GEO Environmental Engineering

Andrew MacKinnon
A.Mackinnon Ltd

Date: 11.04.2018
Project No: GEO2019-2990
Project Title: West Lakes Hotel, Gosforth, Cumbria – Ground Investigation

Dear Andrew,

Geo Environmental Engineers Ltd (GEO) were commissioned by A. Mackinnon Ltd (Consultant) on behalf of West Lakes Hotel, herein referred to as the Client to carry out a ground investigation of land to the rear of the Hotel where the Client proposes to construct residential housing.

The purpose of the ground investigation was to determine the ground conditions beneath the proposed development area to aid the design of foundations and access roads. The approximate locations of the trial pits were specified by the Consultant.

GEO attended the site on the 1st and 10th March 2018 to complete the intrusive ground investigation works. The ground investigation comprised:

- 6 No. Mechanically Excavated Trial Pits (TP01 to TP05) to depths of between c.2.00m and c.3.10m bgl.
- 1 No. Infiltration Test in trial pit TP01
- 6 No. Dynamic Cone Penetrometer Tests along the proposed access road.
- 6 No. In-Situ Dynamic Probe Super Heavy (DPSH) to c.5m bgl adjacent to each trail pit.
- Site supervision by a suitably qualified and experienced Geo-Environmental Engineer.

The exploratory hole location plan and the results of the ground investigation are attached to this report. Photographs of the trial pits and arisings are included on the log sheets.

The ground investigation encountered topsoil (c.0.30m to c.0.45m thick) overlying orangey brown and dark brown, occasionally silty, very gravelly medium sand with occasional sub-rounded cobbles. The sand was occasionally underlain at depths of between c.1.50m and c.2.80m bgl by a dark orangey brown very sandy fine to coarse sub-rounded gravel of mixed lithology with occasional sub-rounded cobbles.

The stability of the trial pits was noted to be generally poor with frequent collapses of the side walls.

The results of the DCP tests indicates CBR values of between 0.7% and 12.7%, but typically between 1.8% and 4.0% with a general increase in CBR values noted with depth.

The results of the DPSH indicate N100 values of between 0 (probe falling under its own weight) and 12 with a significant increase in strength noted between c.2 and c.3m bgl.

The result of the Infiltration test in trial pit TP01 indicates a soil infiltration rate of $4.3x10^{-04}$ m/s. This equates to a soil with a good drainage characteristic and a medium permeability classification.

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I trust that the information attached is sufficient for your current requirements. If there are any queries, please do not hesitate to contact Geo-Environmental Engineering Ltd.

Yours Faithfully

.....
James Brock *BSc (Hons), MSc*
Associate - Geo Environmental Engineering Ltd

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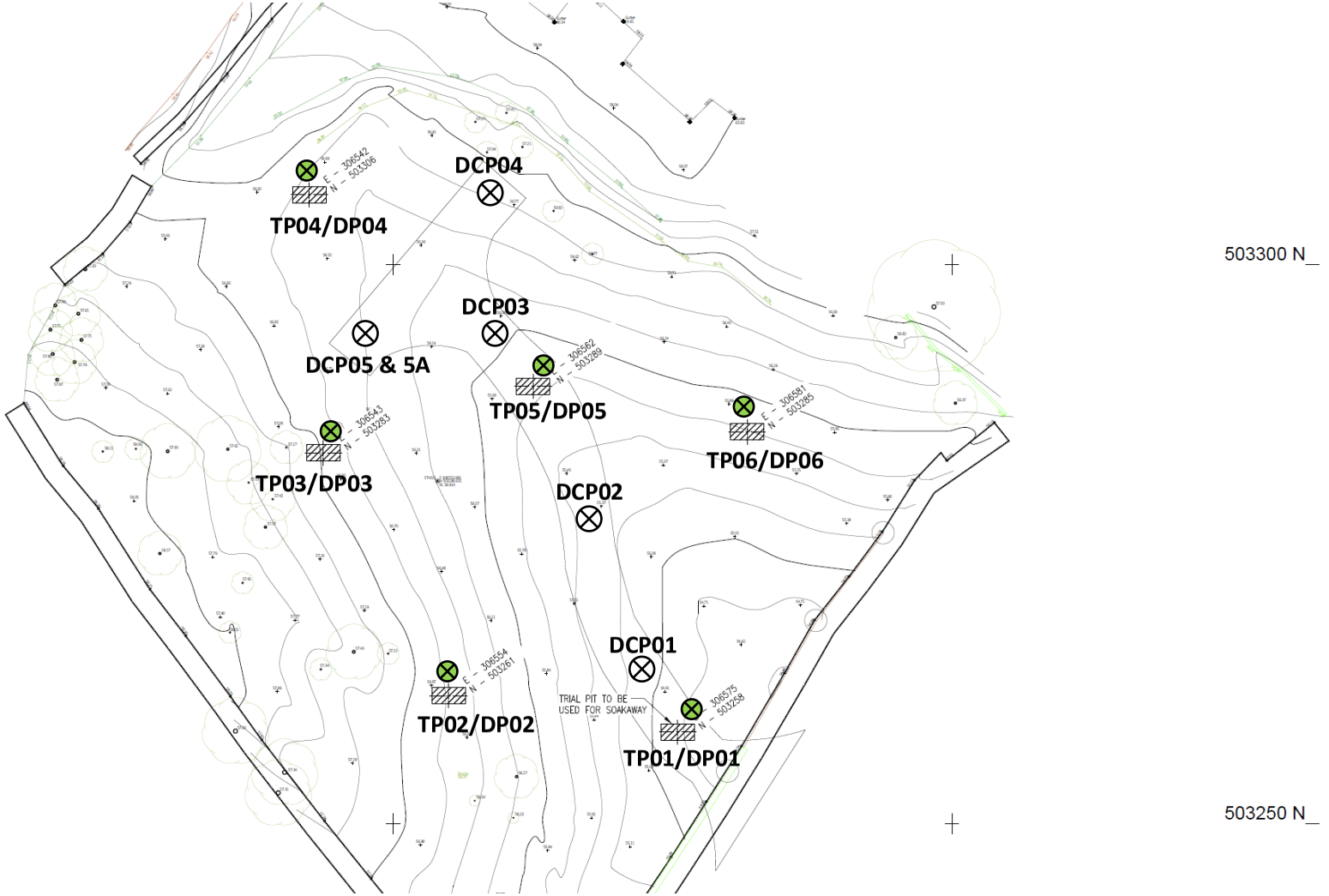
GEO2018-2990: West Lakes Hotel, Gosforth - Exploratory Hole Location Plan (Not to Scale)



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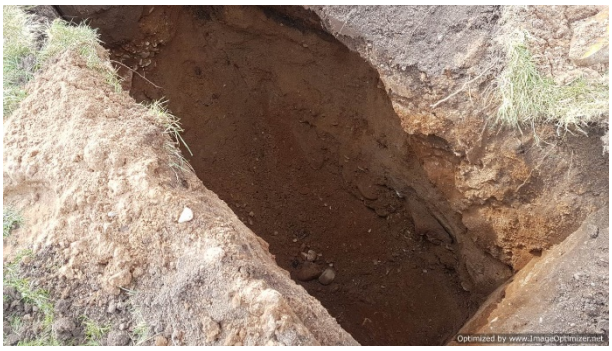
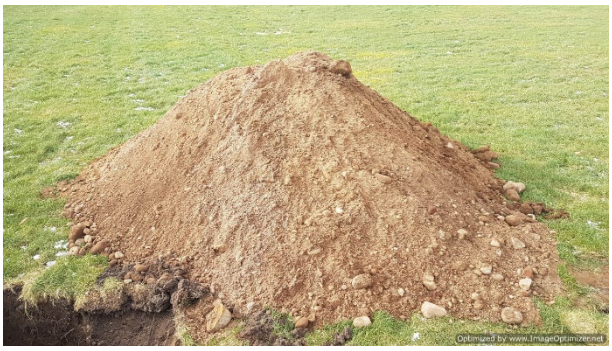
GEO2018-2990: West Lakes Hotel, Gosforth. TP01

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.45	Dark brown sandy loamy TOPSOIL.		
0.45	1.50	Orangey brown very gravelly medium SAND with occasional sub-rounded cobbles. Gravel is fine to medium sub-rounded mixed lithology.		
1.50	2.00	Dark orangey brown very sandy fine to coarse sub-rounded GRAVEL of mixed lithology with occasional sub-rounded cobbles.		
		End of trial hole at 2.00m due to collapse of side walls. Trial pit stability is poor. Trial hole remained dry on completion. Permeability test completed. See test results below. Trial hole backfilled with arisings on completion.		No Samples

Site: West Lakes Hotel, Gosforth
Engineer: J. Brock
Site Works Date: 01/03/2018
Plant: JCB Tracked 360 Excavator

Log Notes:
HSV = Hand Shear Vane (result in kN/m^2)
CBR = California Bearing Ratio by Mexe Cone Penetrometer (%)
LP = Limited Penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub





Permeability Test Results Trial Pit Dimensions: 1.70m long x 1.10m wide		
Time:	**Duration (mins)**	**Depth (m bgl):**
11:30	0	1.50
11:35	5	1.57
11:39	9	1.62
11:44	14	1.69
11:48	18	1.78

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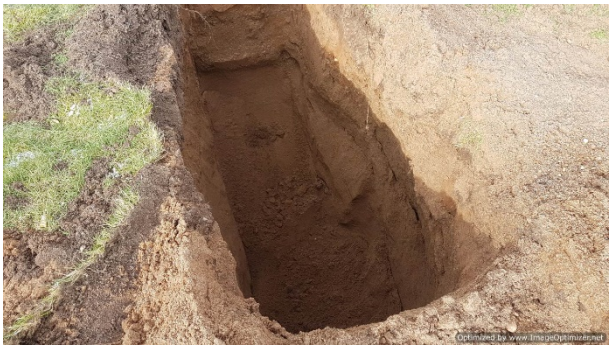
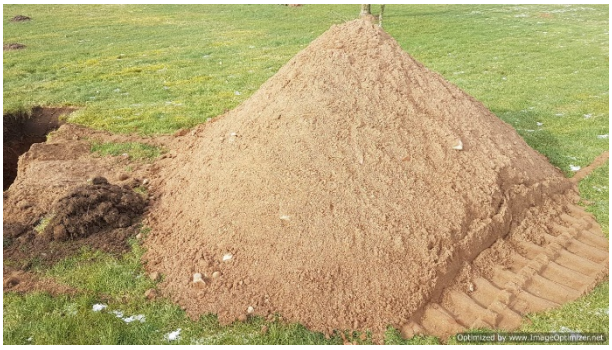
GEO2018-2990: West Lakes Hotel, Gosforth. TP02

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.30	Dark brown sandy loamy TOPSOIL.		0.20 - T
0.30	2.30	Orangey brown very gravelly medium SAND with occasional sub-rounded cobbles. Gravel is fine to medium sub-rounded mixed lithology.		1.00 - T
		End of trial hole at 2.00m due to collapse of side walls. Trial pit stability is poor. Trial hole remained dry on completion. Trial hole backfilled with arisings on completion.		

Site: West Lakes Hotel, Gosforth
Engineer: J. Brock
Site Works Date: 01/03/2018
Plant: JCB Tracked 360 Excavator

Log Notes:
HSV = Hand Shear Vane (result in kN/m^2)
CBR = California Bearing Ratio by Mexe Cone Penetrometer (%)
LP = Limited Penetration (HSV/CBR)
NP = No penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub





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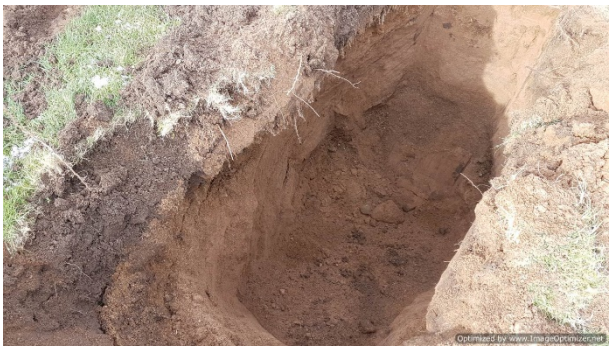
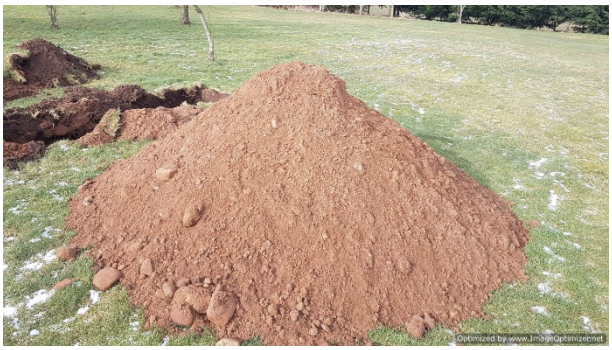
GEO2018-2990: West Lakes Hotel, Gosforth. TP03

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.30	Dark brown sandy loamy TOPSOIL.		
0.30	1.6	Dark orangey brown very gravelly medium SAND with occasional sub-rounded cobbles. Gravel is fine to medium sub-rounded mixed lithology.		
1.60	2.00	Dark orangey brown very sandy fine to coarse sub-rounded GRAVEL of mixed lithology with occasional sub-rounded cobbles.		
		End of trial hole at 2.00m due to collapse of side walls. Trial pit stability is poor. Trial hole remained dry on completion. Trial hole backfilled with arisings on completion.		No samples.

Site: West Lakes Hotel, Gosforth
Engineer: J. Brock
Site Works Date: 01/03/2018
Plant: JCB Tracked 360 Excavator

Log Notes:
HSV = Hand Shear Vane (result in kN/m²)
CBR = California Bearing Ratio by Mexe Cone Penetrometer (%)
LP = Limited Penetration (HSV/CBR)
NP = No penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub





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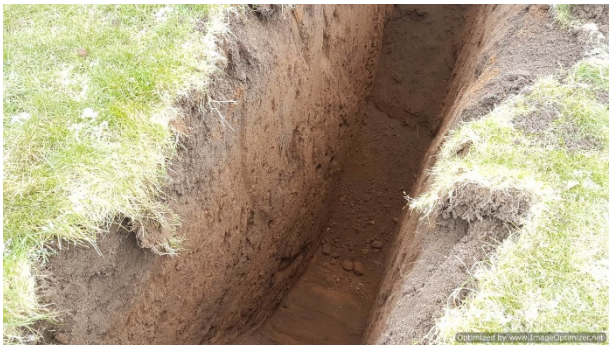
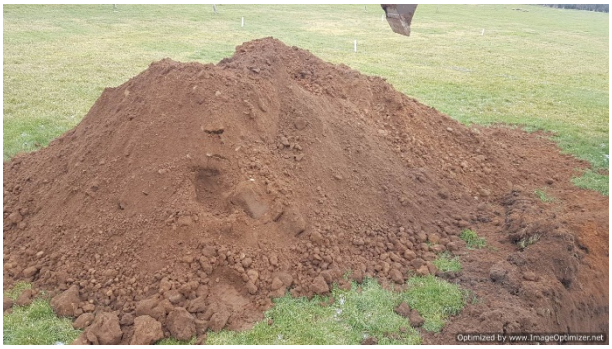
GEO2018-2990: West Lakes Hotel, Gosforth. TP04

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.35	Dark brown sandy loamy TOPSOIL.		0.20 - T
0.35	2.80	Dark brown silty very gravelly medium SAND with occasional sub-rounded cobbles. Gravel is fine to medium sub-rounded mixed lithology.		0.80 - T
2.80	3.10	Dark orangey brown very sandy fine to coarse sub-rounded GRAVEL of mixed lithology with occasional sub-rounded cobbles.		
		End of trial hole at 3.00m. Trial pit stability is good. Trial hole remained dry on completion. Trial hole backfilled with arisings on completion.		

Site: West Lakes Hotel, Gosforth
Engineer: J. Brock
Site Works Date: 01/03/2018
Plant: JCB Tracked 360 Excavator

Log Notes:
HSV = Hand Shear Vane (result in kN/m^2)
CBR = California Bearing Ratio by Mexe Cone Penetrometer (%)
LP = Limited Penetration (HSV/CBR)
NP = No penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub





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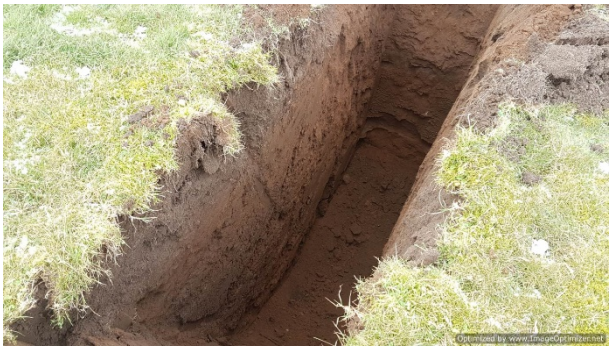
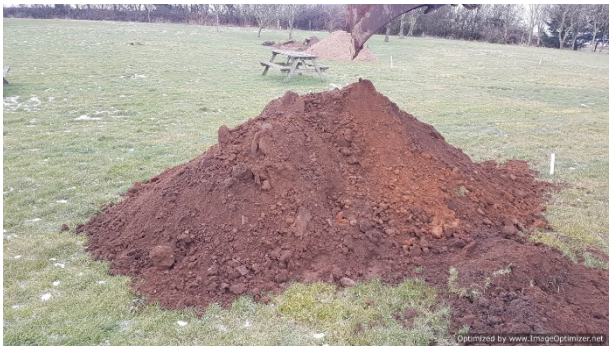
GEO2018-2990: West Lakes Hotel, Gosforth. TP05

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.40	Dark brown sandy loamy TOPSOIL.		
0.40	2.60	Dark brown silty very gravelly medium SAND with occasional sub-rounded cobbles. Gravel is fine to medium sub-rounded mixed lithology.		
2.60	2.80	Dark orangey brown very sandy fine to coarse sub-rounded GRAVEL of mixed lithology with occasional sub-rounded cobbles.		
		End of trial hole at 2.80 due collapse of gravels at base. Trial pit stability is fair. Trial hole remained dry on completion. Trial hole backfilled with arisings on completion.		No samples.

Site: West Lakes Hotel, Gosforth
Engineer: J. Brock
Site Works Date: 01/03/2018
Plant: JCB Tracked 360 Excavator

Log Notes:
HSV = Hand Shear Vane (result in kN/m^2)
CBR = California Bearing Ratio by Mexe Cone Penetrometer (%)
LP = Limited Penetration (HSV/CBR)
NP = No penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub





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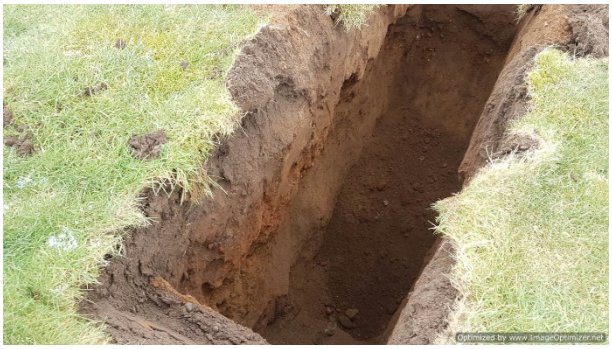
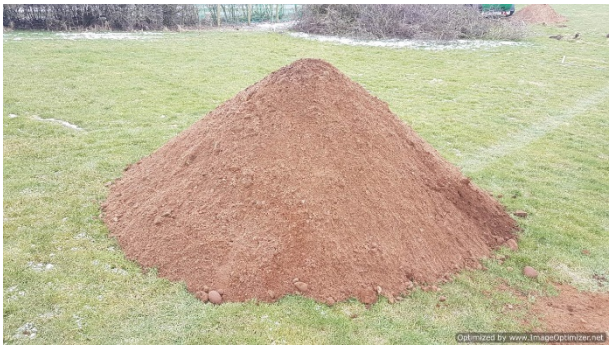
GEO2018-2990: West Lakes Hotel, Gosforth. TP06

Depth From (m)	Depth To (m)	Strata Description	Legend	Testing / Samples
0.00	0.40	Dark brown sandy loamy TOPSOIL.		0.20 - T
0.40	2.50	Orangey brown very gravelly medium SAND with occasional sub-rounded cobbles. Gravel is fine to medium sub-rounded mixed lithology.		1.50 - T
		End of trial hole at 2.00m due to collapse of side walls. Trial pit stability is poor. Trial hole remained dry on completion. Trial hole backfilled with arisings on completion.		

Site: West Lakes Hotel, Gosforth
Engineer: J. Brock
Site Works Date: 01/03/2018
Plant: JCB Tracked 360 Excavator

Log Notes:
HSV = Hand Shear Vane (result in kN/m^2)
CBR = California Bearing Ratio by Mexe Cone Penetrometer (%)
LP = Limited Penetration (HSV/CBR)
NP = No penetration (HSV/CBR)
B = Bulk Bag, J = Amber Glass Jar, T = Plastic Tub





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In-Situ Dynamic Probe Record Sheet - Super Heavy DPSH

Site Location: West Lakes Hotel
Client: West Lakes Hotel
Project Ref: 2018-2990
Driller: SG
Engineer: JB
Fieldworks Date: 10.03.2018
Fieldworks Notes: N/A
Standard: BS1377 Part 9 DPSH

Probe Location:	DP01	DP02	DP03	DP04	DP05	DP06
Depth (m bgl):	N100	N100	N100	N100	N100	N100
0.1	0	0	0	1	0	0
0.2	1	1	1	1	1	1
0.3	1	2	1	1	1	1
0.4	1	2	1	1	1	1
0.5	1	3	1	1	1	1
0.6	1	2	2	2	0	0
0.7	1	3	1	1	1	1
0.8	1	3	2	1	1	1
0.9	1	3	2	0	0	0
1	2	3	2	1	1	1
1.1	3	4	4	1	1	1
1.2	3	4	3	0	0	1
1.3	4	5	3	1	1	2
1.4	6	4	3	0	0	5
1.5	5	4	3	3	1	5
1.6	7	5	4	4	1	6
1.7	7	4	3	3	1	6
1.8	6	3	4	2	1	4
1.9	8	4	4	3	4	5
2	8	4	4	3	5	7
2.1	10	4	4	4	5	9
2.2	8	4	4	4	8	11
2.3	9	5	5	3	9	10
2.4	8	5	5	0	9	10
2.5	8	6	5	5	8	9
2.6	7	7	7	5	13	10
2.7	5	6	8	5	11	9
2.8	5	7	10	7	9	7
2.9	6	8	11	10	10	7
3	6	7	8	12	10	6
3.1	5	6	6	7	7	7
3.2	5	4	7	4	7	8
3.3	4	4	6	5	6	7
3.4	4	6	6	5	4	7
3.5	4	8	5	4	3	5
3.6	4	6	6	6	3	5
3.7	5	4	6	10	2	6
3.8	7	4	6	6	1	3
3.9	5	5	7	6	2	4
4	5	4	6	6	3	4
4.1	5	5	7	4	3	5
4.2	5	6	6	6	2	4
4.3	6	6	5	6	3	4
4.4	8	7	6	4	4	5
4.5	8	7	5	4	4	7
4.6	8	7	5	3	3	7
4.7	7	8	6	2	4	6
4.8	8	7	5	3	4	6
4.9	7	6	4	3	3	7
5	6	7	5	3	4	6

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Notes:

The Dynamic Probe test is used to determine the resistance of soils in-situ to the intermittent penetration of a cone, driven dynamically in a standard manner and in accordance to B.S. 1377: Part 9. The equipment consists of a 90° cone which may be sacrificial or retained for recovery, a series of extension or driving rods, a torque wrench and a driving device.

There are two types of test: Heavy Dynamic Probing (DPH) and Super Heavy Dynamic Probing (DPSH). The dimensions of the cone and the mass and drop height of the driving weight differ between the two tests. The extension rods used in the test are either 0.5-metre-long (for top of the hole) or 1-metre-long, manufactured from 35mm diameter heat-treated alloy steel, with graduations marked every 100mm along their length. The rods are flush-coupled and designed such that rod ends butt-up fully against each other when driving, forming a continuous jointed series with a straight axis. The driving device may be an Automatic Trip Hammer as part of a Dynamic Sampling drilling rig or a purpose-designed Probing Rig with characteristics conforming to BS 1377: Part 9.

The blow count is recorded for every 100mm of driving (N100) and the results presented as a plot of blow count against depth. Where the DPSH is utilised the sum total of three N100 increments (c.300mm penetration – N300 value) correlates to an equivalent SPT "N" value.

Dynamic Cone Penetrometer Calculation Sheet

Location:	**DCP01 - West Lakes Hotel, Gosforth**
Test Depth (mm):	**0**
Zero Blow Reading:	**195**

Blows	Pentration Reading (mm)	Depth BGL (mm)	Actual Penetration (mm)	Cumulative Blows	DCP (mm/blow)	CBR Value[1] $CBR=10^{(2.48-1.057.Log(DCP))}$
1	285	90	90	1	90.0	2.6
1	365	170	80	2	80.0	2.9
1	415	220	50	3	50.0	4.8
1	485	290	70	4	70.0	3.4
1	555	360	70	5	70.0	3.4
1	630	435	75	6	75.0	3.1
1	720	525	90	7	90.0	2.6
1	815	620	95	8	95.0	2.5
1	900	705	85	9	85.0	2.8
1	960	765	60	10	60.0	4.0
						FULL DEPTH

Location:	**DCP02 - West Lakes Hotel, Gosforth**
Test Depth (mm):	**0**
Zero Blow Reading:	**75**

Blows	Pentration Reading (mm)	Depth BGL (mm)	Actual Penetration (mm)	Cumulative Blows	DCP (mm/blow)	CBR Value[1] $CBR=10^{(2.48-1.057.Log(DCP))}$
1	215	140	215	1	215.0	0.7
1	310	235	95	2	95.0	1.8
1	380	305	70	3	70.0	2.6
1	450	375	70	4	70.0	2.6
1	535	460	85	5	85.0	2.1
1	660	585	125	6	125.0	1.3
1	745	670	85	7	85.0	2.1
1	850	775	105	8	105.0	1.6
1	960	885	110	9	110.0	1.6
						FULL DEPTH

1 - TRRL Equation, $Log_{10}(CBR) = 2.48 - 1.057Log_{10}$ (mm/blow)

Dynamic Cone Penetrometer Calculation Sheet

Location:	**DCP03 - West Lakes Hotel, Gosforth**
Test Depth (mm):	**0**
Zero Blow Reading:	**65**

Blows	Pentration Reading (mm)	Depth BGL (mm)	Actual Penetration (mm)	Cumulative Blows	DCP (mm/blow)	CBR Value[1] $CBR=10^{(2.48-1.057.Log(DCP))}$
1	195	130	130	1	130.0	1.8
1	250	185	55	2	55.0	4.4
1	315	250	65	3	65.0	3.7
1	370	305	55	4	55.0	4.4
1	430	365	60	5	60.0	4.0
1	495	430	65	6	65.0	3.7
1	590	525	95	7	95.0	2.5
1	685	620	95	8	95.0	2.5
1	740	675	55	9	55.0	4.4
1	785	720	45	10	45.0	5.4
1	830	765	45	11	45.0	5.4
1	850	785	20	12	20.0	12.7
1	885	820	35	13	35.0	7.0
1	940	875	55	14	55.0	4.4
						FULL DEPTH

Location:	**DCP04 - West Lakes Hotel, Gosforth**
Test Depth (mm):	**0**
Zero Blow Reading:	**80**

Blows	Pentration Reading (mm)	Depth (mm)	Actual Penetration (mm)	Cumulative Blows	DCP (mm/blow)	CBR Value[1] $CBR=10^{(2.48-1.057.Log(DCP))}$
1	190	110	190	1	190.0	0.8
1	260	180	70	2	70.0	2.6
1	325	245	65	3	65.0	2.9
1	390	310	65	4	65.0	2.9
1	430	350	40	5	40.0	5.0
1	480	400	50	6	50.0	3.9
1	530	450	50	7	50.0	3.9
1	590	510	60	8	60.0	3.1
1	640	560	50	9	50.0	3.9
1	705	625	65	10	65.0	2.9
1	795	715	90	11	90.0	2.0
1	870	790	75	12	75.0	2.4
1	945	865	75	13	75.0	2.4
						FULL DEPTH

1 - TRRL Equation, $Log_{10}(CBR) = 2.48 - 1.057Log_{10}$ (mm/blow)

Dynamic Cone Penetrometer Calculation Sheet

Location:	**DCP05 - West Lakes Hotel, Gosforth**
Test Depth (mm):	**0**
Zero Blow Reading:	**65**

Blows	Pentration Reading (mm)	Depth BGL (mm)	Actual Penetration (mm)	Cumulative Blows	DCP (mm/blow)	CBR Value[1] $CBR=10^{(2.48-1.057.Log(DCP))}$
1	195	130	130	1	130.0	1.8
1	265	200	70	2	70.0	3.4
1	330	265	65	3	65.0	3.7
1	385	320	55	4	55.0	4.4
1	430	365	45	5	45.0	5.4
1	485	420	55	6	55.0	4.4
1	555	490	70	7	70.0	3.4
1	630	565	75	8	75.0	3.1
1	945	880	315	9	315.0	0.7
						FULL DEPTH

Location:	**DCP05 A - West Lakes Hotel, Gosforth**
Test Depth (mm):	**0**
Zero Blow Reading:	**70**

Blows	Pentration Reading (mm)	Depth (mm)	Actual Penetration (mm)	Cumulative Blows	DCP (mm/blow)	CBR Value[1] $CBR=10^{(2.48-1.057.Log(DCP))}$
1	180	110	180	1	180.0	0.9
1	260	190	80	2	80.0	2.3
1	345	275	85	3	85.0	2.1
1	425	355	80	4	80.0	2.3
1	525	455	100	5	100.0	1.7
1	620	550	95	6	95.0	1.8
1	710	640	90	7	90.0	2.0
1	830	760	120	8	120.0	1.4
1	920	850	90	9	90.0	2.0
						FULL DEPTH

1 - TRRL Equation, $Log_{10}(CBR) = 2.48 - 1.057Log_{10}$ (mm/blow)

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PERCOLATION TEST RESULTS AND SOIL INFILTRATION ASSESSMENT

SITE: West Lakes Hotel, Gosforth
JOB NO: 2018-2990
TEST LOCATION: TP01
TEST NO.: 1

GROUND CONDITIONS: Very gravelly medium SAND.

TEST HOLE SIZE:

Width	1100	mm
Length	1700	mm
Depth of hole	1800	mm
Depth of water	1500	mm

MONITORING RESULTS:

Recorded Time			Total Time	Depth of water
Hours	Minutes	Seconds	(secs)	(mm)
0	0	0	0	1500
0	5	0	300	1570
0	9	0	540	1620
0	14	0	840	1690
0	18	0	1080	1780

PERCOLATION TEST RESULTS AND SOIL INFILTRATION ASSESSMENT

TEST NO.: 1

SOIL INFILTRATION RATE ASSESSMENT:

Vol. Outflowing between 75% and 25% effective depth:
V_{p75-25} = 1.4025 m^3

Mean surface area (pit sides to 50% effective depth + base of pit):
A_{p50} = 6.07 m^2

Time for the outflow between 75% and 25% effective depth:
t_{p75-25} = 540 secs

Soil Infiltration rate:
f = 4.3E-04 m/s

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