene	mg/kg dry wt	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Poychlorinated Biphenyls Trace in	n Soil					
PCB-101	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-105	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-110	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-114	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-118	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-121	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-123	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-126	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010



This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.

The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.

Sample Type: Sediment						
S	ample Name:	VC05 0-0.5m	VC21 0-0.5m	VC12 0-0.5m	VC34 0-0.5m	VC47 0-0.5m
		27-May-2008 7:00	27-May-2008 6:30	27-May-2008 6:45	27-May-2008 4:50	27-May-2008
		pm 642092.1	pm	pm 642092 7	pm 642082.10	11:40 am
Poweblaringtod Riphonyle Trace	Lab Number:	043903.1	043903.4	043903.7	043903.10	043903.13
POD 400	; iii 30ii	0.00000	0.0010	0.0010	0.0010	0.0010
PCB-128	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-138	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-141	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-149	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-151	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-153	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-156	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-157	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-159	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-167	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-169	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-170	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-180	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-189	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-194	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-206	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-209	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-28 + PCB-31	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-44	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-49	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-52	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-60	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-77	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-81	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
PCB-86	mg/kg dry wt	< 0.00099	< 0.0010	< 0.0010	< 0.0010	< 0.0010
Total PCB (Sum of 33 congeners)	mg/kg dry wt	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Total Petroleum Hydrocarbons i	in Soil					
Dry Matter	g/100g as rcvd	75	80	74	80	77
C7 - C9	mg/kg dry wt	< 8.5	< 8.8	< 9.0	< 8.5	< 9.2
C10 - C14	mg/kg dry wt	< 20	< 20	< 20	< 20	< 20
C15 - C36	mg/kg dry wt	< 30	< 30	< 30	< 30	< 30
Total hydrocarbons (C7 - C36)	mg/kg dry wt	< 60	< 60	< 60	< 60	< 60

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	Samples				
Environmental Solids Sample Preparation*	Air dried at 35°C and sieved, <2mm fraction.	-	1, 4, 7, 10, 13				
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	1, 4, 7, 10, 13				
Polycyclic Aromatic Hydrocarbons Trace in Soil	Sonication extraction, SPE cleanup, GC-MS SIM analysis	-	1, 4, 7, 10, 13				
Poychlorinated Biphenyls Trace in Soil	Sonication extraction, SPE cleanup, GPC cleanup (if required), GC-MS analysis	-	1, 4, 7, 10, 13				
Total Petroleum Hydrocarbons in Soil	Sonication extraction, Silica cleanup, GC-FID analysis	-	1, 4, 7, 10, 13				
Dry Matter (Org)	Dried at 103°C (removes 3-5% more water than air dry), gravimetry.	0.10 g/100g as rcvd	1, 4, 7, 10, 13				
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2	-	1, 4, 7, 10, 13				
Total Cyanide Distillation*	Distillation of sample as received. APHA 4500-CN $^{\circ}$ C & E 21 $^{\rm st}$ ed. 2005.	-	1, 4, 7, 10, 13				

Sample Type: Sediment			
Test	Method Description	Default Detection Limit	Samples
Total Cyanide*	Distillation, colorimetry. APHA 4500-CN ⁻ C & E 21 st ed. 2005.	0.10 mg/kg dry wt	1, 4, 7, 10, 13
Total Nitrogen	Catalytic Combustion (900°C, O_2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.050 g/100g dry wt	1, 4, 7, 10, 13

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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