



PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

CONTRACT: The Orchard House
Western Avenue
Emsworth
Hampshire
PO10 7LP

Order No: 325819

CLIENT: McCarthy & Stone Retirement
Lifestyles Ltd
Southern House
1 Embankment Way
Ringwood
Hampshire
BH24 1EU

FAO: Jackie Dunn

REPORT NO: 17-80683/BG/GIR

PREPARED BY:



B. Graham BSc (Hons) MSc FGS

APPROVED BY:



R. J. Holloway BSc (Hons) MSc FGS CEnv MCIWEM C.WEM

DATE: 29 March 2017

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ACS Testing Ltd. Unit 14 Blackhill Road West, Holton Heath Trading Park, Poole, Dorset, BH16 6LE.
Ph 01202 622858 – Fax 01202 625045 – Email geo@acstesting.co.uk – www.acstesting.co.uk

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EXECUTIVE SUMMARY

This executive summary contains an overview of the key findings and conclusions. No reliance should be placed on any part of the executive summary until the whole of the report has been read. Other sections of the report may contain information that puts into context the findings that are summarised in the executive summary.

Instructions / Brief	Conduct and document an intrusive investigation, in situ and laboratory testing to provide geotechnical data to assist with foundation design.
Proposal	Proposed to demolish the existing buildings and erect a three storey block of 22 retirement living apartments.
Previous Reports	Desk Study Report – 16-73762/GW/DSReport – 19/07/16
Exploration & Laboratory Testing	Four windowless boreholes drilled to 4.00m. Standard Penetration Testing at 1.00m intervals within each borehole. One in situ borehole infiltration test carried out within WS01. Four samples were tested for index properties comprising natural moisture content, liquid limit and plastic limit.
Findings (Geotechnical)	The intrusive ground investigation has revealed three different soil units underlying the site. Topsoil was identified in all boreholes to a maximum depth of 0.47m and comprised either brown slightly silty slightly gravelly SAND or brown clayey slightly sandy slightly gravelly SILT. River Terrace Deposits were revealed underlying the Topsoil in all boreholes proven to depths between 1.69m and >3.00m. The unit included light brown clay, silt, sand and gravel dominant units with varying secondary constituent proportions. The Lambeth Group was revealed beneath the River Terrace Deposits and typically comprised either a soft becoming firm silty slightly sandy CLAY or loose to medium dense very clayey very silty SAND. Groundwater was struck in all four boreholes with standing levels recorded between 2.79m and 1.00m with reduced levels between 7.70mAOD and 5.56mAOD. An infiltration rate of 3.48×10^{-7} m/s was recorded in WS01. Testing revealed the shallow soils to have a low to medium volume change potential.
Recommendations (Geotechnical)	It is considered that the underlying ground conditions are not suitable for traditional foundations and it is considered a different foundation solution is pursued. Due to shrinkable clay a suspended / suspendable ground floor slab is to be utilised within the proposed building. Heave precautions will also be required. Soakaway tests in accordance with BRE 365 to be carried out to determine if the site is suitable for soakaways, At the appropriate time deeper boreholes should be drilled to provide geotechnical parameters for pile design.

1.0 INTRODUCTION

1.1 Instructions

- 1.1.1 ACS Testing Ltd. (ACS) were instructed by Jackie Dunn of McCarthy & Stone Retirement Lifestyles Ltd on 14 February 2017 to carry out a preliminary intrusive investigation for a proposed development at The Orchard House, Western Avenue, Emsworth, Hampshire.
- 1.1.2 The term site within this report is defined as the area outlined in red on the Site Location Plan included as Appendix A.

1.2 Objectives

- 1.2.1 The objectives of this report are to document the intrusive investigation, in-situ testing and laboratory testing to provide geotechnical data to assist with foundation and drainage design.

1.3 Proposed Development

- 1.3.1 It is understood that a planning application has not been submitted to Havant Borough Council at the time of writing. However initial proposals comprise demolishing the existing structures onsite and erecting a three storey block of 22 retirement living apartments. Proposals include the creation of 25 parking spaces with site access from Western Avenue.

1.4 Previous Reports

- 1.4.1 ACS have been previously commissioned by the Client to carry out environmental works at the site. The following report has been produced by ACS:
 - ▶ Desk Study Report – 16-73762/GW/DSReport – 19/07/16

1.5 Report Limitations

- 1.5.1 This report has been prepared in accordance with the instructions received from McCarthy & Stone Retirement Lifestyles Ltd. and includes the findings of a preliminary ground investigation carried out by ACS.
- 1.5.2 The report is based upon the findings of an intrusive ground investigation which includes soil sampling, site testing, and laboratory testing for physical parameters. It should be appreciated that there may be areas of the site that have not been investigated where ground conditions may vary from those encountered. It should also be appreciated that the sub-surface features revealed may be more widespread than identified by the works carried out.
- 1.5.3 The information contained in this report is intended for the use of McCarthy & Stone Retirement Lifestyles Ltd. pursuant to the development described above. The recommendations contained herein may not be appropriate to other development proposals.

- 1.5.4 The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted, the number of locations where the ground was sampled and the number of samples tested. No liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the Client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by ACS Testing Ltd.

1.6 **References**

BS EN ISO 14688-1:2002. *Geotechnical Investigation and Testing. Identification and Classification of Soil*. BSI 2002.

BS 5930:2015. *Code of Practice for Site Investigations*. BSI 2015.

NHBC (2016). *NHBC Standards, Part 4 Foundations*. NHBC

2.0 ACS EXPLORATION & TESTING

- 2.0.1 A preliminary intrusive investigation was undertaken by ACS February 2017. Exploratory hole locations were selected by the Client to provide initial geotechnical information to aid with initial foundation and drainage design without causing too much damage to the garden areas of the site.
- 2.0.2 Utility plans supplied to ACS by the Client were assessed prior to the intrusive works. A Cable Avoidance Tool (CAT) was used to confirm the location of services prior to drilling at each exploratory hole location. Hand dug pits were excavated to 1.00m as a precaution against unidentified buried services before drilling commenced.
- 2.0.3 Exploratory Hole Location Plans showing the borehole locations are included as Appendix B.

2.1 Windowless Lined Boreholes

- 2.1.1 Four windowless boreholes were drilled using a Dando Terrier Mk2 on 21/02/17. All boreholes were drilled to a depth of 4.00m.
- 2.1.2 A windowless lined sampling drilling method was used to form the boreholes to provide complete soil recovery. Samples were collected from the boreholes and scheduled for laboratory testing to provide geotechnical information.
- 2.1.3 Windowless borehole logs are included as Appendix C.

2.2 Infiltration Testing

- 2.2.1 During the intrusive ground investigation one borehole infiltration test was carried out within WS01 to provide early indications on whether the underlying ground conditions would potentially be suitable for soakaways.
- 2.2.2 A copy of the infiltration test certificate is included within Appendix D.

2.3 Geotechnical Testing

- 2.3.1 Four samples were tested for natural moisture content, liquid limit and plastic limit. From these tests the plasticity indices can be calculated which can be used to determine the volume change potential of cohesive soils.
- 2.3.2 Standard Penetration Tests (SPT) were carried out in each borehole at regular vertical intervals. The results of the tests are shown on the borehole logs and Figures 2 and 3 in Section 4.0 of this report. As casing was left in WS01 for the infiltration test there was some collapse of the remaining borehole sides and therefore continuous SPT(C) were carried out.
- 2.3.3 Laboratory test result certificates are included within Appendix E.

3.0 GROUND CONDITIONS

3.1 General Strata Encountered

3.1.1 Summarised ground conditions are outlined below. Full details are shown on the borehole logs included as Appendix C.

Strata	Exploratory Holes Encountered in	Top of Stratum Depth (mbgl)	Thickness (m)
Topsoil	All	Ground Level	0.11-0.47
River Terrace Deposits	All	0.11 – 0.47	1.22 - >2.81
Lambeth Group	WS01-02 & 04	1.69 – 2.24*	Proven to 4.00

Table 1: Summary of strata revealed from the intrusive investigation. * Top of Lambeth group not revealed in WS03.

3.1.2 Topsoil

Topsoil was revealed in all four boreholes proven to depths between 0.11m and 0.47m. The Topsoil onsite was typically recorded as either a brown slightly silty slightly gravelly SAND or a brown clayey slightly sandy slightly gravelly SILT.

3.1.3 River Terrace Deposits

River Terrace Deposits were revealed to be underlying the Topsoil in every borehole location proven to depths between 1.69m and >3.00m.

It is considered that four different River Terrace Deposits units were revealed during the investigation. The shallowest unit was found to typically comprise a very soft light brown clayey slightly sandy gravelly SILT. Underlying this unit within WS02-04 was a soft to firm light brown silty slightly sandy gravelly to very gravelly CLAY. The basal unit revealed was proven to be either a medium dense to dense light brown clayey silty sandy GRAVEL or a medium dense light brown very silty very gravelly SAND.

3.1.4 Lambeth Group

Units of the Lambeth Group were encountered beneath the River Terrace Deposits within three of the four boreholes drilled.

Typically two different units were revealed with either a soft becoming firm silty slightly sandy CLAY or a loose to medium dense very clayey very silty SAND.

3.2 Groundwater

3.2.1 Groundwater was struck in all four boreholes. The strikes and standing levels are summarised in the table below.

Client Reference	Water Strike (mbgl)	Standing Level After 20 minutes	
		(mbgl)	(mAOD)
WS01	2.84	2.79	5.56
WS02	1.81	1.77	6.74
WS03	2.57	2.21	6.40
WS04	1.15	1.00	7.70

Table 2: Summary of groundwater strikes and standing levels

4.0 IN-SITU & GEOTECHNICAL TEST RESULTS

4.1 Borehole Infiltration

- 4.1.1 One in-situ borehole infiltration test was undertaken to provide an early indication on whether or not soakaways will be viable for future surface water run off drainage.
- 4.1.2 The in-situ infiltration test completed in WS01 revealed an infiltration rate of 3.48×10^{-7} m/s.

4.2 Index Properties - Moisture Content and Atterberg Limit testing (LL/PL/PI)

- 4.2.1 In accordance with NHBC 4.2, shrinkable soils are those containing more than 35% fine particles ($60\mu\text{m}$) and have a Modified Plasticity Index of 10% or greater. The Modified Plasticity Index is calculated as the Plasticity Index of the soil multiplied by the percentage of particles less than $425\mu\text{m}$.
- 4.2.2 The Modified Plasticity Index can be used to determine the volume change potential of the underlying soil. The Table below summarises the volume change potential of a soils based on the Modified Plasticity Index.

Modified Plasticity Index	Volume Change Potential
40% and greater	High
20% to less than 40%	Medium
10% to less than 20%	Low
Less than 10%	No-Shrinkable

Table 3: Modified Plasticity Index relating to Volume Change Potential.

- 4.2.3 The results of the laboratory testing undertaken on the cohesive units revealed are shown in Table 4 below.

Reference (Depth m)	Unit	Moisture Content %	Percentage passing 425µm sieve (%)	Plastic Limit (%)	Liquid Limit (%)	Plasticity Index (%)	Modified Plasticity Index (%)
WS01 2.24-2.59	Lambeth Group	19	100	15	41	26	26
WS02 0.11-1.00	Superficial Deposit	23	94	16	38	22	20.7
WS02 1.20-1.50		20	48	22	67	45	21.6
WS03 1.00-1.34		18	63	18	44	26	16.4
					Minimum		16.4
					Maximum		26

Table 4: Moisture content and Atterberg Limit testing results

4.2.4 Figure 1 below shows the results of the Atterberg Limit testing plotted on an A-Chart.

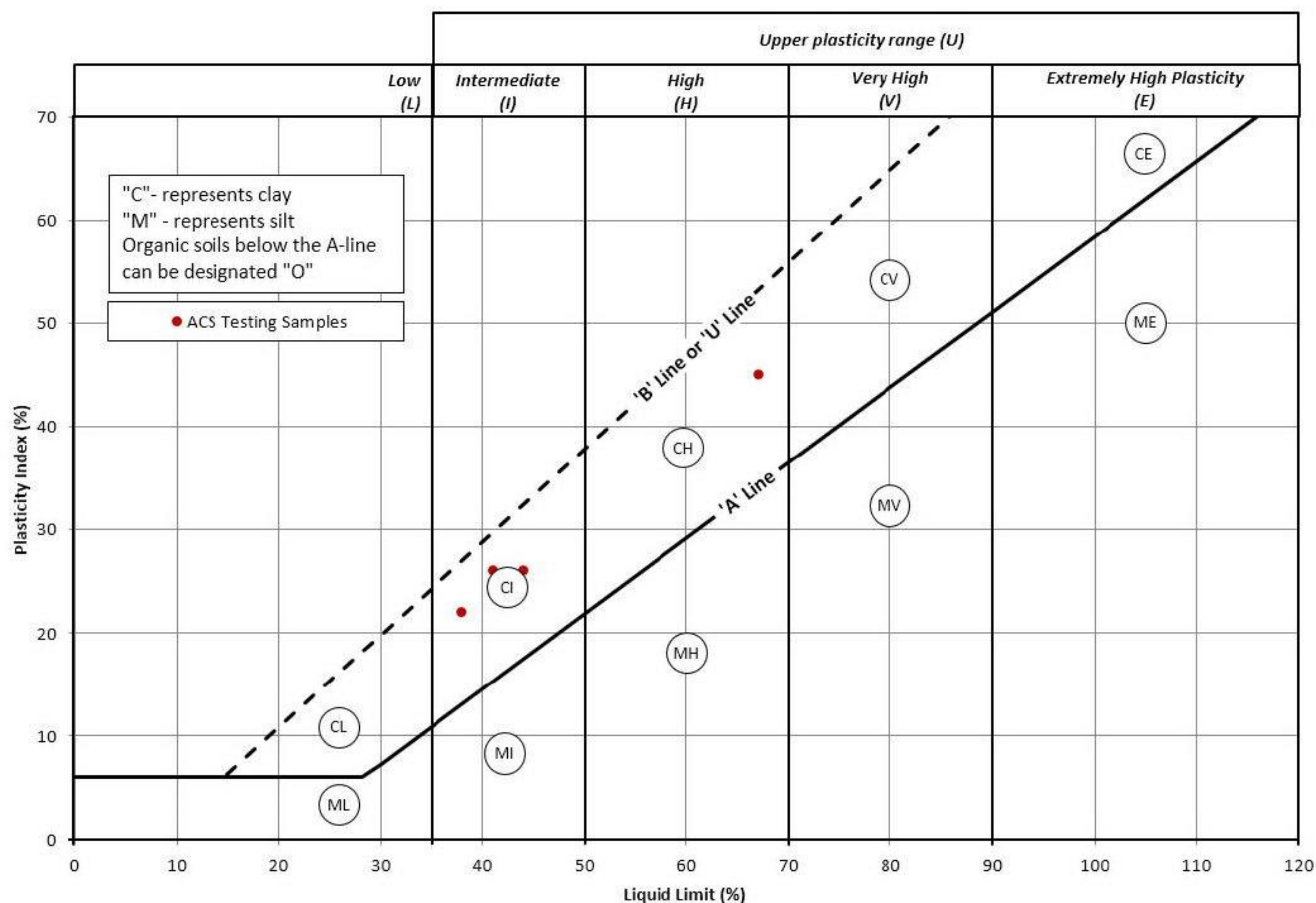


Figure 1. A-Chart plotting the results of Atterberg Limit testing

4.3 SPT[N] Results

4.3.1 Figures 2 & 3, below, show the results of the in-situ SPT testing for WS01-04. Testing was terminated at N = 50 therefore values of N = 50 may not represent the true N value which could be higher.

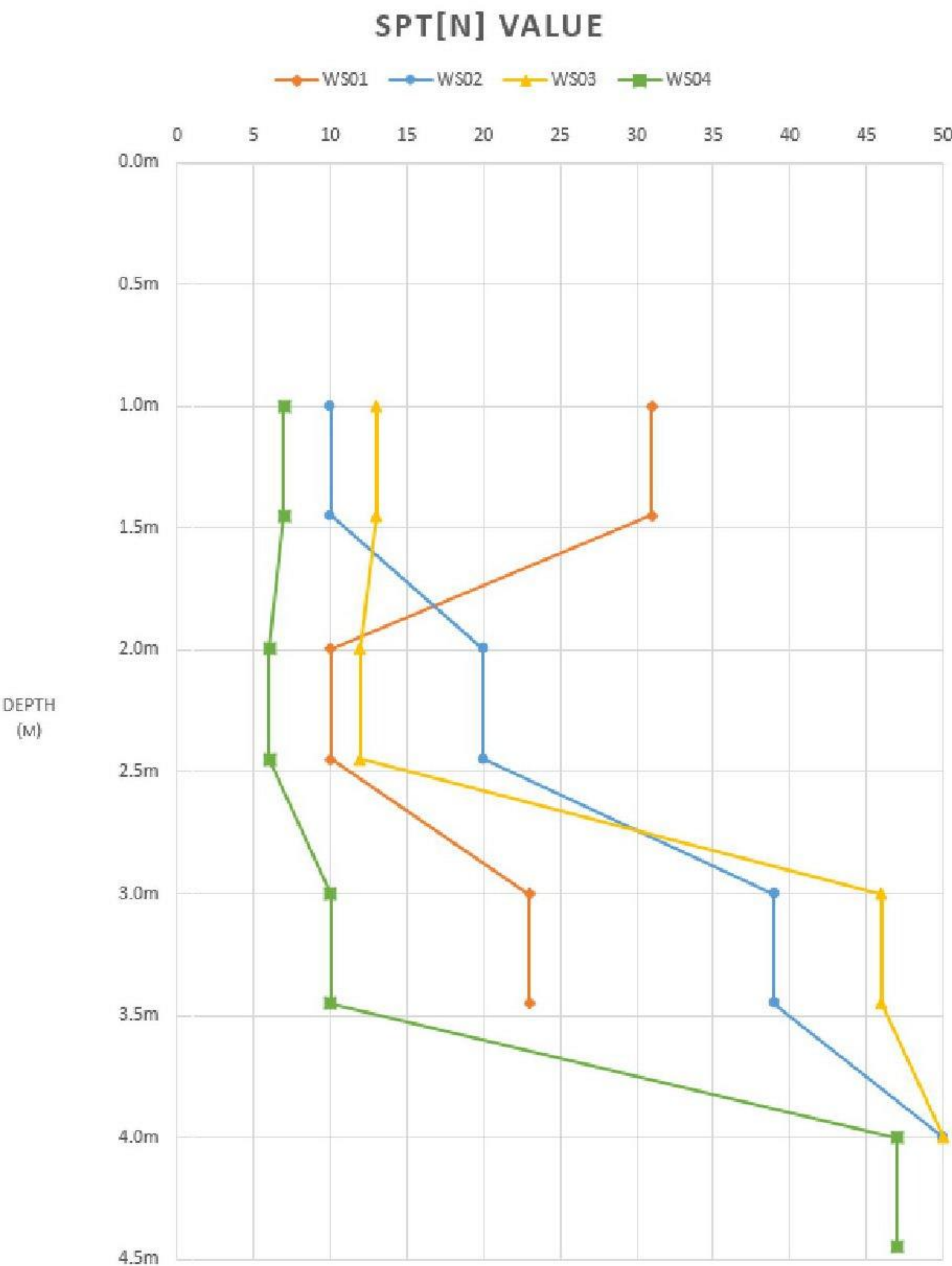


Figure 2: SPT[N] values against ground level.

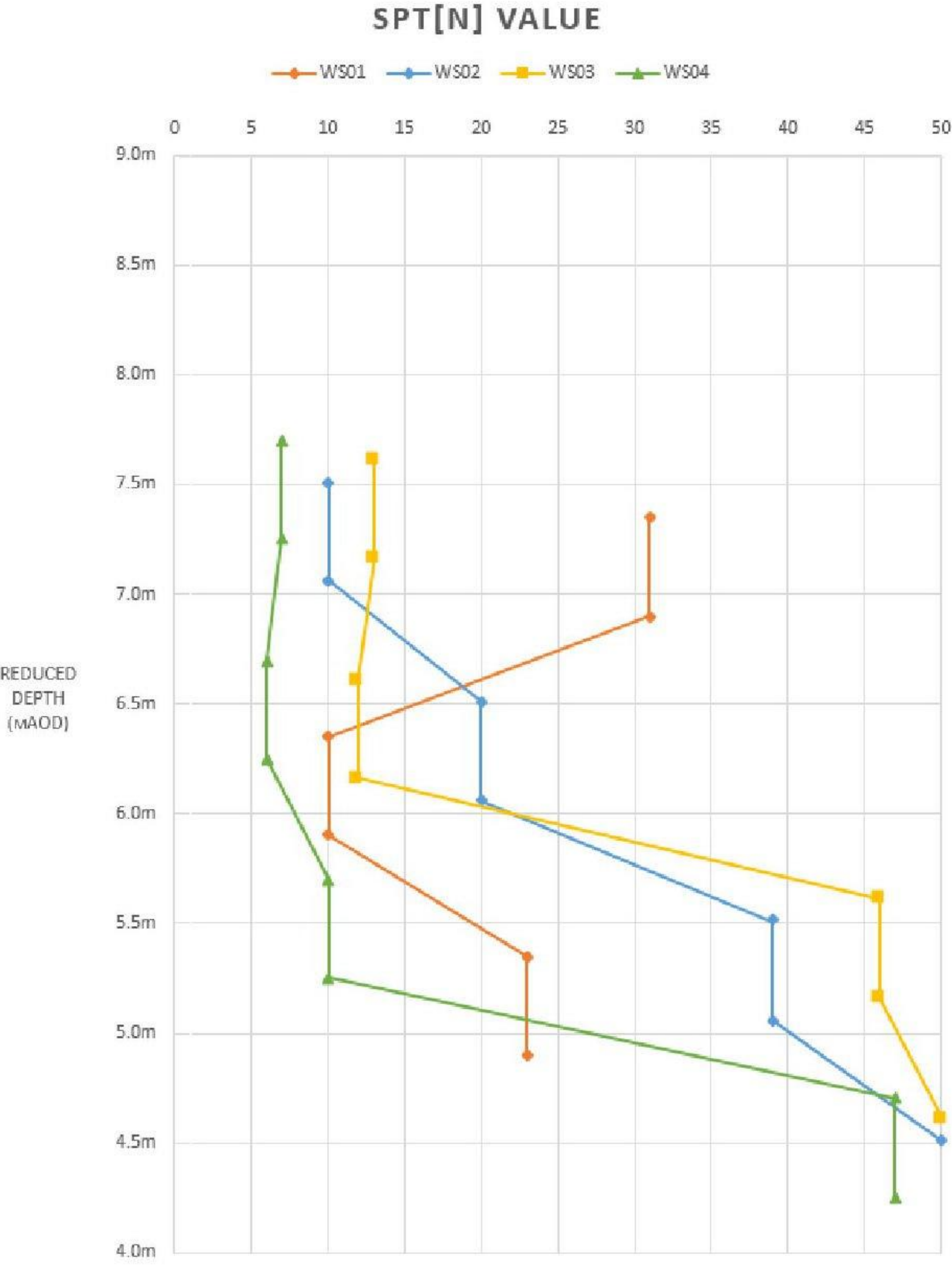


Figure 3: SPT[N] values against reduced level

5.0 GEOTECHNICAL ASSESSMENT

5.1 Ground Conditions

5.1.1 The ACS investigation has revealed three units during the intrusive works. The units found in the investigation are generally consistent with what is shown on online geological maps. A description of the units revealed and their parameters are discussed below.

5.1.2 Topsoil

Topsoil was proven in every borehole to a maximum depth of 0.47m and typically comprised either a brown slightly silty slightly gravelly SAND or a brown clayey slightly sandy slightly gravelly SILT.

5.1.3 River Terrace Deposits

River Terrace Deposits were underlying the Topsoil in every borehole location proven to depths between 1.69m and >3.00m. The unit revealed light brown clay, silt, sand and gravel dominant units with varying secondary constituent proportions.

SPT [N] values were recorded between 7 and 46 within the River Terrace Deposits with no clear correlation between the units and N values revealed. The N values recorded in WS01-03 within the River Terrace Deposits are typically suitable for the use of traditional foundations, however given the shallow groundwater and looser ground in WS04 a reduced bearing capacity would be applicable and this foundation solution may not be considered feasible.

Three samples from the River Terrace Deposits were tested for Atterberg Limits to enable the shrinkage potential of the unit. The Modified Plasticity Index for the samples tested revealed results between 16.4% and 21.6% indicating the River Terrace Deposits to have a low to medium volume change potential.

5.1.4 Lambeth Group

The River Terrace Deposits were revealed to be overlying the Lambeth Group within three of the four boreholes. The unit was shown to comprise either a soft becoming firm silty slightly sandy CLAY or a loose to medium dense very clayey very silty SAND.

SPT [N] values were recorded between 6 and 50 within the Lambeth Group. The SPT values below where visual samples were collected have been assumed to be part of the Lambeth Group. The N values within the Lambeth Group increased with depth in every borehole. Low N values at 2.00m (6) and 3.00m (10) indicate that the shallow soils may not be suitable for traditional foundations, however WS04 is not located under the proposed building and may be a localised area of softer / looser ground.

One sample from the Lambeth Group was tested for Atterberg Limits to determine the shrinkage potential of the unit. The Modified Plasticity Index for the sample was 26% indicating medium volume change potential.

5.2 Groundwater

- 5.2.1 Groundwater was struck in all four boreholes with resting levels between 2.79m and 1.00m with reduced levels between 7.70mAOD and 5.56mAOD. Therefore there exists the potential for groundwater to be present within shallow excavations / foundation excavations.

5.3 Drainage

- 5.3.1 WS01 revealed a low infiltration rate of 3.48×10^{-7} m/s indicating that soakaways may not be feasible for the proposed developments surface water runoff.

5.4 Volume Change Potential

- 5.4.1 The samples that have been tested to determine index properties including Atterberg Limits have shown the Modified Plasticity Index to exhibit a low to medium volume change potential, in accordance with "NHBC 4.2 Building Near Trees". For a robust approach a medium volume change potential has been adopted.
- 5.4.2 Shrinkable soils are subject to change in volumes as their moisture content is altered. Soil moisture contents vary seasonally and are influenced by a number of factors including the action of tree roots. The resulting shrinkage or swelling of the soil can cause subsidence or heave damage to foundations, the structures they support and services. It will be required that all floor slabs are suspended to allow for the ground to heave. Heave protection will also be required beneath and beside ground-beams, if a piled foundation solution is used.

6.0 CONSIDERATIONS & RECOMMENDATIONS

6.1 *Foundation Design Recommendations*

- 6.1.1 The selection and design of foundations and ground-floor slab construction is beyond the scope of current instructions and is the responsibility of the designers of the proposed building. The following recommendations, deriving from observations made during the investigation and testing are provided to assist the design process. It should be acknowledged that due to access restrictions only a preliminary investigation has been carried out at this time with not all of the boreholes being beneath the footprint of the proposed building.
- 6.1.2 Based on the marginal ground and shallow groundwater recorded at typical founding depths for traditional foundations; it is considered that the ground conditions are not suitable as a bearing stratum for traditional foundations for the proposed development. It should be acknowledged that demolition of the existing buildings and foundation removal will further disturb the upper layers.
- 6.1.3 It is therefore recommended that an alternative foundation solution is pursued. It is considered that this will likely comprise piling into competent strata to a greater depth than achieved in the boreholes drilled to date.

6.2 *Ground Floor Construction*

- 6.2.1 Due to the presence of shrinkable clay, it will be necessary for suspended / suspendable ground floor slabs to be utilised within the proposed buildings. Any organic material should be removed from beneath the proposed building.
- 6.2.2 Heave can take place in a shrinkable soil when it takes up moisture and swells after the felling or removal of trees and hedgerows. Heave precautions will need to be taken into consideration at the design stage.
- 6.2.3 Trees / shrubs should be planted in accordance with NHBC 4.2 or similar guidance due to the presence of shrinkable soils.

6.3 *Drainage*

- 6.3.1 The borehole infiltration test revealed a permeability of $3.48 \times 10^{-7} \text{m/s}$ indicating the shallow underlying ground conditions may not be suitable for surface water drainage. The shallow soils have been revealed to be variable with both cohesive and granular material. Furthermore shallow groundwater has been recorded across the site which may further negate the potential for soakaways.
- 6.3.2 It should however be noted that the current occupier indicates that the surface water currently drains to a soakaway beneath a statue in the rear garden and that no flooding occurs onsite.
- 6.3.3 It is recommended that infiltration tests are carried out in accordance with BRE 365 at an appropriate time to determine if soakaways will be feasible for the proposed development.

6.4 Further Investigation

- 6.4.1 At the appropriate time, further investigation comprising deeper boreholes should be conducted to a suitable depth to provide geotechnical parameters for pile design. It is recommended that this investigation should comprise at least three boreholes to a minimum depth of 5m greater than the expected pile length. At this stage it is considered that boreholes in the range of 20-25m deep will be required to provide suitable geotechnical parameters.

7.0 QUALITY STATEMENT

- 7.1 We confirm that in preparing this report we have exercised reasonable skill and care in order to produce accurate details.
- 7.2 We confirm that testing has been conducted in accordance with relevant Standards, as requested by the Client, with reference to the Organisation's Quality Manual Procedures.
- 7.3 The results and contents of this report are based upon in-situ analysis and/or the laboratory testing of specimens or sample material submitted to the laboratory.
- 7.4 Consequently, comments contained herein are derived from the determination of the results from the analysed material and that of any additional information, drawings, plans or similar such data as supplied by the Client.
- 7.5 ACS Testing warrants only the accuracy of the test result and information contracted to be supplied to the Client but will accept no liability in respect of the use to which the Client puts such information or the purpose for which such information was requested.
- 7.6 Unless specifically assigned and confirmed in writing within the terms of the Agreement/Written Order the Organisation asserts and retains all Copyright and other Intellectual Property rights, in and over the report and its contents.

APPENDIX A

SITE LOCATION PLAN – 16-73762/01





ACS TESTING LTD
UNIT 14 BLACKHILL ROAD WEST
HOLTON HEATH TRADING PARK
POOLE, DORSET
BH16 6LE
T: 01202 628647
E: geo@acstesting.co.uk

DO NOT SCALE

KEY:



DO NOT SCALE

REV	DESCRIPTION	BY	CHK	APP	DATE

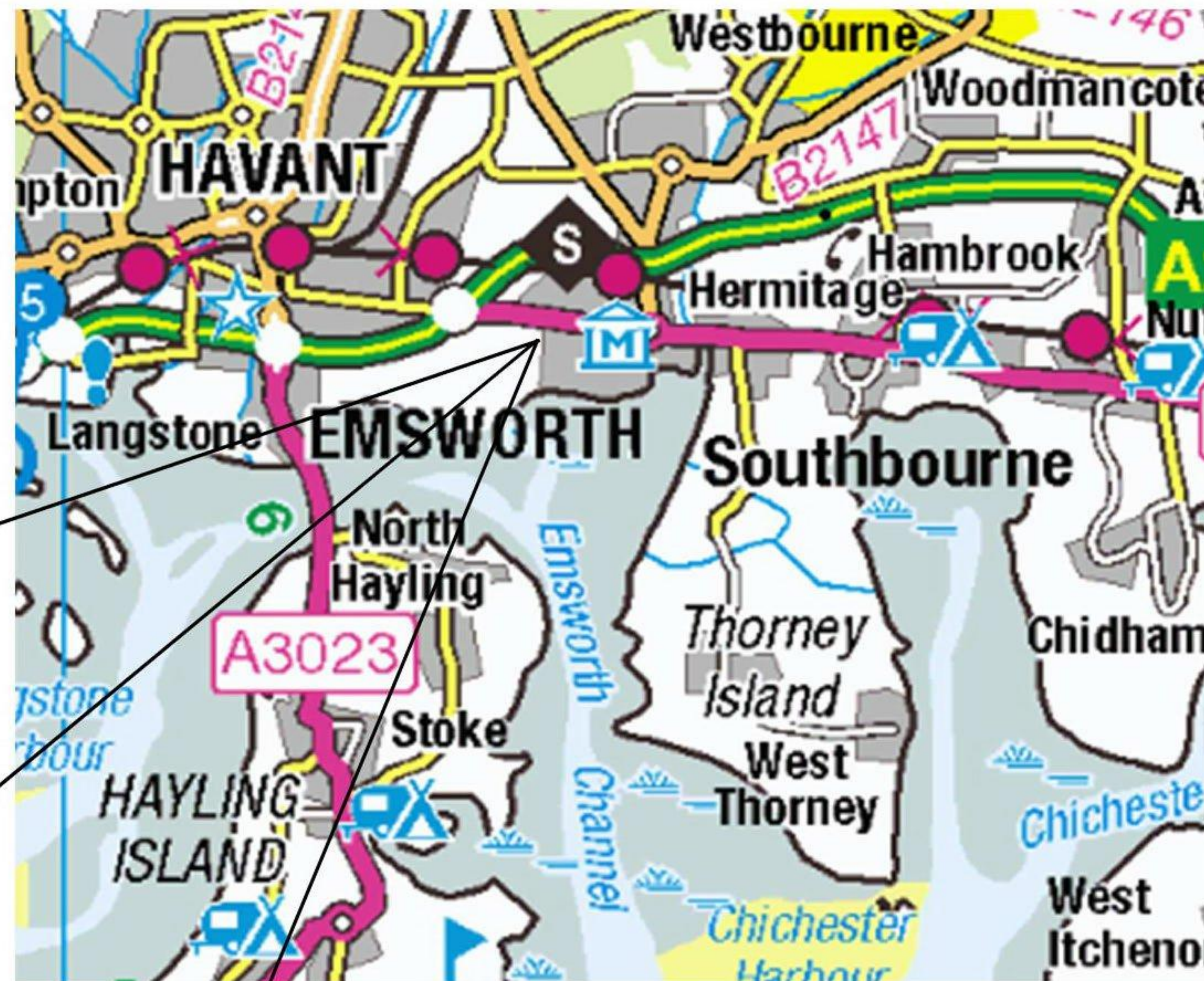
CLIENT:
MCCARTHY & STONE RETIREMENT
LIFESTYLES LTD.

SITE:
THE ORCHARD HOUSE, WESTERN
AVENUE, EMSWORTH

DRAWING TITLE:
SITE LOCATION PLAN

SCALE: @
JOB NO. 16-73762
DRAWING NO. 16-73762/01
DATE.
REVISION.

NOTES:



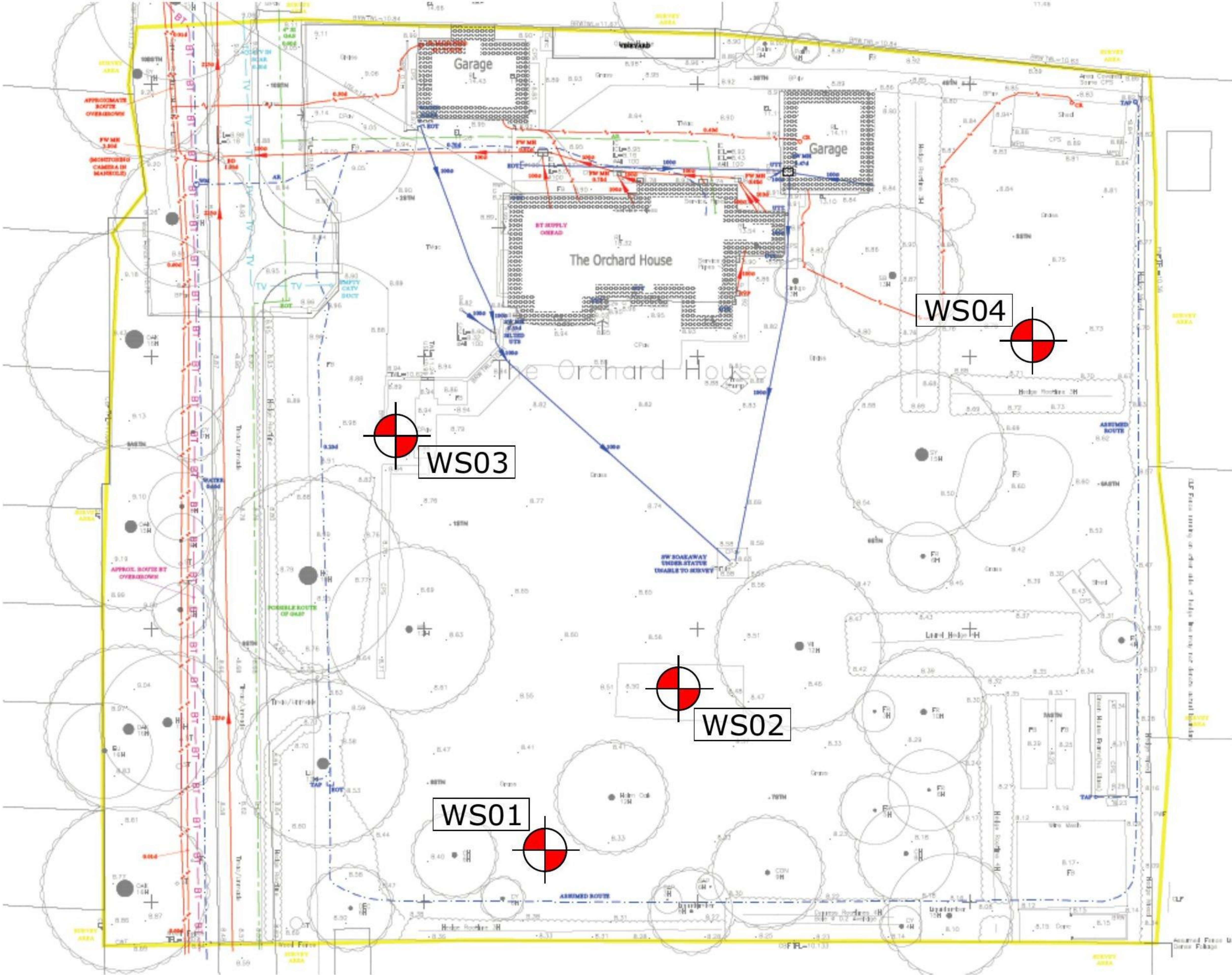
APPENDIX B

EXPLORATORY HOLE LOCATION PLAN

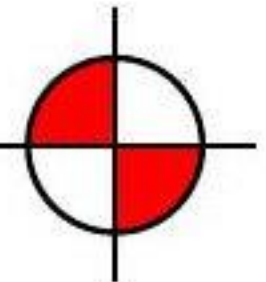
Current – 17-80683/02
Proposed – 17-80683/03



Notes:



Key:



Windowless Borehole



DO NOT SCALE

Drawing:
Exploratory Hole Location Plan - Current

Client:
McCarthy & Stone Retirement Lifestyles Ltd

Project:	Project No:
The Orchard House	17-80683
Western Avenue	Drawing No:
Emsworth	17-80683/02
	Revision:

Drawn By:	Date:
BG	22/03/2017

Checked By:	Date:
RJH	22/03/2017

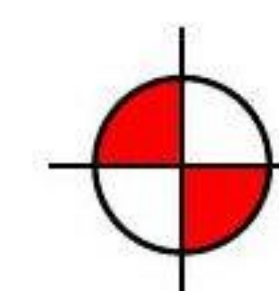


ACS Testing Ltd
Unit 14 Blackhill Road West
Holton Heath Trading Park
Poole, BH16 6LE
T: 01202 622858 | F: 01202 625045
E: geo@acstesting.co.uk | W: acstesting.co.uk
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Notes:

Key:



Windowless Borehole



DO NOT SCALE

Drawing:
Exploratory Hole Location Plan - Proposed

Client:
McCarthy & Stone Retirement Lifestyles Ltd

Project:	Project No:
The Orchard House	17-80683
Western Avenue	Drawing No:
Emsworth	17-80683/03
	Revision:

Drawn By:	Date:
BG	22/03/2017

Checked By:	Date:
RJH	22/03/2017



ACS Testing Ltd
Unit 14 Blackhill Road West
Holton Heath Trading Park
Poole, BH16 6LE
T: 01202 622858 | F: 01202 625045
E: geo@acstesting.co.uk | W: acstesting.co.uk
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APPENDIX C

BOREHOLE LOGS – WS01-04





ACS Testing Ltd
Tel: 01202 622858
Fax: 01202 625045
Email: testing@acstesting.co.uk
www.acstesting.co.uk

BOREHOLE LOG
WINDOWLESS SAMPLING

Borehole No.
WS01
Sheet 1 of 1

Client: McCarthy & Stone Retirement Lifestyles Ltd

Contract: The Orchard House

Location: The Orchard House, Emsworth, PO10 7LP

Lab. Ref: **17-80683**

Drilling Equipment:
Dando Terrier Tracked Dynamic Percussion
Rig MK2

Ground Level (mAOD): 8.35

Co-ords: DNS

Date(s): 21/02/2017

Hole Type
WLS

Scale
1:25

Logged By
LF

All units = (m)	Stratum Description	Depth (Level)	Thickness	Legend	Water Strikes	Backfill	Sample (Type) Depth	In Situ Testing			Drill Run
								Depth	Type	Results	
1	TOPSOIL. Brown slightly silty slightly gravelly SAND. Gravel comprises fine, medium and coarse; sub angular to sub rounded flint. Numerous rootlets present.										Hand dug pit
	Very soft light brown slightly clayey sandy slightly gravelly SILT. Gravel comprises fine to medium; sub angular to sub rounded flint. Occasional rootlets noted.	0.25 (8.10)	(0.50)								
	Very soft light brown clayey slightly sandy gravelly SILT. Gravel comprises fine, medium and coarse; sub angular to sub rounded flint. Occasional rootlets and rare angular flint cobbles noted.	0.75 (7.60)									
	Dense becoming medium dense light brown very clayey very silty slightly sandy GRAVEL. Gravel comprises fine, medium and coarse; angular to sub rounded flint. Rare angular flint cobbles present.	1.00 (7.35)	(1.24)				1.00	SPT(S)	N=31 (2,6/9,8,7,7)		
2											(87mm dia) Rec=80%
	Soft becoming firm brown silty slightly sandy CLAY.	2.24 (6.11)	(0.35)								(87mm dia) Rec=90%
	Grey mottled brown clayey very sandy SILT. Sand lenses observed throughout and parting noted at 3.55-3.69.	2.59 (5.76)									
3											(87mm dia) Rec=80%
	Soft becoming firm brown silty slightly sandy CLAY.	3.69 (4.66)	(0.31)								
4	End of Borehole at 4.000m	4.00 (4.35)									
5											

Remarks:
SPT not taken at base as infiltration test was undertaken in borehole. Ground level inferred from topographical survey.

Groundwater Observations:

Date	Strike	Casing	Time Elapsed	Standing	Remarks
21-02-2017	2.84m	3.00m	20mins	2.79m	

Technical Notes (where applicable):
Consistency of fine grained soil assessed by hand worked tests in accordance with BS5930. Densities of granular material based on in situ SPT N-values. Chalk descriptions in accordance with CIRIA C574



ACS Testing Ltd
Tel: 01202 622858
Fax: 01202 625045
Email: testing@acstesting.co.uk
www.acstesting.co.uk

BOREHOLE LOG

WINDOWLESS SAMPLING

Borehole No.

WS02

Sheet 1 of 1

Client: McCarthy & Stone Retirement Lifestyles Ltd

Contract: The Orchard House

Location: The Orchard House, Emsworth, PO10 7LP

Lab. Ref: 17-80683

Drilling Equipment: Dando Terrier Tracked Dynamic Percussion Rig MK2

Ground Level (mAOD): 8.51

Co-ords: DNS

Date(s): 21/02/2017

Hole Type: WLS

Scale: 1:25

Logged By: LF

All units = (m)	Stratum Description	Depth (Level)	Thickness	Legend	Water Strikes	Backfill	Sample (Type) Depth	In Situ Testing			Drill Run
								Depth	Type	Results	
1	TOPSOIL. Very soft brown slightly sandy slightly gravelly SILT. Gravel comprises fine to medium; sub angular to sub rounded flint. Numerous rootlets present.	0.11 (8.40)	(0.89)					1.00	SPT(S)	N=10 (1,2/2,2,3,3)	Hand dug pit
	Very soft light brown clayey slightly sandy slightly gravelly SILT. Gravel comprises fine to medium; sub angular to sub rounded flint.	1.00 (7.51)									(102mm dia) Rec=85%
		Soft to firm light brown silty slightly sandy gravelly to very gravelly CLAY. Gravel comprises fine, medium and coarse; angular to sub rounded flint.	1.73 (6.78)								
2	Medium dense light brown clayey very silty SAND.	2.00 (6.51)					2.00	SPT(C)	N=20 (4,3/4,3,6,7)		
	End of Borehole at 2.000m										
3								3.00	SPT(C)	N=39 (7,9/10,10,10,9)	
4								4.00	SPT(C)	N=50 (25 for 115mm/50 for 215mm)	
5											

Remarks:

Unable to drill borehole beyond 2.00m due to collapsing sides. SPT extended down to 4.00m
 Ground level inferred from topographical survey.

Groundwater Observations:

Date	Strike	Casing	Time Elapsed	Standing	Remarks
21-02-2017	1.81m	0.00m	20mins	1.77m	

Technical Notes (where applicable):

Consistency of fine grained soil assessed by hand worked tests in accordance with BS5930. Densities of granular material based on in situ SPT N-values. Chalk descriptions in accordance with CIRIA C574



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BOREHOLE LOG

WINDOWLESS SAMPLING

Borehole No.

WS03

Sheet 1 of 1

Client: McCarthy & Stone Retirement Lifestyles Ltd

Contract: The Orchard House

Location: The Orchard House, Emsworth, PO10 7LP

Lab. Ref: 17-80683

Drilling Equipment: Dando Terrier Tracked Dynamic Percussion Rig MK2

Ground Level (mAOD): 8.61

Co-ords: DNS

Date(s): 21/02/2017

Hole Type: WLS

Scale: 1:25

Logged By: LF

All units = (m)	Stratum Description	Depth (Level)	Thickness	Legend	Water Strikes	Backfill	Sample (Type) Depth	In Situ Testing			Drill Run
								Depth	Type	Results	
1	TOPSOIL. Very soft slightly clayey slightly sandy slightly gravelly SILT. Gravel comprises fine, medium and coarse; angular to sub rounded flint. Numerous rootlets present. Very soft light brown clayey slightly sandy slightly gravelly SILT. Gravel comprises fine, medium and coarse; sub angular to sub rounded flint.	0.19 (8.42)	(0.81)								Hand dug pit
	Soft to firm light brown silty slightly sandy gravelly to very gravelly CLAY. Gravel comprises fine, medium and coarse; angular to sub rounded flint. Layers of clayey silt between 1.00-1.09 and 1.34-1.55.	1.00 (7.61)	(1.00)					1.00	SPT(C)	N=13 (3,3/2,4,3,4)	(102mm dia) Rec=100%
	Medium dense light brown very silty very gravelly SAND. Gravel comprises fine, medium and coarse; angular to sub rounded flint.	2.00 (6.61)	(0.49)					2.00	SPT(C)	N=12 (3,2/1,2,4,5)	(87mm dia) Rec=80%
	Light brown very silty slightly gravelly SAND. Gravel comprises fine sub rounded flint.	2.49 (6.12)									
	Light brown very silty very gravelly SAND. Gravel comprises fine, medium and coarse; angular to sub rounded flint.	2.75 (5.86)									
3	End of Borehole at 3.00m	3.00 (5.61)					3.00	SPT(C)	N=46 (9,10/10,13,11,12)		
4							4.00	SPT(C)	N=50 (25 for 135mm/50 for 205mm)		
5											

Remarks:

Unable to drill borehole beyond 3.00m due to collapsing sides. SPT extended down to 4.00m.
 Ground level inferred from topographical survey.

Groundwater Observations:

Date	Strike	Casing	Time Elapsed	Standing	Remarks
21-02-2017	2.57m	0.00m	20mins	2.21m	

Technical Notes (where applicable):

Consistency of fine grained soil assessed by hand worked tests in accordance with BS5930. Densities of granular material based on in situ SPT N-values. Chalk descriptions in accordance with CIRIA C574



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BOREHOLE LOG

WINDOWLESS SAMPLING

Borehole No.

WS04

Sheet 1 of 1

Client: McCarthy & Stone Retirement Lifestyles Ltd

Contract: The Orchard House

Location: The Orchard House, Emsworth, PO10 7LP

Lab. Ref: 17-80683

Drilling Equipment: Dando Terrier Tracked Dynamic Percussion Rig MK2

Ground Level (mAOD): 8.70

Co-ords: DNS

Date(s): 21/02/2017

Hole Type

WLS

Scale

1:25

Logged By

LF

All units = (m)	Stratum Description	Depth (Level)	Thickness	Legend	Water Strikes	Backfill	Sample (Type) Depth	In Situ Testing			Drill Run
								Depth	Type	Results	
	TOPSOIL. Very soft brown clayey slightly sandy slightly gravelly SILT. Gravel comprises fine, medium and coarse; sub angular to sub rounded flint. Occasional rootlets noted.		(0.47)								
	Very soft light brown clayey slightly sandy slightly gravelly SILT. Gravel comprises fine to medium; sub angular to sub rounded flint.	0.47 (8.23)	(0.53)								Hand dug pit
1	Soft to firm light brown silty slightly sandy gravelly to very gravelly CLAY. Gravel comprises fine, medium and coarse; angular to sub rounded flint.	1.00 (7.70)	(0.44)					1.00	SPT(C)	N=7 (2,2/2,2,1,2)	
	Light brown mottled white clayey silty very sandy GRAVEL. Gravel comprises predominantly fine and medium with coarse; angular to sub rounded flint.	1.44 (7.26)									(102mm dia) Rec=85%
	Loose light brown very clayey very silty SAND. Previous unit occurs at 2.00-2.21m.	1.69 (7.01)									
2			(1.31)					2.00	SPT(C)	N=6 (1,1/1,1,2,2)	(87mm dia) Rec=90%
3	End of Borehole at 3.00m	3.00 (5.70)						3.00	SPT(C)	N=10 (2,1/1,2,3,4)	
4								4.00	SPT(C)	N=47 (10,11/11,12,13,11)	
5											

Remarks:

Unable to drill borehole beyond 3.00m due to collapsing sides. SPT extended to 4.00m.
 Ground level inferred from topographical survey.

Groundwater Observations:

Date	Strike	Casing	Time Elapsed	Standing	Remarks
21-02-2017	1.15m	0.00m	20mins	1.00m	

Technical Notes (where applicable):

Consistency of fine grained soil assessed by hand worked tests in accordance with BS5930. Densities of granular material based on in situ SPT N-values. Chalk descriptions in accordance with CIRIA C574

APPENDIX D

BOREHOLE INFILTRATION CERTIFICATE – WS01



SOIL INFILTRATION RATE

Job Reference : 17-80683

Client : McCarthy & Stone Retirement Lifestyles Ltd

Client Reference : WS01

Site : The Orchard House

Test Number : 1

Location : Emsworth

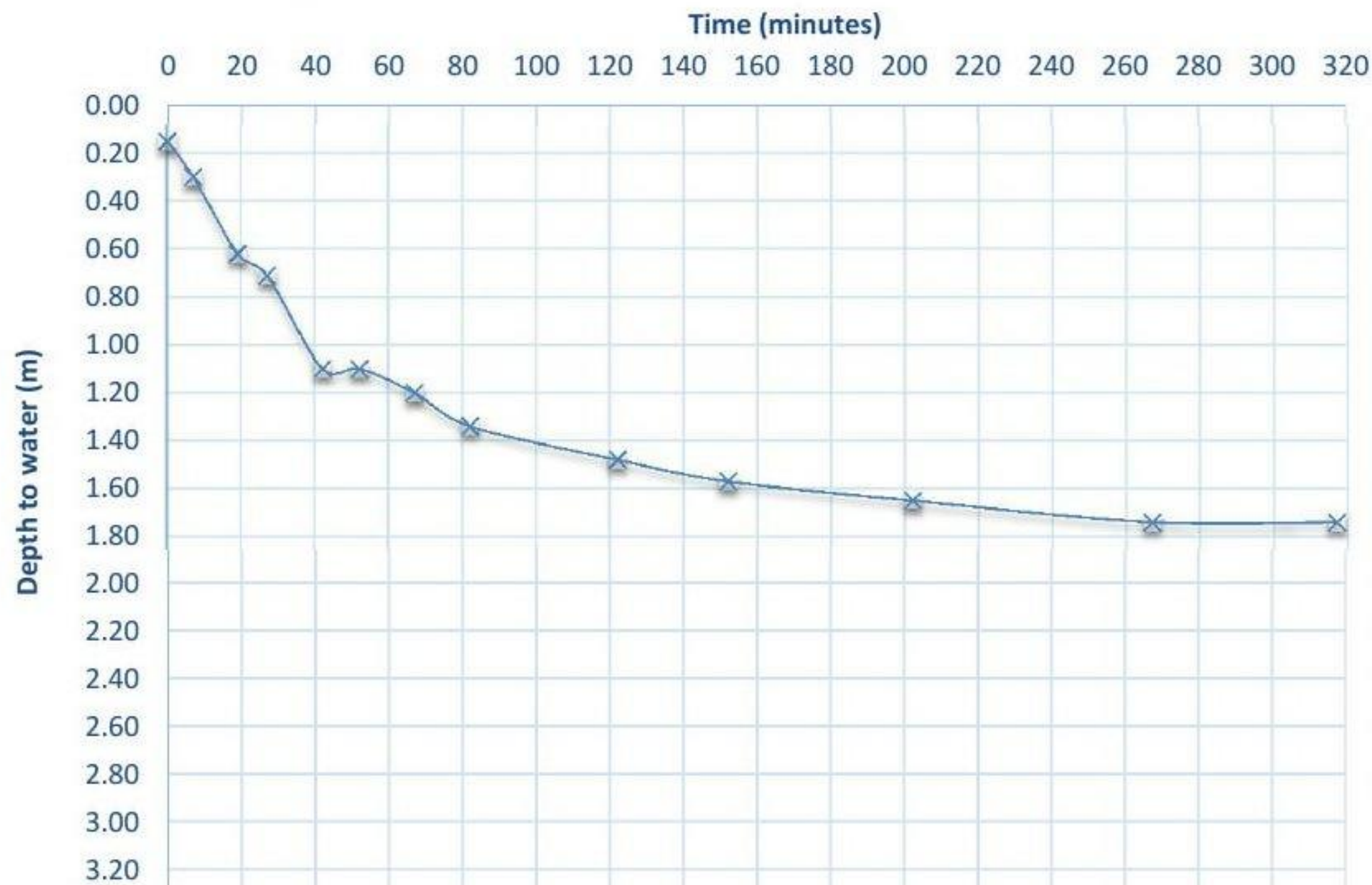
Date Tested :
21/02/2017

Technician :
AM

Weather :
Overcast

Parameters	
Borehole Diameter	0.116 m
Borehole Depth	3.3 m
Borehole Casing Depth	3.00 m
L (Length of Open Hole)	0.30 m
H ₁ (Head Measured at T ₁)	3.15 m
H ₂ (Head Measured at T ₂)	1.56 m
T ₁ (Time 1)	0 mins
T ₂ (Time 2)	317 mins
Cross Sectional Area	0.0106 m ²
Intake Factor	1.12

Time		Depth to Water (m)	Head (m)
Minutes	Seconds		
0	0	0.15	3.15
7	420	0.30	3.00
19	1140	0.62	2.68
27	1620	0.71	2.59
42	2520	1.10	2.20
52	3120	1.10	2.20
67	4020	1.20	2.10
82	4920	1.34	1.96
122	7320	1.48	1.82
152	9120	1.57	1.73
202	12120	1.65	1.65
267	16020	1.74	1.56
317	19020	1.74	1.56



Remarks:

**Soil Infiltration
Rate m/s :**

3.48E-07

Approved by:

R J Holloway - Principal Geo-Environmental
Engineer

Date: 22/02/2017

Richard Holloway

APPENDIX E

LABORATORY TEST CERTIFICATES

17-80683



CERTIFICATE OF TEST - DETERMINATION OF MOISTURE CONTENT
TESTED IN ACCORDANCE WITH B.S. 1377 : PART 2 : 1990 : CL 3.2.3.2

Laboratory reference no(s) :	17-80683 - 321469	Head Office Certificate No : 321469-17-80683-S2
Client :	McCarthy & Stone Retirement Lifestyles Limited	
Certificate address :	4th Floor, 100 Holdenhurst Road Bournemouth, Dorset, BH8 8AQ	
Contract :	The Orchard House	
Source of material (as indicated by client) :	in-situ	
Client reference/data :	WS01	
Location of sample on site :	2.24-2.59m	
Borehole/pit no / depth :	N/A @ N/A m	
Date sampled :	21/02/2017	
Sampled by :	ML	
Date received :	23/02/2017	
Material description :	Brown silty sandy CLAY	
Total mass received :	1.46 kg	
Method of preparation :	BS 1377 : Part 1 & Part 2 : 1990	
Variation from test procedure :	None	
Location & orientation of test specimen within original sample :	N/A	
Sampling certificate :	No - None Submitted	
Client's indicated specification(s) :	n/a	

The test specimen was oven dried at : **108** °C

Moisture content : **19** %

Remarks : **None**

Tested by : **LTMMJKSDC**

Date tested : **23.02.2017** Approved :


 Martin Slater Senior Technician

Date : **06/03/2017**

Bulk samples will be retained for a minimum of 21 days from date of receipt unless a written instruction is received within 14 days of receipt requesting sample retention

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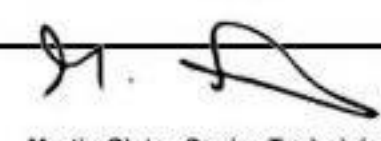


**CERTIFICATE OF TEST - DETERMINATION OF LIQUID/PLASTIC LIMIT, PLASTICITY/LIQUIDITY INDEX
TESTED IN ACCORDANCE WITH B.S. 1377 : PART 2 : 1990 : CLAUSE 4.3 & 5.0**

Laboratory reference no(s) :	17-80683 - 321469	Head Office Certificate No : 321469-17-80683-S4
Client :	McCarthy & Stone Retirement Lifestyles Limited	
Certificate address :	4th Floor, 100 Holdenhurst Road Bournemouth Dorset BH8 8AQ	
Contract :	The Orchard House	
Source of material (as indicated by client) :	in-situ	
Client reference/data :	WS01	
Location of sample on site :	2.24-2.59m	
Borehole/pit no / depth	N/A @ N/A m	
Date sampled :	21/02/2017	
Sampled by :	ML	
Date received :	23/02/2017	
Material description :	Brown silty sandy CLAY	
Total mass received :	1.46 kg	
Method of preparation :	BS 1377 : Part 1 & Part 2	
Variation from test procedure :	None	
Location & orientation of test specimen within original sample :	N/A	
Sampling certificate :	No - None Submitted	
Client's indicated specification(s) :	n/a	

Soil tested in natural condition (BS 1377:Part 2:1990 Clause 4.2.3)			
Proportion of material retained on 425 µm test sieve	:	0	%
Proportion of material passing 425 µm test sieve	:	100	%
Plastic limit	:	15	%
Liquid limit	:	41	%
Plasticity index	:	26	%
Liquidity index	:	0.154	

Remarks : **No compliance statement given as no client's indicated specification details submitted.**

Tested by : DHLTM	Date tested : 23.02.2017	Approved :  Martin Slater Senior Technician	Date : 06/03/2017
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CERTIFICATE OF TEST - DETERMINATION OF MOISTURE CONTENT
TESTED IN ACCORDANCE WITH B.S. 1377 : PART 2 : 1990 : CL 3.2.3.2

Laboratory reference no(s) :	17-80683 - 321470	Head Office Certificate No :	321470-17-80683-S2
Client :	McCarthy & Stone Retirement Lifestyles Limited		
Certificate address :	4th Floor, 100 Holdenhurst Road Bournemouth, Dorset, BH8 8AQ		
Contract :	The Orchard House		
Source of material (as indicated by client) :	in-situ		
Client reference/data :	WS02		
Location of sample on site :	0.11-1.00m		
Borehole/pit no / depth :	N/A @ N/A m		
Date sampled :	21/02/2017		
Sampled by :	ML		
Date received :	23/02/2017		
Material description :	Brown clayey sandy gravelly SILT		
Total mass received :	1.27 kg		
Method of preparation :	BS 1377 : Part 1 & Part 2 : 1990		
Variation from test procedure :	None		
Location & orientation of test specimen within original sample :	N/A		
Sampling certificate :	No - None Submitted		
Client's indicated specification(s) :	n/a		

The test specimen was oven dried at : **108** °C

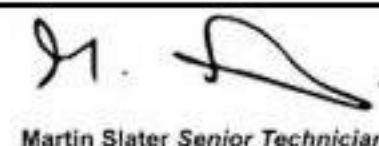
Moisture content : **23** %

Remarks : **None**

Tested by : **LTMMJKSDC**

Date tested : **23.02.2017**

Approved :



Martin Slater Senior Technician

Date : **06/03/2017**

Bulk samples will be retained for a minimum of 21 days from date of receipt unless a written instruction is received within 14 days of receipt requesting sample retention

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**CERTIFICATE OF TEST - DETERMINATION OF LIQUID/PLASTIC LIMIT, PLASTICITY/LIQUIDITY INDEX
TESTED IN ACCORDANCE WITH B.S. 1377 : PART 2 : 1990 : CLAUSE 4.3 & 5.0**

Laboratory reference no(s) :	17-80683 - 321470	Head Office Certificate No : 321470-17-80683-S4
Client :	McCarthy & Stone Retirement Lifestyles Limited	
Certificate address :	4th Floor, 100 Holdenhurst Road Bournemouth Dorset BH8 8AQ	
Contract :	The Orchard House	
Source of material (as indicated by client) :	in-situ	
Client reference/data :	WS02	
Location of sample on site :	0.11-1.00m	
Borehole/pit no / depth	N/A @ N/A m	
Date sampled :	21/02/2017	
Sampled by :	ML	
Date received :	23/02/2017	
Material description :	Brown clayey sandy gravelly SILT	
Total mass received :	1.27 kg	
Method of preparation :	BS 1377 : Part 1 & Part 2	
Variation from test procedure :	None	
Location & orientation of test specimen within original sample :	N/A	
Sampling certificate :	No - None Submitted	
Client's indicated specification(s) :	n/a	

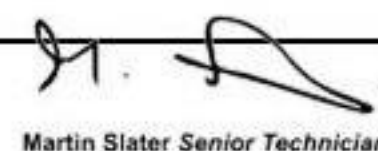
Soil washed through 425 µm test sieve (B.S. 1377 : Part 2 : 1990 Clause 4.2.4)		
Proportion of material retained on 425 µm test sieve	:	6 %
Proportion of material passing 425 µm test sieve	:	94 %
Plastic limit	:	16 %
Liquid limit	:	38 %
Plasticity index	:	22 %
Liquidity index	:	0.385

Remarks : **No compliance statement given as no client's indicated specification details submitted.**

Tested by : **DH**

Date tested : **23.02.2017**

Approved :



Martin Slater Senior Technician

Date : **17/03/2017**

Bulk samples will be retained for a minimum of 21 days from date of receipt unless a written instruction is received within 14 days of receipt requesting sample retention

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CERTIFICATE OF TEST - DETERMINATION OF MOISTURE CONTENT
TESTED IN ACCORDANCE WITH B.S. 1377 : PART 2 : 1990 : CL 3.2.3.2

Laboratory reference no(s) :	17-80683 - 321471	Head Office Certificate No : 321471-17-80683-S2
Client :	McCarthy & Stone Retirement Lifestyles Limited	
Certificate address :	4th Floor, 100 Holdenhurst Road Bournemouth, Dorset, BH8 8AQ	
Contract :	The Orchard House	
Source of material (as indicated by client) :	in-situ	
Client reference/data :	WS02	
Location of sample on site :	1.20-1.50m	
Borehole/pit no / depth :	N/A @ N/A m	
Date sampled :	21/02/2017	
Sampled by :	ML	
Date received :	23/02/2017	
Material description :	Brown silty sandy gravelly CLAY	
Total mass received :	1.26 kg	
Method of preparation :	BS 1377 : Part 1 & Part 2 : 1990	
Variation from test procedure :	None	
Location & orientation of test specimen within original sample :	N/A	
Sampling certificate :	No - None Submitted	
Client's indicated specification(s) :	n/a	

The test specimen was oven dried at : **108** °C

Moisture content : **20** %

Remarks : **None**

Tested by : **LTMMJKSDC** Date tested : **23.02.2017** Approved :  Date : **06/03/2017**

Martin Slater Senior Technician

Bulk samples will be retained for a minimum of 21 days from date of receipt unless a written instruction is received within 14 days of receipt requesting sample retention

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**CERTIFICATE OF TEST - DETERMINATION OF LIQUID/PLASTIC LIMIT, PLASTICITY/LIQUIDITY INDEX
TESTED IN ACCORDANCE WITH B.S. 1377 : PART 2 : 1990 : CLAUSE 4.3 & 5.0**

Laboratory reference no(s) :	17-80683 - 321471	Head Office Certificate No :	321471-17-80683-S4
Client :	McCarthy & Stone Retirement Lifestyles Limited		
Certificate address :	4th Floor, 100 Holdenhurst Road Bournemouth Dorset BH8 8AQ		
Contract :	The Orchard House		
Source of material (as indicated by client) :	in-situ		
Client reference/data :	WS02		
Location of sample on site :	1.20-1.50m		
Borehole/pit no / depth	N/A	@	N/A m
Date sampled :	21/02/2017		
Sampled by :	ML		
Date received :	23/02/2017		
Material description :	Brown silty sandy gravelly CLAY		
Total mass received :	1.26 kg		
Method of preparation :	BS 1377 : Part 1 & Part 2		
Variation from test procedure :	None		
Location & orientation of test specimen within original sample :	N/A		
Sampling certificate :	No - None Submitted		
Client's indicated specification(s) :	n/a		

Soil washed through 425 µm test sieve (B.S. 1377 : Part 2 : 1990 Clause 4.2.4)			
Proportion of material retained on 425 µm test sieve	:	52	%
Proportion of material passing 425 µm test sieve	:	48	%
Plastic limit	:	22	%
Liquid limit	:	67	%
Plasticity index	:	45	%
Liquidity index	:	0.437	

Remarks : **No compliance statement given as no client's indicated specification details submitted.**

Tested by :	DHLTMMEW	Date tested :	09.03.2017	Approved :		Date :	13/03/2017
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Martin Slater Senior Technician

Bulk samples will be retained for a minimum of 21 days from date of receipt unless a written instruction is received within 14 days of receipt requesting sample retention

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CERTIFICATE OF TEST - DETERMINATION OF MOISTURE CONTENT
TESTED IN ACCORDANCE WITH B.S. 1377 : PART 2 : 1990 : CL 3.2.3.2

Laboratory reference no(s) :	17-80683 - 321472	Head Office Certificate No : 321472-17-80683-S2
Client :	McCarthy & Stone Retirement Lifestyles Limited	
Certificate address :	4th Floor, 100 Holdenhurst Road Bournemouth, Dorset, BH8 8AQ	
Contract :	The Orchard House	
Source of material (as indicated by client) :	in-situ	
Client reference/data :	WS03	
Location of sample on site :	1.00-1.34	
Borehole/pit no / depth :	N/A @ N/A m	
Date sampled :	21/02/2017	
Sampled by :	ML	
Date received :	23/02/2017	
Material description :	Brown silty sandy gravelly CLAY	
Total mass received :	1.36 kg	
Method of preparation :	BS 1377 : Part 1 & Part 2 : 1990	
Variation from test procedure :	None	
Location & orientation of test specimen within original sample :	N/A	
Sampling certificate :	No - None Submitted	
Client's indicated specification(s) :	n/a	

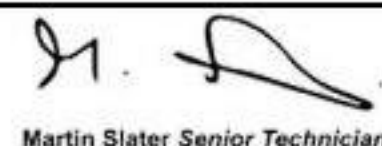
The test specimen was oven dried at : **108** °C

Moisture content : **18** %

Remarks : **None**

Tested by : **LTMMJKSDC**

Date tested : **23.02.2017** Approved :


 Martin Slater Senior Technician

Date : **06/03/2017**

Bulk samples will be retained for a minimum of 21 days from date of receipt unless a written instruction is received within 14 days of receipt requesting sample retention

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**CERTIFICATE OF TEST - DETERMINATION OF LIQUID/PLASTIC LIMIT, PLASTICITY/LIQUIDITY INDEX
TESTED IN ACCORDANCE WITH B.S. 1377 : PART 2 : 1990 : CLAUSE 4.3 & 5.0**

Laboratory reference no(s) : **17-80683 - 321472** Head Office Certificate No : **321472-17-80683-S4**

Client : **McCarthy & Stone Retirement Lifestyles Limited**
 Certificate address : **4th Floor, 100 Holdenhurst Road
 Bournemouth
 Dorset
 BH8 8AQ**

Contract : **The Orchard House**
 Source of material (as indicated by client) : **in-situ**
 Client reference/data : **WS03**
 Location of sample on site : **1.00-1.34**
 Borehole/pit no / depth : **N/A @ N/A m**
 Date sampled : **21/02/2017**
 Sampled by : **ML**
 Date received : **23/02/2017**
 Material description : **Brown silty sandy gravelly CLAY**
 Total mass received : **1.36 kg**
 Method of preparation : **BS 1377 : Part 1 & Part 2**
 Variation from test procedure : **None**
 Location & orientation of test specimen within original sample : **N/A**

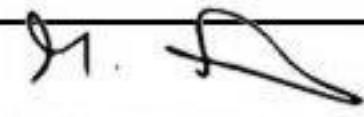
Sampling certificate : **No - None Submitted**
 Client's indicated specification(s) : **n/a**

Soil washed through 425 µm test sieve (B.S. 1377 : Part 2 : 1990 Clause 4.2.4)

Proportion of material retained on 425 µm test sieve	:	37	%
Proportion of material passing 425 µm test sieve	:	63	%

Plastic limit	:	18	%
Liquid limit	:	44	%
Plasticity index	:	26	%
Liquidity index	:	0.407	

Remarks : **No compliance statement given as no client's indicated specification details submitted.**

Tested by : **DHLTMMEW** Date tested : **09.03.2017** Approved :  Date : **13/03/2017**

Martin Slater Senior Technician

Bulk samples will be retained for a minimum of 21 days from date of receipt unless a written instruction is received within 14 days of receipt requesting sample retention

Any statement of compliance with a given specification relates only to the test covered by this certificate.

Opinions and interpretations, if stated, are not within the scope of our UKAS accreditation

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Head Office

Unit 14
 Blackhill Road West
 Holton Heath Trading Park
 Poole
 Dorset BH16 6LE

Tel 01202 622858
Fax 01202 626046

Registered Office

Unit 14
 Blackhill Road West
 Holton Heath Trading Park
 Poole
 Dorset BH16 6LE
 ACS Testing Limited
 Registered in England and
 Wales No. 4639658



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