GRAVESHAM BOROUGH COUNCIL

FACTUAL REPORT

on

GROUND INVESTIGATION

at

GRAVESEND TOWN PIER

(PONTOON)

APRIL 2010

REPORT NO: 723995

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Table of Contents

1	**INTRODUCTION**	**4**
2	**SITE DESCRIPTION**	**5**
	2.1 Location and Topography	
	2.2 Geology	
	2.3 Hydrogeology and Hydrology	
3	**FIELDWORK**	**6**
4	**LABORATORY TESTING**	**7**
5	**REFERENCES**	**9**
	APPENDIX A	**i**
	(i) Site Location Plan	
	(ii) Exploratory Hole Location Plan	
	APPENDIX B	**ii**
	(i) Key to Exploratory Hole Logs	
	(ii) Borehole Logs	
	(iii) Standard Penetration Test (SPT) Summary Sheet	
	APPENDIX C	**iii**
	(i) Geotechnical Test Results	

1 INTRODUCTION

This investigation was carried out on the instructions of Gifford (the Engineer) on behalf of Gravesham Borough Council (the Client). The purpose of the work was to undertake a Phase 2 (exploratory) over-water investigation to determine ground conditions and provide information for the design of foundations for a new floating pontoon berth for the Gravesend to Tilbury ferry.

This report details the work carried out both on site and in the geotechnical and chemical testing laboratories; and it contains the exploratory hole logs and laboratory testing results.

The ground investigation has been carried out using cable percussive techniques of soft ground boring, in general accordance with the recommendations of BS5930: 1999 *Code of Practice for Site Investigations.* Whilst every attempt is made to record full details of the strata encountered in the exploratory holes, techniques of hole formation and sampling will inevitably lead to disturbance, mixing or loss of material in some soils and rocks. The investigation has also been carried out in accordance with BS10175 *Investigation of Potentially Contaminated Sites: Code of Practice* (2001). A comprehensive desk study, other than an inspection of geological maps, has not been undertaken as part of this investigation. No testing has been undertaken to detect the presence of gas in the ground.

All information given in this report is based on the ground conditions encountered during the site work, and on the results of laboratory and field tests performed during the investigation. However, there may be conditions at the site that have not been taken into account, such as unpredictable soil strata, contaminant concentrations, and water conditions between or below exploratory holes. It should be noted that groundwater levels usually vary due to seasonal and/or other effects and may at times differ to those measured during the investigation.

This report was prepared by Structural Soils Ltd for the sole and exclusive use of Gravesham Borough Council in response to particular instructions. Any other parties using the information contained in this report do so at their own risk and any duty of care to those parties is excluded.

2 SITE DESCRIPTION

2.1 Location and Topography

The area of the site works is an undefined area of the River Thames, near the south bank, just to the east of Gravesend Town Pier. The British National Grid Reference of the site is TQ 648 745. The work area is confined to approximately 100m by 50m in size. Gravesend Town Pier is a decorative cast iron structure and is approximately 50m long and 15m wide. At the end of the pier it widens to approximately 25m where a restaurant is located. Along the shoreline to the south is a seawall approximately 7m high. Access to the site area was by a small workboat from one of the surrounding nearby piers. The tidal range reaches in excess of 5.5m during spring tides.

Both boreholes were drilled from a spud-legged barge, which was constructed at Denton Wharf which is owned and operated by the Port of London Authority, approximately 1.5km to the east. The barge was towed to site by a commercial tug.

2.2 Geology

The British Geological Survey map (sheet 271, scale 1:50,000) shows the site to be underlain by possible *'Tidal River or Creek Deposits; present day intertidal mudflat'* overlying possible alluvium comprising *'mainly silt and clay locally peaty'* overlying the Upper Chalk.

2.3 Hydrogeology and Hydrology

The Environment Agency (EA) groundwater vulnerability maps (Thames Estuary, sheet 40, scale 1:100,000) shows the site location as overlying a Major (highly permeable) Aquifer. We interpret this as referring to the Upper Chalk.

These are highly permeable formations usually with a known or probable presence of significant fracturing. They may be highly productive and able to support large abstractions for public supply and other purposes.

The soils on this site have been classified as having a high (urban) leaching potential (HU), as soil information for restored mineral workings and urban areas is based on fewer observations than elsewhere. A worst-case vulnerability (HU) classification is assumed for these areas and for current mineral workings until proved otherwise.

3 FIELDWORK

2 no. over-water cable percussion boreholes (BH1 and BH2) were completed between 15 and 28 January 2010 at locations shown on the Exploratory Hole Location Plan in Appendix A. The scope of investigation and choice of investigation equipment was decided by the Engineer. The positions were selected by the Engineer and set out by Structural Soils Limited.

The boreholes were drilled using a cable tool percussion drilling rig and were 200mm at the sea bed, reducing to 150mm diameter at 20.0m depth. The depths of the boreholes were 25.0m and they encountered made ground comprising sand and gravel and slightly sandy slightly gravelly clay overlying chalk. The chalk increased in strength and density with depth, from structureless chalk to moderately weak structured chalk.

Sampling and in-situ testing details were specified by the Engineer. Geotechnical samples were taken and returned to the laboratory for classification and potential testing.

Samples for potential contamination testing were placed in appropriate contamination sample containers that were supplied by the laboratory. Containers for volatiles testing of soil samples were filled to capacity. The water sample containers (with preservatives where required) were filled to capacity to minimise volatilisation. All samples were then kept in cool boxes with ice packs and were transported to the laboratories under Chain of Custody documentation, as promptly as possible to maintain sample integrity.

The exploratory holes were logged by an engineer in general accordance with the recommendations of BS5930: 1999 including amendment 1 (2007) and CIRIA Report C574 *Engineering in Chalk.* Detailed descriptions, together with relevant comments, are given in the logs included in Appendix B.

On completion both exploratory holes (BH1 and BH2) were backfilled with bentonite grout.

4 LABORATORY TESTING

Samples for potential geotechnical testing were returned to the company's laboratory in Bristol and those for potential contamination testing were sent to accredited chemical testing laboratories. Geotechnical tests were scheduled by the Engineer.

Geotechnical laboratory testing was generally carried out in accordance with BS1377: 1990, *Methods of Test for Soils for Civil Engineering Purposes*, Parts 1 to 8, unless indicated otherwise. Where non-standard procedures have been undertaken, this is recorded on the report sheet. The results are reported in tabular and/or graphical form and included as Appendix C of this report. Chemical testing (e.g. for concrete classification) results are contained in the same appendix.

4.1 Moisture Content

2 no. moisture content tests were undertaken using the oven-drying method in accordance with BS1377: Part 2: 1990. The results are tabulated in the Summary of Classification Tests.

4.2 Liquid Limit, Plastic Limit and Plasticity Index

2 no. liquid and plastic limit tests were performed in accordance with BS1377: Part 2: 1990. The results are tabulated in an A Line Plot (in accordance with BS5930: 1999) and the Summary of Classification Tests.

4.3 Saturation Moisture Content of Chalk

27 no. saturation moisture contents were undertaken on representative samples of intact Chalk, in accordance with BS1377: Part 2: 1990. The results are tabulated in the Summary of Chalk Tests.

4.4 Particle Size Distribution

1 no. particle size distribution test was undertaken by sieving in accordance with BS1377: Part 2: 1990, in accordance with BS1377: Part 2: 1990. The result is represented graphically as a particle size distribution curve and in tabular format.

4.5 Split and Describe U100 Samples

6 no. undisturbed U100 samples were extruded, split, sketched and logged by an Engineer in general accordance with the recommendations of BS5930 and CIRIA report C574 *Engineering in Chalk*. The sketches and detailed descriptions are presented on Summary Sheets.

4.6 One - Dimensional Consolidation Test

1 no. one-dimensional consolidation test was undertaken in accordance with BS1377: Part 5: 1990. 4 no. loading and 1 no. unloading stages were undertaken on each sample with pressures of between 40kPa and 240kPa.

The results are represented as voids ratio e/log pressure together with values of the coefficients of compressibility (m_v) and consolidation (c_v).

4.7 Chemical Analyses

1 no. soil sample was tested to determine its pH values and water soluble sulphate content in accordance with BS1377: Part 3:1990 clause 5.

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A J Petty Bsc (Hons) FGS

A Cattell BSc PhD CGeol FGS

5 REFERENCES

5.1 BS 5930:1999 *Code of Practice for Site Investigations*

5.2 BS 5930:1999 *Code of Practice for Site Investigations: amendment 1* (2007)

5.3 BS 10175: 2001 *Investigation of potentially contaminated sites: Code of practice*

5.4 Geological Survey of Great Britain sheet 271 scale 1:50,000

5.5 NRA Groundwater Vulnerability Map sheet 40 scale 1:100,000

5.6 BS EN ISO 14688-1:2002 *Geotechnical investigation and testing – Identification and classification of soil: Part 1: Identification and description*

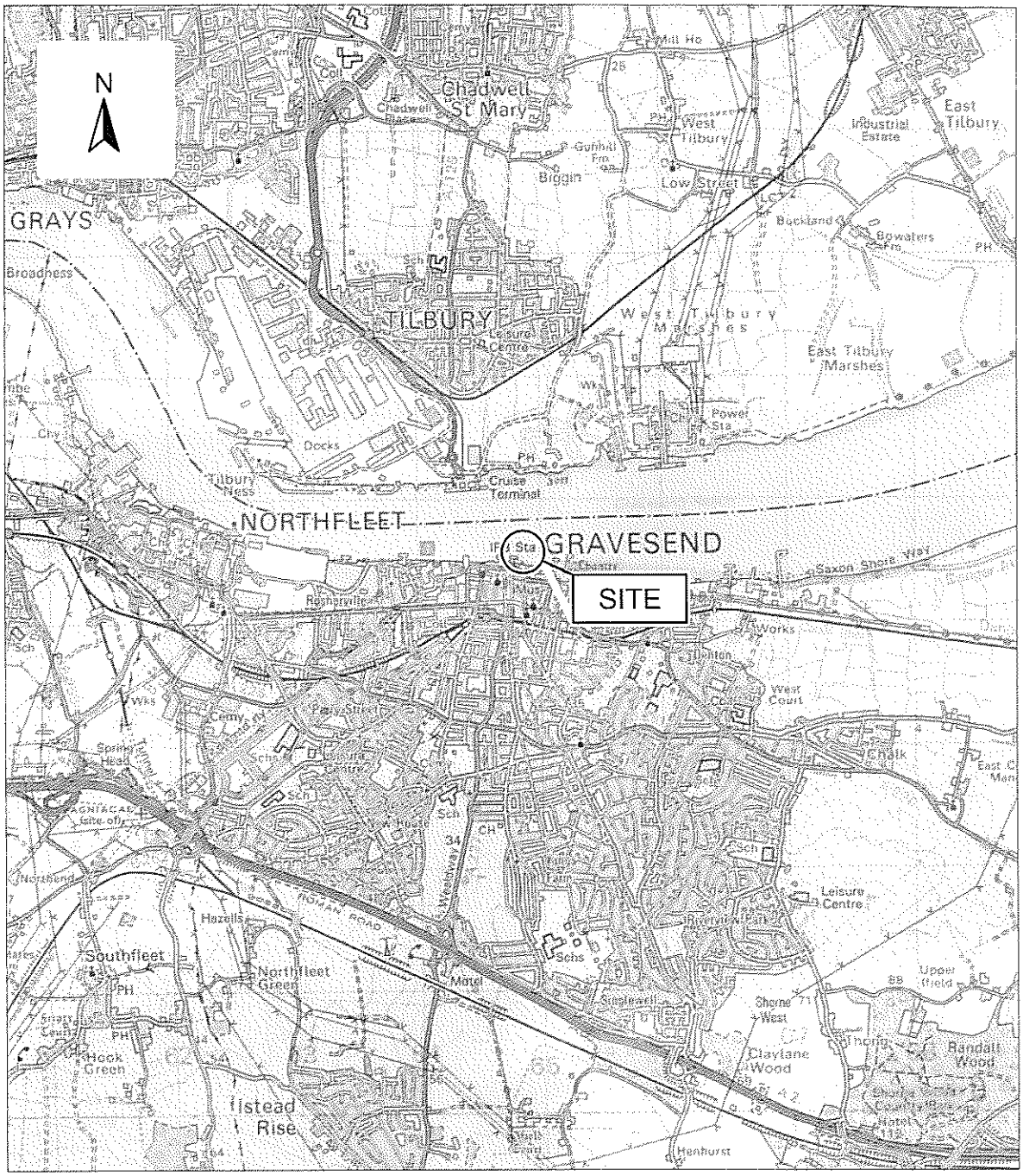
5.7 BS EN ISO 14688-1:2004 *Geotechnical investigation and testing – Identification and classification of soil: Part 2: Principles for a classification*

5.8 CIRIA Report C574 *Engineering In Chalk* (2002)

APPENDIX A

(i) Site Location Plan

(ii) Exploratory Hole Location Plan



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REV.	DATE	DESCRIPTION	BY	CHD.	APR.
00	26.02.2010	-	CPM	AP	-

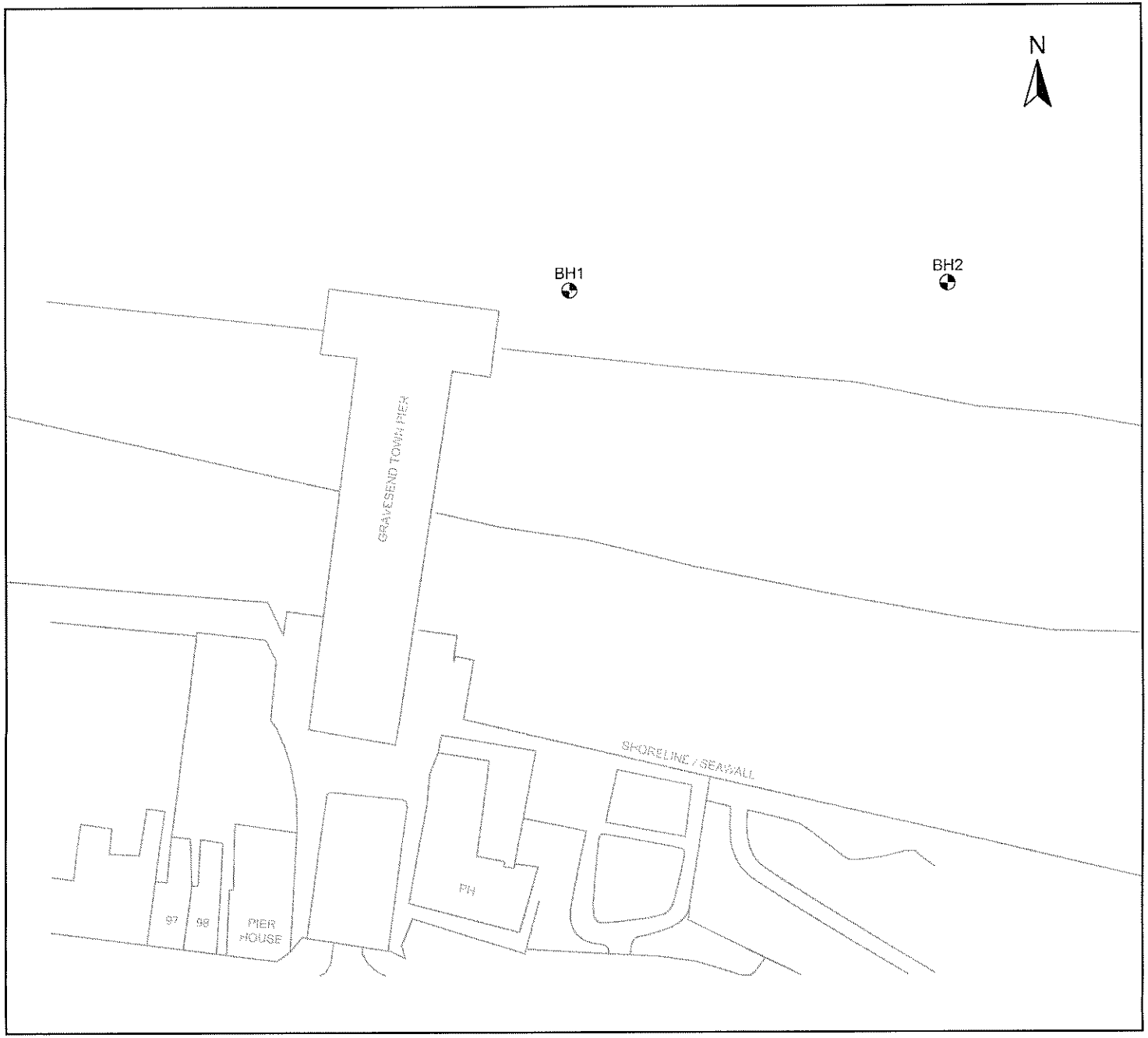
DIMENSION	SCALE	ORIGIN SIZE
m	1:50 000	A4

CLIENT: Gravesham Borough Council

PROJECT: Gravesham Town Pier (Pontoon)

TITLE: SITE LOCATION MAP

GRID REFERENCE	JOB NO.	DRAWING STATUS	FIGURE
TQ 648 745	723995	-	Figure 1



LEGEND

BH Borehole Location

REV.	DATE	DESCRIPTION	BY	CHD.	APR.
00	26.02.2010	-	CPM	AP	-

DIMENSION	SCALE	ORIGIN SIZE
m	1:750	A4

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CLIENT

Gravesham Borough Council

PROJECT

Gravesham Town Pier (Pontoon)

TITLE

EXPLORATORY HOLE LOCATION PLAN

JOB NO	FIGURE
723995	Figure 2

DRAWING STATUS	REV.
-	00

0 10 20 30 40m

APPENDIX B

(i) Key to Exploratory Hole Logs

(ii) Borehole Logs

(iii) Standard Penetration Test (SPT) Summary Sheet

(iv) U100 Descriptions Sheets

KEY TO EXPLORATORY HOLE LOGS - SUMMARY OF ABBREVIATIONS

SAMPLING

Sample type codes

B	=	Bulk disturbed sample.
D	=	Small Disturbed sample.
ES	=	Soil sample for environmental testing.
U	=	Undisturbed driven tube sample - Number of blows indicated. Percentage recovery reported.

Undisturbed sample detail codes

$U_{(100)}$	=	100mm diameter undisturbed sample.

IN-SITU TESTING

$SPT_{(c)}$	=	Standard Penetration Test using a solid 60 degree cone.
SPT	=	Standard Penetration Test using split spoon sampler. ($SPT_{(NR)}$ indicates 'No Sample Recovery').
	=	
	=	

ADDITIONAL NOTES

1. All soil and rock descriptions and legends in general accordance with BS5930:1999.
2. Material types divided by a broken line (- - -) indicates an unclear boundary.
3. The data on any sheet within the report showing the AGS icon is available in the AGS format.

AGS

KEY TO EXPLORATORY HOLE LOGS - SUMMARY OF GRAPHIC SYMBOLS

WATER COLUMN SYMBOLS

First water strike, second water strike etc.

Standing water level following first strike, standing water level following second strike etc.

Seepage.

Standing water level recorded at documented date.

MATERIAL GRAPHIC LEGENDS

Chalk

MADE GROUND

Possible MADE GROUND

Sandy gravelly silty CLAY

INSTRUMENTATION SYMBOLS

STRUCTURAL SOILS

BOREHOLE LOG

Contract:	Client:	Borehole:
Gravesend Town Pier	**Gravesham Borough Council**	**BH1**

Contract Ref:	Start:	Ground Level (m AD):	National Grid Co-ordinate:	Sheet:
723995	**22.01.10** End: **22.01.10**	**-2.1**	**E:564795.0 N:174514.0**	**1** of **3**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						POSSIBLE MADE GROUND: Light grey silty fine to coarse SAND and angular to subrounded fine to coarse GRAVEL of flint and chalk with frequent timber fragments.	(0.80)	
0.50-1.00	1	B						
0.50	1A	ES					0.80	
1.00	2A	ES				Structureless CHALK composed of sandy gravelly SILT. Gravel is subangular to subrounded fine to coarse chalk and flint. Clasts are very weak low density white with black specks and occasional orange brown staining. Matrix is cream.		
1.00-1.45	2	SPT	N=11					
1.00	2	D						
1.00-1.50	3	B						
							(2.20)	
2.00	4	$U_{(100)}$	20 blows 100% recovery					
2.60-3.00	5	B						
							3.00	
3.00	3A	ES				Structureless CHALK composed of silty sandy subangular to subrounded fine to coarse GRAVEL with occasional cobbles. Clasts are very weak low density white with black specks and occasional orange brown and brown staining. Matrix is cream to white. Occasional rinded flint gravels and cobbles.		
3.00-3.45	6	SPT	N=16					
3.00	6	D						
3.00-3.50	7	B					(1.20)	
4.00	8	$U_{(100)}$	20 blows 100% recovery					
							4.20	
						Very weak to weak low to medium density cream with frequent black specks CHALK. Occasional orange brown staining. Occasional rinded flint gravel and cobbles.		
4.60	9	D						
5.00-5.45	10	SPT	N=21					
5.00	10	D						
5.00-6.00	11	B						
							(3.80)	
6.00	4A	ES						
6.50	12	$U_{(100)}$	27 blows 80% recovery					
7.10	13	D						
							8.00	
8.00-8.45	14	SPT	N=40			Weak low to medium density white with occasional black specks CHALK. Occasional orange brown staining. Occasional rinded flint gravel and cobbles.		
8.00	14	D						
8.00-8.50	15	B						

Boring Progress and Water Observations						Chiselling		
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth	From	To	Duration (hh:mm)

General Remarks

1. Over water borehole drilled from spud-legged barge.
2. Borehole commenced in 8" casing and tools, reducing to 6" casing and tools at 20.0m depth.
3. Borehole moved approximately 1.0m east following casing snapping over weekend of 23/24 January 2010.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**DS**	**APetty**	

GINT_LIBRARY_V8_03 GLB|CABLE PERCUSSION LOG | 723995_GRAVESEND_TOWN_PIER.GPJ - v8_03 | 13/04/10 - 11:32 | AP.
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BOREHOLE LOG

Contract:	Client:	Borehole:
Gravesend Town Pier	**Gravesham Borough Council**	**BH1**

Contract Ref:	Start:	Ground Level (m AD):	National Grid Co-ordinate:	Sheet:
723995	**22.01.10** End: **22.01.10**	**-2.1**	**E:564795.0 N:174514.0**	**2** of **3**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						Weak low to medium density white with occasional black specks CHALK. Occasional orange brown staining. Occasional rinded flint gravel and cobbles. *(stratum text copied from layer on previous sheet)*		
9.50-9.84	16	SPT	N=81*					
9.50	16	D						
9.50-10.00	17	B						
							(5.00)	
11.00-11.45	18	SPT	N=29					
11.00	18	D						
11.00-11.50	19	B						
12.50-12.95	20	SPT	N=32					
12.50	20	D						
12.50-13.00	21	B					13.00	
						Weak medium density white with occasional black specks CHALK. Occasional orange brown staining. Frequent rinded flint gravel and cobbles and flint bands.		
14.00-14.45	22	SPT	N=45					
14.00	22	D						
14.00-14.50	23	B						
							(3.50)	
15.50-15.93	24	SPT	N=55*					
15.50	24	D						
15.50-16.00	25	B					16.50	
						Weak to moderately weak medium density white with occasional black specks CHALK. Occasional orange brown staining. Occasional rinded flint gravel and cobbles and flint bands.		
17.00-17.45	26	SPT	N=50					
17.00	26	D						
17.00-17.50	27	B						

Boring Progress and Water Observations						Chiselling		
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth	From	To	Duration (hh:mm)

General Remarks

4. Borehole backfilled with bentonite cement grout on completion.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**DS**	**APetty**	

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STRUCTURAL SOILS

BOREHOLE LOG

Contract:	Client:	Borehole:
Gravesend Town Pier	**Gravesham Borough Council**	**BH1**

Contract Ref:	Start:	Ground Level (m AD):	National Grid Co-ordinate:	Sheet:
723995	**22.01.10** End: **22.01.10**	**-2.1**	**E:564795.0 N:174514.0**	**3** of **3**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
18.50-18.88 18.50 18.50-19.00	28 28 29	SPT D B	N=67*			Weak to moderately weak medium density white with occasional black specks CHALK. Occasional orange brown staining. Occasional rinded flint gravel and cobbles and flint bands. *(stratum text copied from layer on previous sheet)*	(5.00)	
20.00-20.38 20.00 20.00-21.50	30 30 31	SPT D B	N=67*				21.50	
21.50-21.74 21.50 21.50-23.00	32 32 33	SPT D B	N=167*			Moderately weak to moderatley strong medium to high density white with occasional black specks CHALK. Occasional orange brown staining. Occasional rinded flint gravel and cobbles.		
23.00-23.24 23.00-24.50	34 35	SPT(c) B	N=100*				(3.50)	
24.50-24.66	36	SPT(c)	N=1500*				25.00	
						Borehole terminated at 25.0m depth.		

Boring Progress and Water Observations						Chiselling		
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth	From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 2000**	**DS**	**APetty**	

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BOREHOLE LOG

Contract:	Client:	Borehole:
Gravesend Town Pier	**Gravesham Borough Council**	**BH2**

Contract Ref:	Start:	Ground Level (m AD):	National Grid Co-ordinate:	Sheet:
723995	**15.01.10** End: **21.01.10**	**-1.9**	**E:564849.0 N:174515.0**	**1** of **3**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.50-0.70	1	B				MADE GROUND: Black silty fine to coarse SAND and angular to subrounded fine to coarse GRAVEL of flint chalk slag limestone and brick. occasional metal fragments. Rare tyre fragment.	(0.80) 0.80	
0.80	2	D				MADE GROUND: Firm green grey mottled brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse flint and chalk. Occasional metal fragments.	(0.70) 1.50	
1.00-1.45	3	SPT	N=19			Firm orange brown and brown thinly laminated slightly sandy slightly gravelly silty CLAY. Gravel is subangular to subrounded fine to medium flint and chalk.	(1.10) 2.60	
1.00	3	D						
1.00-1.50	4	B						
2.00	5	$U_{(100)}$	22 blows 100% recovery					
2.60-3.00	6	B				Structureless CHALK composed of silty sandy subangular to subrounded fine to coarse GRAVEL. Clasts are very weak low density white with black specks and occasional orange brown and brown staining. Matrix is cream brown. Occasional rinded flint gravels.	(1.90) 4.50	
3.00-3.45	7	$SPT_{(NR)}$	N=2					
3.00	7	D						
3.00-4.00	8	B						
4.00-4.45	9	SPT	N=4					
4.00-5.00	10	B						
4.00	9	D						
5.00-5.45	11	$SPT_{(NR)}$	N=9			Structureless CHALK composed of silty sandy subangular to subrounded fine to coarse GRAVEL with occasional cobbles. Clasts are very weak and weak low to medium density white with black specks and occasional orange brown and brown staining. Matrix is cream brown. Occasional rinded flint gravels.	(1.00) 5.50	
5.00	11	D						
5.00-6.00	12	B						
6.50-6.95	13	SPT	N=10			Structureless CHALK composed of silty sandy subangular to subrounded fine to coarse GRAVEL with occasional cobbles. Clasts are very weak and weak low to medium density white with black specks and occasional orange brown and brown staining. Matrix is cream. Occasional rinded flint gravels and cobbles.	(2.50) 8.00	
6.50	13	D						
6.50-7.00	14	B						
8.00-8.45	15	SPT	N=24			Weak low to medium density white occasionally mottled cream with frequent black specks CHALK. Occasional orange brown staining. Occasional gravel sized rinded flints.		
8.00	15	D						
8.00-8.50	16	B						

Boring Progress and Water Observations						Chiselling		
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth	From	To	Duration (hh:mm)

General Remarks

1. Over water borehole drilled from spud-legged barge.
2. Borehole commenced in 8" casing and tools, reducing to 6" casing and tools at 20.0m depth.
3. Artesian water encountered at 20.0m depth, rising to an approximate level of between +3.0 and +4.0m CD overnight.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 3000**	**DS**	**APetty**	

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STRUCTURAL SOILS

BOREHOLE LOG

Contract:	Client:	Borehole:
Gravesend Town Pier	**Gravesham Borough Council**	**BH2**

Contract Ref:	Start:	Ground Level (m AD):	National Grid Co-ordinate:	Sheet:
723995	**15.01.10** End: **21.01.10**	**-1.9**	**E:564849.0 N:174515.0**	**2** of **3**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
9.50	17	$U_{(100)}$	30 blows 88% recovery			Weak low to medium density white occasionally mottled cream with frequent black specks CHALK. Occasional orange brown staining. Occasional gravel sized rinded flints. *(stratum text copied from layer on previous sheet)*		
10.10	18	D					(5.50)	
11.00-11.45	19	SPT	N=25					
11.00	19	D						
11.00-11.50	20	B						
12.50	21	$U_{(100)}$	37 blows 100% recovery					
13.10	22	D					13.50	
13.50	23	B				Weak to moderately weak medium density white with rare black specks CHALK. Rare orange brown staining. Occasional gravel sized rinded flints.	(1.00)	
14.00-14.45	24	SPT	N=50					
14.00	24	D					14.50	
15.00	25	B				Weak to moderately weak medium density white with occasional black specks CHALK. Rare orange brown staining. Frequent gravel sized rinded flints and flint cobbles and flint bands.		
15.50-15.90	26	SPT	N=60*					
15.50	26	D						
16.50	27	B					(5.00)	
17.00-17.38	28	SPT	N=67*					
17.00	28	D						

Boring Progress and Water Observations						Chiselling		
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth	From	To	Duration (hh:mm)

General Remarks

4. Borehole backfilled with bentonite cement grout on completion.

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 3000**	**DS**	**APetty**	

AGS

GINT_LIBRARY_V8_03.GLB|CABLE PERCUSSION LOG | 723995_GRAVESEND_TOWN_PIER.GPJ - v8_03 | 13/04/10 - 11:33 | AP.
Structural Soils Ltd, Head Office - Bristol: The Old School, Stillhouse Lane, Bedminster, Bristol, BS3 4EB. Tel: 0117-947-1000, Fax: 0117-947-1004, Web: www.soils.co.uk, Email:admin@soils.co.uk.

STRUCTURAL SOILS

BOREHOLE LOG

Contract:	Client:	Borehole:
Gravesend Town Pier	**Gravesham Borough Council**	**BH2**

Contract Ref:	Start:	Ground Level (m AD):	National Grid Co-ordinate:	Sheet:
723995	**15.01.10** End: **21.01.10**	**-1.9**	**E:564849.0 N:174515.0**	**3** of **3**

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
18.00	29	B				Weak to moderately weak medium density white with occasional black specks CHALK. Rare orange brown staining. Frequent gravel sized rinded flints and flint cobbles and flint bands. *(stratum text copied from layer on previous sheet)*		
18.50-18.84	30	SPT	N=81*					
18.50	30	D						
							19.50	
19.50	31	B				Moderately weak to moderately strong medium to high density white with occasional black specks CHALK. Rare orange brown staining. Frequent gravel sized rinded flints and flint cobbles.		
20.00-20.25	32	SPT	N=158*					
20.00	32	D						
20.00-21.50	33	B						
21.50-21.75	34	SPT	N=115*					
21.50	34	D						
21.50-23.00	35	B					(5.50)	
23.00-23.26	36	SPT	N=120*					
23.00	36	D						
23.00-25.00	37	B						
							25.00	
25.00-25.06	38	SPT	N=600*			Borehole terminated at 25.0m depth.		
25.00	38	D						

Boring Progress and Water Observations						Chiselling		
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth	From	To	Duration (hh:mm)

General Remarks

All dimensions in metres | Scale: **1:50**

Method Used:	Plant Used:	Drilled By:	Logged By:	Checked By:
Cable percussion	**Dando 3000**	**DS**	**APetty**	

GINT_LIBRARY_V8_03 GLBICABLE PERCUSSION LOG | 723995_GRAVESEND_TOWN_PIER.GPJ - v8_03 | 13/04/10 - 11:33 | AP
Structural Soils Ltd, Head Office - Bristol: The Old School, Stillhouse Lane, Bedminster, Bristol, BS3 4EB. Tel: 0117-947-1000, Fax: 0117-947-1004, Web: www.soils.co.uk, Email:admin@soils.co.uk

STRUCTURAL SOILS

STANDARD PENETRATION TEST SUMMARY TABLE

Contract:	Client:	Job No:
Gravesend Town Pier	**Gifford**	**723995**

Exploratory Position ID	Depth (m)	Hole Dia (mm)	Casing Depth (m)	Water Depth (m)	Seating Drive		Test Drive			Comments
					Blows	Pen (mm)	Blows	R (mm)	Result	
BH1	1.00				1,2	150	3,3,2,3		N=11	
	3.00				2,4	150	4,4,4,4		N=16	
	5.00				1,3	150	4,5,6,6		N=21	
	8.00				1,3	150	5,5,16,14		N=40	
	9.50				5,9	150	12,24,14+	185	N=81*	
	11.00				3,4	150	5,7,8,9		N=29	
	12.50				5,5	150	8,8,8,8		N=32	
	14.00				5,7	150	7,10,10,18		N=45	
	15.50				6,7	150	8,9,15,18+	275	N=55*	
	17.00				4,4	150	4,8,10,28		N=50	
	18.50				1,1	150	15,18,17	225	N=67*	
	20.00				6,8	150	16,24,10	225	N=67*	
	21.50				9,16	150	38,12+	90	N=167*	
	23.00				15,10	85	46,4	150	N=100*	CPT
	24.50				18,7	150	50+	10	N=1500*	CPT
BH2	1.00				5,3	150	4,4,4,7		N=19	
	3.00				0,0	150	1,0,1,0		N=2	No Recovery
	4.00				1,0	150	1,1,1,1		N=4	
	5.00				2,2	150	3,1,2,3		N=9	No Recovery
	6.50				5,5	150	5,3,2,0		N=10	
	8.00				6,5	150	5,4,6,9		N=24	
	11.00				3,4	150	6,5,7,7		N=25	
	14.00				5,8	150	10,11,14,15		N=50	
	15.50				3,5	150	8,12,16,14+	250	N=60*	
	17.00				10,12	150	12,17,21	225	N=67*	
	18.50				9,12	150	15,20,15+	185	N=81*	
	20.00				7,15	150	29,21+	95	N=158*	
	21.50				12,13	115	22,28+	130	N=115*	
	23.00				10,15	130	24,26+	125	N=120*	
	25.00				25	30	50+	25	N=600*	

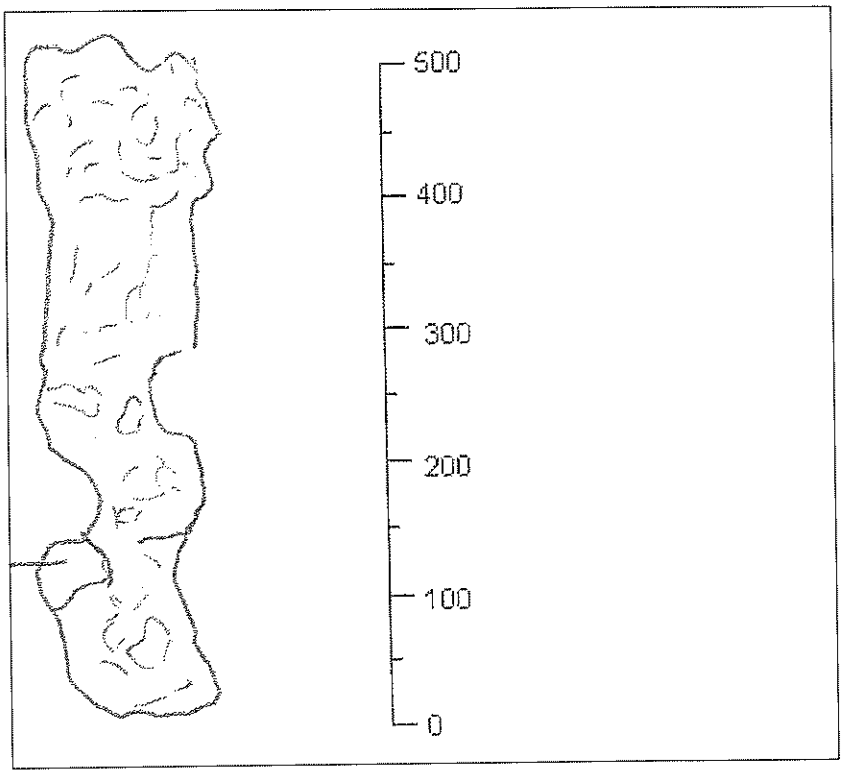
Notes:
1. **Tests carried out in accordance with BS1377: Part 9: 1990: 3.3.**
2. **Reported blows are for 75mm penetration unless indicated "+".**
3. **Where full test drive was not achieved, actual penetration (R) and extrapolated N value (N*) reported.**
4. **Tests carried out using a split spoon sampler unless noted as SPT(c) (denotes use of solid cone method) in the comments column.**
5. **Entries in the water depth column reflects the measured water depth at time of test.**

AGS

STRUCTURAL SOILS

SAMPLE REPORT

Contract:	Client:	Exploratory Position:
Gravesend Town Pier	**Gravesham Borough Council**	**BH1**
Contract Ref: **723995**	Sample Details: Depth (m): **2** - Ref: **4** - Type: **U**	Sheet: **1** of **6**



Sample Description

2.00m - 2.45m

Structureless CHALK composed of sandy gravelly SILT with rare cobbles. Clasts are white with occasional black specks weak low density with occasional orange brown staining. Matrix is cream with occasional orange brown staining. Occasional rinded flint gravel and cobbles.

Logged By: APetty

Undisturbed Type: U-100 Blows: 20 Recovery: 100%

Sampled Date: 22/01/2010

Sampled By: DSmart

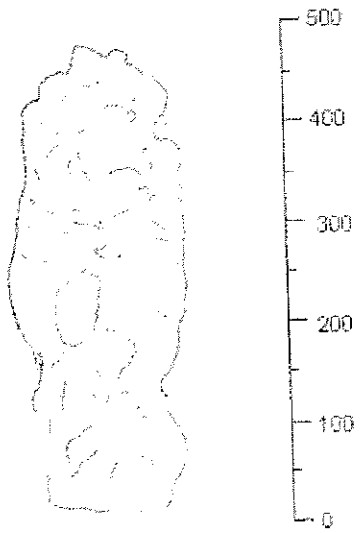
Sample Preparation: Sample waxed at both ends

GINT_LIBRARY_V8_03.GLB/G - SAMPLE DESCRIPTION REPORT V1 | 723995_GRAVESEND_TOWN_PIER.GPJ - v8_03 | 13/04/10 - 11:34 | AP.

STRUCTURAL SOILS

SAMPLE REPORT

Contract:	Client:	Exploratory Position:
Gravesend Town Pier	**Gravesham Borough Council**	**BH1**
Contract Ref: **723995**	Sample Details: Depth (m): **4** - Ref: **8** - Type: **U**	Sheet: **2** of **6**



Sample Description

4.00m - 4.20m

Structureless CHALK composed of sandy gravelly SILT. Clasts are white with occasional black specks weak low density. Occasional orange brown staining. Matrix is cream with orange brown staining. Occasional rinded flint gravel.

4.20m - 4.45m

Weak low density cream and white with frequent black and brown specks and occasional orange brown staining CHALK. Occasional brown clay.

Logged By: APetty

Undisturbed Type: U-100 Blows: 20 Recovery: 100%

Sampled Date: 22/01/2010

Sampled By: DSmart

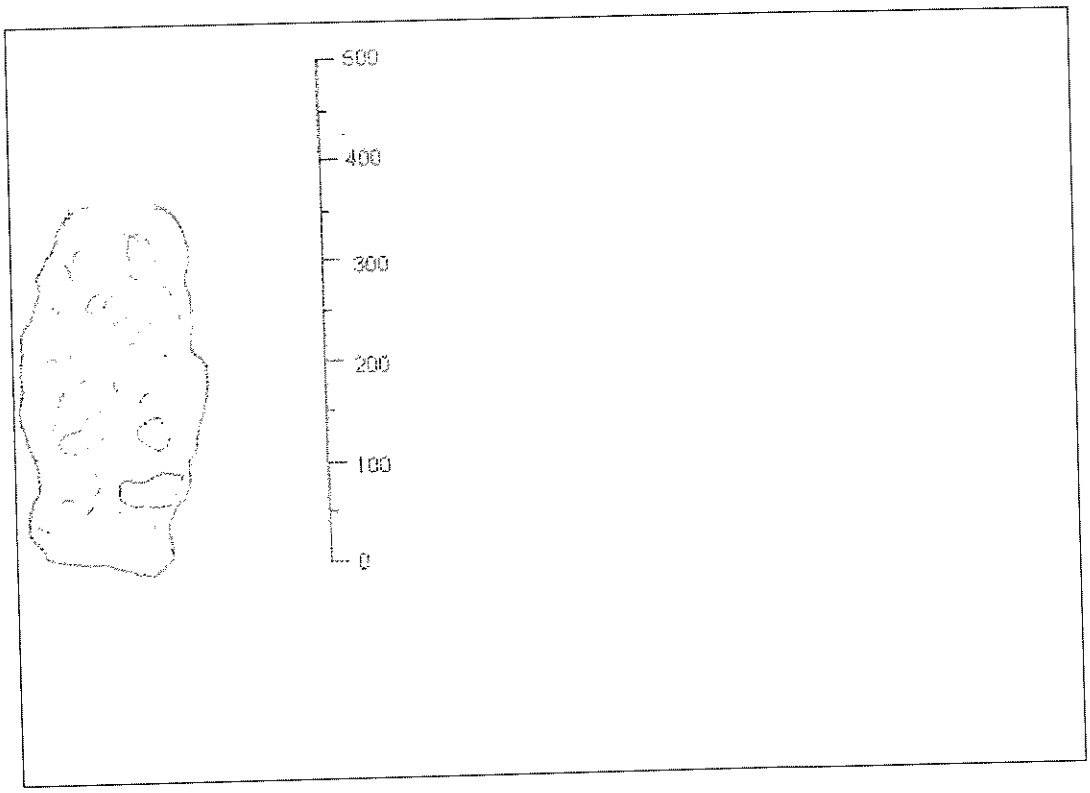
Sample Preparation: Sample waxed at both ends

GINT_LIBRARY_V8_03.GLB\G - SAMPLE DESCRIPTION REPORT V1 | 723995_GRAVESEND_TOWN_PIER.GPJ - v8_03 | 13/04/10 - 11:34 | AP.

STRUCTURAL SOILS

SAMPLE REPORT

Contract:	Client:	Exploratory Position:
Gravesend Town Pier	Gravesham Borough Council	BH1
Contract Ref: 723995	Sample Details: Depth (m): 6.5 - Ref: 12 - Type: U	Sheet: 3 of 6



Sample Description

6.50m - 6.86m

Weak low density cream and white with frequent black and brown specks and occasional orange brown staining CHALK. Occasional brown clay. Occasional rinded flint gravel.

Logged By: APetty

Undisturbed Type: U-100 Blows: 27 Recovery: 80%

Sampled By: DSmart

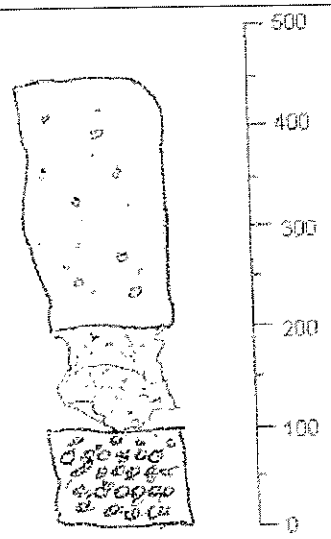
Sample Preparation: Sample waxed at both ends

GINT_LIBRARY_V8_03.GLB/G - SAMPLE DESCRIPTION REPORT V1 | 723995_GRAVESEND_TOWN_PIER.GPJ - v8_03 | 13/04/10 - 11:34 | AP

STRUCTURAL SOILS

SAMPLE REPORT

Contract:	Client:	Exploratory Position:
Gravesend Town Pier	**Gravesham Borough Council**	**BH2**
Contract Ref: **723995**	Sample Details: Depth (m): **2** - Ref: **5** - Type: **U**	Sheet: **4** of **6**



Sample Description

2.00m - 2.25m

Firm brown slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse chalk and flint.

2.25m - 2.35m

Brown slightly gravelly fine to coarse SAND. Gravel is subangular to subrounded fine to coarse chalk and occasional flint.

2.35m - 2.45m

Firm light brown sandy gravelly CLAY. Gravel is subangular to subrounded fine to coarse chalk and occasional flint.

Logged By: APetty

Undisturbed Type: U-100 Blows: 22 Recovery: 100%

Sampled By: DSmart

Sample Preparation: Waxed at both ends.

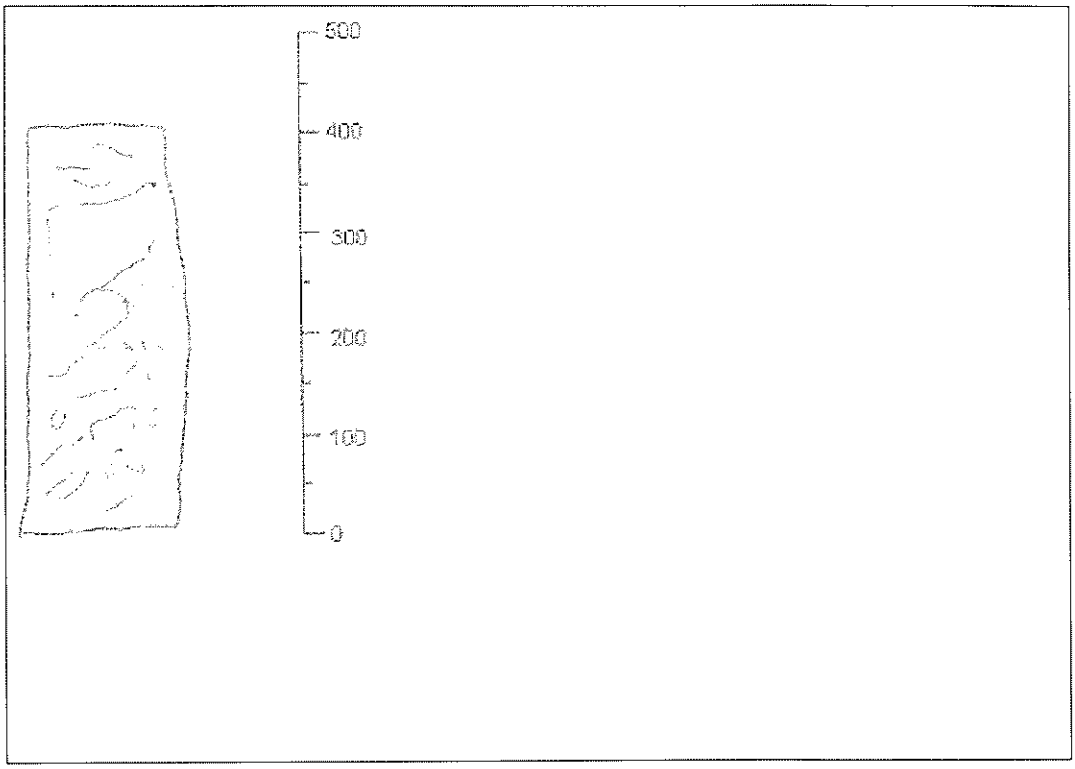
GINT_LIBRARY_V8_03.GLBIG - SAMPLE DESCRIPTION REPORT V1 | 723995_GRAVESEND_TOWN_PIER.GPJ - v8_03 | 13/04/10 - 11:34 | AP.

STRUCTURAL SOILS

SAMPLE REPORT

Contract:	Client:	Exploratory Position:
Gravesend Town Pier	**Gravesham Borough Council**	**BH2**

Contract Ref:	Sample Details:	Sheet:
723995	Depth (m): **9.5** - Ref: **17** - Type: **U**	**5** of **6**



Sample Description

9.50m - 9.90m

Weak low density white mottled cream with occasional black specks and orange brown staining CHALK. Rare rinded flint gravel.

...at 9.68m depth red brown staining.

Logged By: APetty

Undisturbed Type: U-100 Blows: 30 Recovery: 88%

Sampled By: DSmart

Sample Preparation: Waxed at both ends.

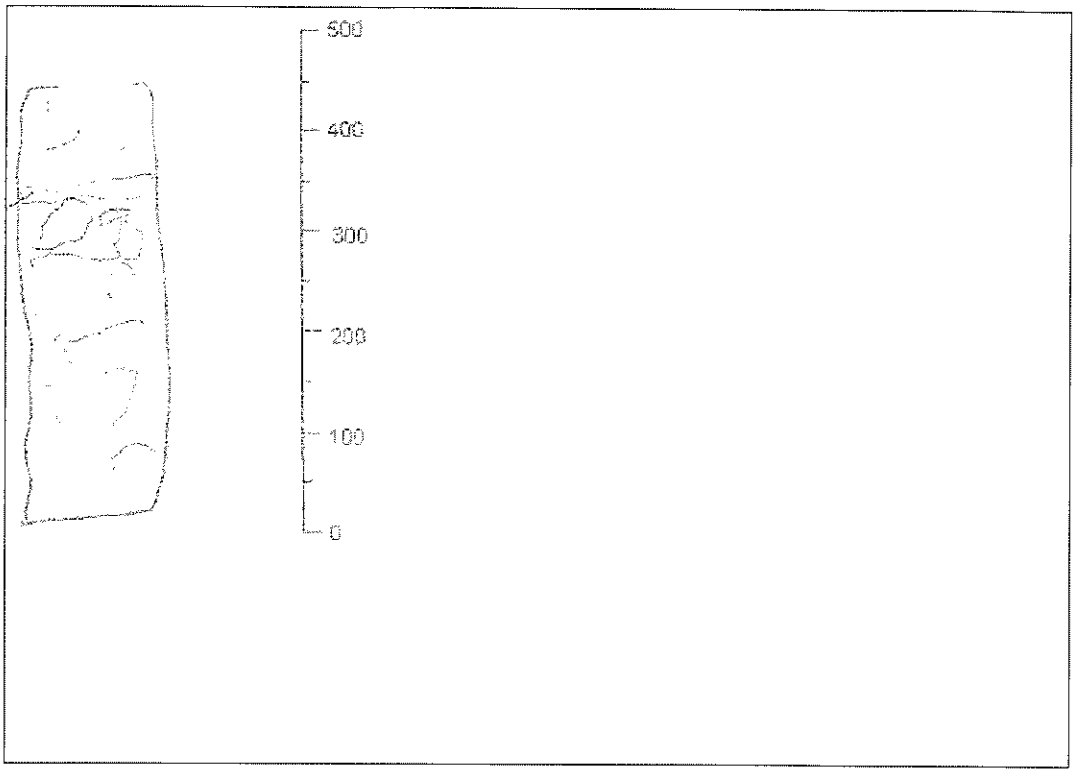
GINT_LIBRARY_V8_03.GLB\G - SAMPLE DESCRIPTION REPORT V1 | 723995_GRAVESEND_TOWN_PIER.GPJ - v8_03 | 13/04/10 - 11:34 | AP.

STRUCTURAL SOILS

SAMPLE REPORT

Contract:	Client:	Exploratory Position:
Gravesend Town Pier	**Gravesham Borough Council**	**BH2**

Contract Ref:	Sample Details:	Sheet:
723995	Depth (m): **12.5** - Ref: **21** - Type: **U**	**6** of **6**



Sample Description

12.50m - 12.95m

Weak low to medium density white with occasional black specks and orange brown staining CHALK. Rare rinded flint gravel.

...at 12.60m depth band of distinct orange brown staining approximately 50mm wide.

Logged By: APetty

Undisturbed Type: U-100 Blows: 37 Recovery: 100%

Sampled By: DSmart

Sample Preparation: Waxed at both ends.

GINT_LIBRARY_V8_03.GLB/G - SAMPLE DESCRIPTION REPORT V1 | 723995_GRAVESEND_TOWN_PIER.GPJ - v8_03 | 13/04/10 - 11:34 | AP

APPENDIX C

(i) Geotechnical Test Results

TESTING VERIFICATION CERTIFICATE

UKAS TESTING
1774

The test results included in this report are certified as:-

ISSUE STATUS: **FINAL**

CHECKING STATUS: **CHECKED**

In accordance with Structural Soils Ltd Laboratory Quality Assurance Manual, Issue 6, January 2010 all results sheets and summaries of results issued by the laboratory are checked by an approved signatory. This check will also involve checking of at least 10% of calculations for each test type to ensure that data has been correctly entered into the computer and calculated. The integrity of the test data and results are ensured by control of the computer system employed by the laboratory as part of the Software Verification Program as detailed in the Laboratory Quality Assurance Manual.

This testing verification certificate covers all testing compiled on or before the following datetime: **15/03/2010 13:22:15**.

Testing reported after this date is not covered by this Verification Certificate.

Approved Signatory
David Trowbridge (Laboratory Manager)

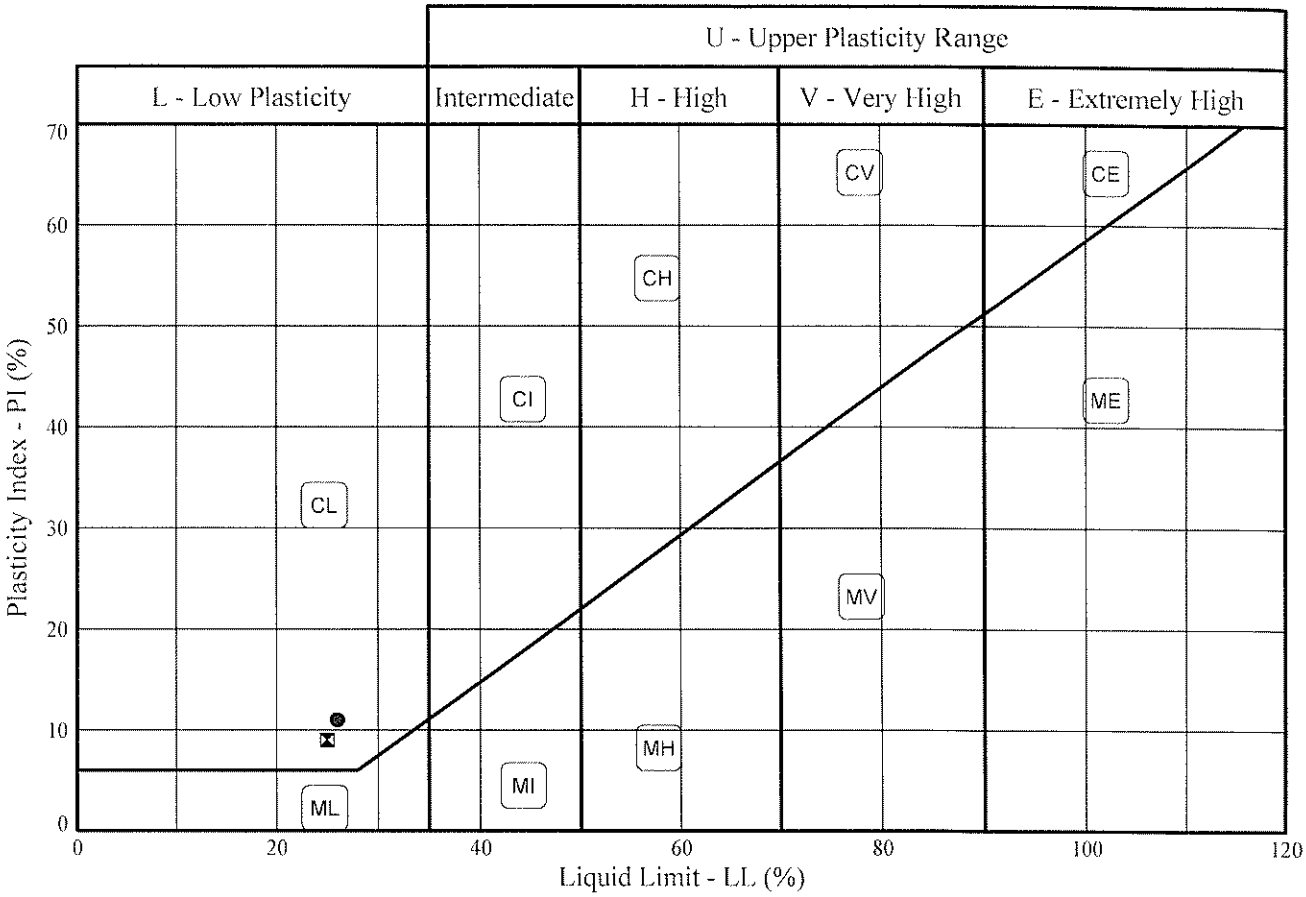
STRUCTURAL SOILS 1a Princess Street Bedminster Bristol BS3 4AG	Contract: **Gravesend Town Pier**	Job No: **723995**

AGS

GINT_LIBRARY_V8_03 GLB\L - LAB VERIFICATION REPORT | 723995_GRAVESEND_TOWN_PIER.GPJ - v8_03 | 15/03/10 - 13.22 | DT

PLASTICITY CHART - PI Vs LL

In accordance with clause 42.3 of BS5930:1981
Testing in accordance with BS1377-2:1990



Sample Identification				BS Test Method #	Preparation Method +	MC %	LL %	PL %	PI %	<425um %
	Exploratory Position ID	Sample	Depth (m)							
●	BH2	4B	1.00	3.2/4.3/5.3/5.4	4.2.4	22	26	15	11	78
⊠	BH2	5U	2.00	3.2/4.3/5.3/5.4	4.2.4	19	25	16	9	89

Tested in accordance with the following clauses of BS1377-2:1990.

3.2 - Moisture Content
4.3 - Cone Penetrometer Method
4.4 - One Point Cone Penetrometer Method
4.6 - One Point Casagrande Method
5.3 - Plastic Limit Method
5.4 - Plasticity Index

+ Tested in accordance with the following clauses of BS1377-2:1990.

4.2.3 - Natural State
4.2.4 - Wet Sieved

Key: * = Non standard test, NP = Non plastic.

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By	Date
MATT STOKES	12/03/10

Contract	Job No
Gravesend Town Pier	**723995**

AGS

GINT_LIBRARY_V8_03 GLBIL - ALINE STANDARD - EC7 | 723995_GRAVESEND_TOWN_PIER.GPJ - v8_03 | 12/03/10 - 14:56 | MS

SUMMARY OF SOIL CLASSIFICATION TESTS

In accordance with clauses 3.2,4.3,4.4,5.3,5.4,7.2,8.2,8.3 of BS1377:Part 2:1990

Exploratory Position ID	Sample No	Sample Type	Depth m	Moisture Content %	Bulk Density Mg/m^3	Dry Density Mg/m^3	Particle Density Mg/m^3	Liquid Limit %	Plastic Limit %	Plasticity Index %	% <425um	Description of Sample
BH2	4	B	1.00	22				26	15	11	78	Light yellowish brown mottled grey slightly gravelly sandy CLAY
BH2	5	U	2.00	19				25	16	9	89	Light brown slightly gravelly sandy CLAY

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By	Date	Contract Ref:
MATT STOKES	12.03.10	723995

Contract: **Gravesend Town Pier**

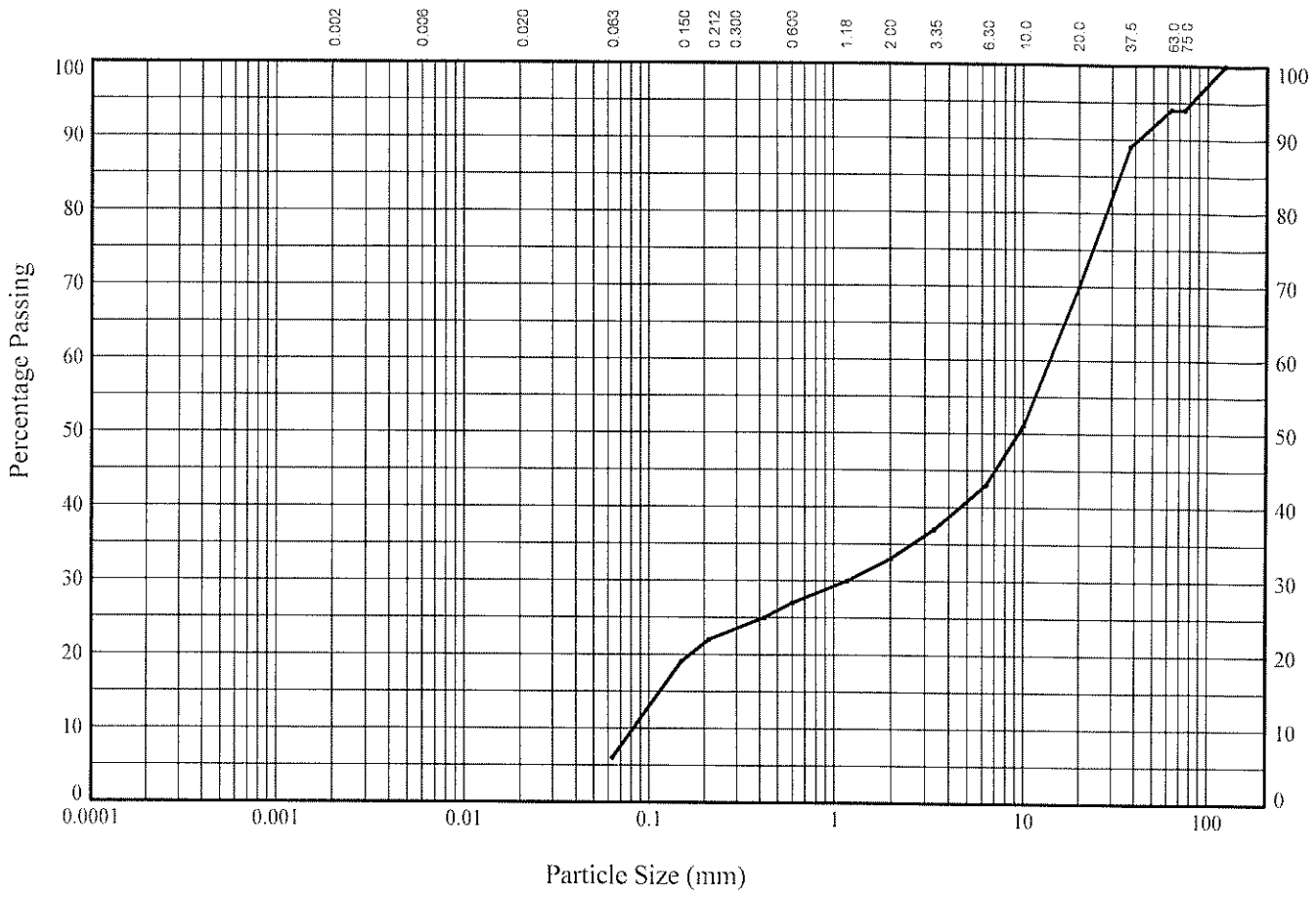
AGS

PARTICLE SIZE DISTRIBUTION TEST

In accordance with clauses 9.2,9.5 of BS1377:Part 2:1990

NON STANDARD TEST

Borehole : **BH2** Sample Ref: **1** Sample Type: **B** Depth (m): **0.50**



CLAY	fine	medium	coarse	fine	medium	coarse	fine	medium	coarse	COBBLES
	SILT			SAND			GRAVEL			

BS Test Sieve (mm)	Percentage Passing
125.0	100
75.0	94
63.0	94
37.5	89
20.0	70
10.0	51
6.30	43
5.00	
3.35	37
2.00	33
1.18	30
0.600	27
0.425	25
0.300	
0.212	22
0.150	19
0.063	6

Particle Diameter	Percentage Passing

Soil Fraction	Sieve Percentage
COBBLES	**6**
GRAVEL	**61**
SAND	**27**
SILT/CLAY	**6**

Soil Description:

Brown mottled grey silty/clayey very sandy GRAVEL with low cobble content

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By		Date
A. D. Frost	ALAN FROST	12/03/10

Contract	Job No
Gravesend Town Pier	**723995**

AGS

GINT_LIBRARY_V8_03.GLB/L - PSD - EC7 | 723995_GRAVESEND_TOWN_PIER.GPJ - v8_03 | 12/03/10 - 09:09 | AF

SUMMARY OF CHALK TESTS

In accordance with clause 3.3 of BS1377:Part 2:1990, clause 6 of BS1377:Part 4:1990 and ISRM Suggested Methods:1981

Exploratory Position ID	Sample No	Sample Type	Depth m	Moisture Content %	Bulk Density Mg/m³	Dry Density Mg/m³	Saturated Moisture Content %	Porosity %	CCV %	% > 10 mm	Description of Sample
BH1	5	B	2.60	29	1.92	1.49	30				White CHALK
BH1	7	B	3.00	30	1.90	1.46	31				White CHALK
BH1	11	B	5.00	32	1.88	1.42	34				White CHALK
BH1	15	B	8.00	28	1.93	1.52	29				White CHALK
BH1	19	B	11.00	30	1.91	1.47	31				White CHALK
BH1	21	B	12.50	27	1.93	1.52	29				White CHALK
BH1	23	B	14.00	29	1.91	1.49	30				White CHALK
BH1	25	B	15.50	31	1.88	1.44	32				White CHALK

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By		Date	Contract Ref:
	MATT STOKES	20.02.10	723995
Contract: Gravesend Town Pier			

SUMMARY OF CHALK TESTS

In accordance with clause 3.3 of BS1377:Part 2:1990, clause 6 of BS1377:Part 4:1990 and ISRM Suggested Methods:1981

Exploratory Position ID	Sample No	Sample Type	Depth m	Moisture Content %	Bulk Density Mg/m³	Dry Density Mg/m³	Saturated Moisture Content %	Porosity %	CCV %	% > 10 mm	Description of Sample
BH1	27	B	17.00	29	1.92	1.49	30				White CHALK
BH1	29	B	18.50	27	1.94	1.53	28				White CHALK
BH1	31	B	20.00	26	1.98	1.57	27				White CHALK
BH1	33	B	21.50	22	2.03	1.66	23				White CHALK
BH1	35	B	23.00	26	1.95	1.54	28				White CHALK
BH2	10	B	4.00	31	1.89	1.44	32				White CHALK
BH2	12	B	5.00	30	1.91	1.47	31				White CHALK
BH2	16	B	8.00	28	1.93	1.51	29				White CHALK

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By		Date	Contract Ref:
	MATT STOKES	20.02.10	723995
Contract:	Gravesend Town Pier		

AGS

SUMMARY OF CHALK TESTS

In accordance with clause 3.3 of BS1377:Part 2:1990, clause 6 of BS1377:Part 4:1990 and ISRM Suggested Methods:1981

Exploratory Position ID	Sample No	Sample Type	Depth m	Moisture Content %	Bulk Density Mg/m^3	Dry Density Mg/m^3	Saturated Moisture Content %	Porosity %	CCV %	% > 10 mm	Description of Sample
BH2	20	B	11.00	28	1.90	1.48	30				White CHALK
BH2	23	B	13.50	30	1.90	1.46	31				White CHALK
BH2	25	B	15.00	29	1.91	1.48	31				White CHALK
BH2	27	B	16.50	29	1.88	1.45	32				White CHALK
BH2	29	B	18.00	32	1.89	1.43	33				White CHALK
BH2	31	B	19.50	28	1.93	1.51	29				White CHALK
BH2	33	B	20.00	28	1.95	1.53	28				White CHALK
BH2	35	B	21.50	25	1.97	1.58	26				White CHALK

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By		Date	Contract Ref:
	MATT STOKES	20.02.10	723995
Contract: Gravesend Town Pier			

SUMMARY OF CHALK TESTS

In accordance with clause 3.3 of BS1377:Part 2:1990, clause 6 of BS1377:Part 4:1990 and ISRM Suggested Methods:1981

Exploratory Position ID	Sample No	Sample Type	Depth m	Moisture Content %	Bulk Density Mg/m^3	Dry Density Mg/m^3	Saturated Moisture Content %	Porosity %	CCV %	% > 10 mm	Description of Sample
BH2	37	B	23.00	26	1.96	1.56	27				White CHALK

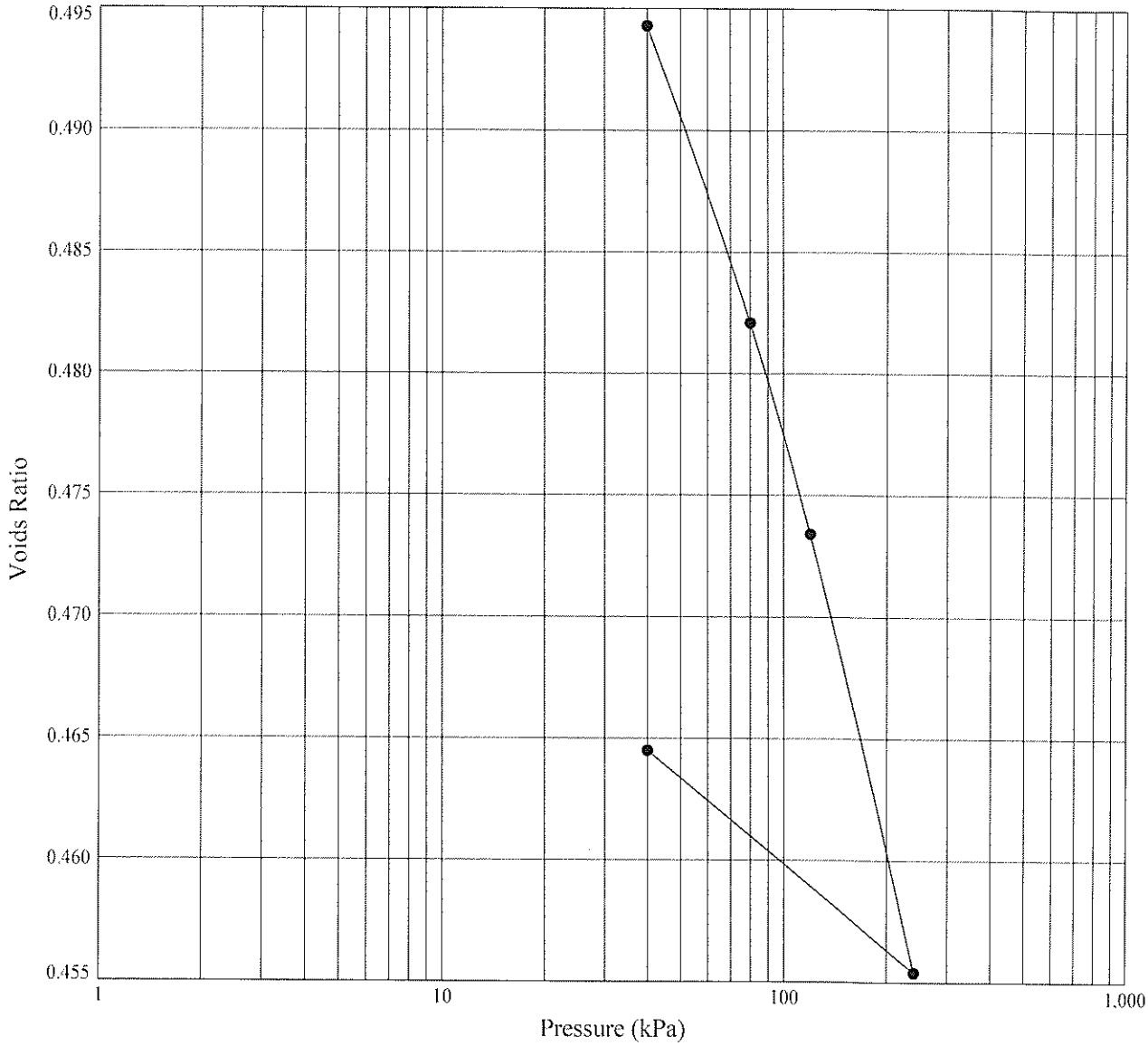
STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By		Date	Contract Ref:
	MATT STOKES	20.02.10	723995
Contract: Gravesend Town Pier			

ONE DIMENSIONAL CONSOLIDATION TEST

In accordance with BS1377:Part 5:1990

Borehole : **BH2** Sample Ref: **5** Sample Type: **U** Depth (m): **2.16**



Initial Specimen Condition			Final Specimen Condition		
Moisture Content (%)	:	**20**	Moisture Content (%)	:	**18**
Bulk Density (Mg/m^3)	:	**2.09**	Bulk Density (Mg/m^3)	:	**2.13**
Dry Density (Mg/m^3)	:	**1.74**	Dry Density (Mg/m^3)	:	**1.80**
Void Ratio	:	**0.5197**	Void Ratio	:	**0.4645**

Specimen Details			
Description	Height (mm)	:	**19.15**
Orangish brown sandy CLAY with occasional chalk gravel	Diameter (mm)	:	**75.03**
	Particle Density (Mg/m^3) (assumed)	:	**2.65**
	Swelling Pressure (kPa)	:	**NA**

Test Results		
Pressure Range (kPa)	Mv (m^2/MN)	Cv (m^2/yr)
0 - 40	**0.42**	**19**
40 - 80	**0.20**	**23**
80 - 120	**0.15**	**16**
120 - 240	**0.10**	**47**
240 - 40	**0.031**	**94**

STRUCTURAL SOILS
1a Princess Street
Bedminster
Bristol
BS3 4AG

Compiled By		Date
	MATT STOKES	11/3/10

Contract	Job No
Gravesend Town Pier	**723995**

AGS

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SUMMARY OF CHEMICAL ANALYSES

In accordance with clauses 9 of BS1377:Part 3:1990 where applicable.

Exploratory Position ID	Sample Ref	Sample Type	Depth (m)	Aqueous Extract Sulphate (g/l SO_4)	pH	% passing 2mm sieve	Description
BH2	4	B	1.00	0.38	8.9	90	Light yellowish brown mottled grey slightly gravelly sandy CLAY

NOTES:- All chemical tests were undertaken by an external laboratory.

STRUCTURAL SOILS 1a Princess Street Bedminster Bristol BS3 4AG	Compiled By		Date	Contract Ref:
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