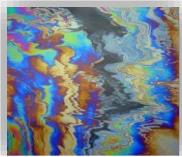




INVESTIGATE



REMEDiate



REGENERATE

TECHNICAL REPORT

GROUND INVESTIGATION
AT
37 THE DRIVE,
ICKENHAM,
GREATER LONDON
FOR
SQUARE HOUSE LTD

REPORT NO. SE1447
APRIL 2018



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**GROUND INVESTIGATION AT 37 THE DRIVE, ICKENHAM, GREATER LONDON,
UB10 8AF**

CLIENT: SQUARE HOUSE LTD

ARCHITECT: JPB ARCHITECTS

1. INTRODUCTION

This report has been prepared in accordance with an emailed instruction, dated 26th February 2018, from the Client's Architect on behalf of the Client.

The brief was set out in our estimate, ref. ESE2106A and dated 20th February 2018, with amendments as the investigation proceeded and includes:

- 4 No. mini boreholes
- Insitu testing
- Geotechnical laboratory testing
- Installation of standpipes followed by groundwater monitoring
- Provision of an interpretative report on the above.

1.1 Site Location and Description

The site is located at 37 The Drive, Ickenham, Greater London, UB10 8AF as indicated on Figure 1. The approximate National Grid Reference of the centre of the site is 506120, 185965.

As shown on Figure 2, the site forms an elongate rectangular area some 120m x 30m in size and comprising an existing house with a garage and access areas in the south eastern third and a rear garden in the remaining area. The site is bound by The Drive to the south east, a golf course to the north west, and nos. 39 and 35A The Drive to the north east and south west, respectively.

1.2 Proposed Development and Purpose of the Ground Investigation

We understand that it is proposed to develop the site with a new centrally located detached house following demolition of the existing house and garage, as indicated on Figure 2.

The purpose of the investigation was to determine the ground conditions at the positions of the exploratory holes, to assess the likelihood of a general pattern of strata being present below the site and to establish the load bearing characteristics of the strata deriving if possible an assessment of the suitability of appropriate founding techniques.

2. INVESTIGATION

2.1 Investigation Details

Four mini boreholes were put down to a depth of 5.45m using a mini sampling rig fitted with windowless sample tubes of varying diameters at the positions determined and set out by Sub Surface South East Ltd, as shown on Figure 2. The samples were subsequently logged in accordance with BS EN ISO 14688-1: 2002 and BS EN ISO 14689-1: 2003 and the resulting Mini Borehole Records are appended.

On completion, boreholes M2 and M4 were backfilled with arisings as no installations were required.

2.2 Sub Surface Detail

Details of the strata encountered in the ground investigation are given on the appended Mini Borehole Records. The exploratory holes found made ground locally underlain by granular drift deposits overlying London Clay Formation strata with a general summary of the strata found is as follows:

2.2.1 Made Ground

The boreholes initially encountered grass overlying made ground to depths of between 0.30m to 0.40m, which generally comprised dark brown to dark greyish brown slightly organic locally gravelly sandy silty clay and occasional sand. Gravel sized fragments consisted of fine to coarse stone and occasional concrete and glass.

2.2.2 Drift Deposits

Underlying the made ground boreholes M1, M3 and M4 encountered granular drift deposits to depths of 1.20m, 0.80m and 1.20m, respectively. In M1 and M3 the strata comprised brownish grey and brown locally clayey sandy fine to coarse flint, sandstone and quartz gravel with occasional cobbles. In M4 the strata comprised brown slightly silty gravelly medium sand.

2.2.3 London Clay Formation Strata

Underlying the drift deposits at depths of between 0.80m and 1.20m in M1, M3 and M4 and the made ground at 0.40m depth in M2 the boreholes encountered natural cohesive strata of the London Clay Formation.

The strata generally comprised soft to firm low strength locally medium strength light brown to brown with grey mottling silty clay with occasional thin bands of silty sand and gravel. Below depths of 1.70m the strata was generally found to be firm to stiff medium strength locally high strength.

2.2.4 Groundwater

Groundwater seepages were encountered in M1 and M3 at depths of 3.50m and 2.50m, respectively. No groundwater was encountered in the remainder of the exploratory holes although it should be noted that they were only left open for a short period of time and groundwater levels and rates of inflow may be subject to seasonal and/ or climatic variations.

Monitoring of standpipes installed in boreholes M1 to 4.00m and M3 to 5.00m found groundwater to be at depth ranging from 1.00m to 1.34m and 0.70m to 0.76m, respectively.

3. SAMPLING, TESTING AND MONITORING

3.1 Sampling

Continuous core, small disturbed and bulk disturbed samples were obtained for the strata encountered and were subjected to careful examination and hand shear vane tests, where appropriate.

The samples will be retained for a period of one month after the issue of this report, for reference purposes, and then disposed of unless otherwise instructed.

3.2 Field Testing

Twenty Standard Penetration Tests (SPTs) were performed in the boreholes, the results of which are recorded on the appended Standard Penetration Test Results Sheet with 'N' values and indicative relative density and shear strength, where appropriate, given on the appended Mini Borehole Records.

3.3 Installations and Monitoring

On completion of boreholes M1 and M3, hdpe standpipes were installed to depths of 4.00m and 5.00m, respectively. The standpipes are slotted from 1.00m depth, have an internal diameter of 50mm and a removable cap to enable both groundwater monitoring and sampling to be undertaken. Details of the installation are given on the appended Mini Borehole Records.

Monitoring of the standpipes for groundwater has been undertaken on two occasions using portable equipment and the results are given on the appended Groundwater Monitoring Results sheet.

3.4 Laboratory Testing

The following laboratory tests were carried out in accordance with BS.1377: 1990, where applicable, and the results are appended.

- Moisture content, plastic limit and liquid limit tests
- Soluble sulphate content and pH value tests

4. APPRAISAL AND RECOMMENDATIONS

4.1 Comments on the Profile

At the outset it should be appreciated that only a small proportion of the area to be developed has been investigated and consequently the recommendations made and opinions expressed in this report can only be applied to such conditions as were encountered in the exploratory holes.

The exploratory holes indicate a nature and degree of similarity to the extent that we consider them likely to be representative of the natural ground conditions. However, no guarantee can be given.

Due to the nature of made ground localised variations in thickness and composition should be anticipated and hence interpolation or extrapolation from the exploratory holes to adjoining areas should only be undertaken with caution.

Details of the findings of the investigation are given on the appended Mini Borehole Records and a summary of the ground conditions is given in Section 2.2.

4.2 Foundations

We understand that it is proposed to construct a new three-storey house on the site, as indicated in Figure 3. The structure will include a lower ground floor opening to the west at the rear of the property where the ground level is lower. However at the time of writing this report no specific details regarding the design loadings were available and consequently the recommendations given are in general terms only.

The ground investigation found made ground locally underlain by granular drift deposits to depths ranging from 0.40m to 1.20m overlying low to medium strength silty clays generally becoming medium to high strength below a depth of 1.70m.

We would not recommend founding in the made ground in its present condition because of its inherent variability in consistency and compaction, and in parts the nature of its constituents.

Providing there is sufficient load bearing capability we recommend that the proposed building is founded on strip footings for wall loads and pad foundations for column loads in the natural cohesive strata.

Atterberg limit tests on the cohesive strata indicate clays of high to very high plasticity which are considered to have a medium to high susceptibility to shrinkage and swelling with varying moisture content. Given the above foundations should be taken down to a minimum 1.00m below finished ground level to avoid the zone which is subject to seasonal moisture content variation and frost action. If buildings are to be constructed adjacent to existing trees, trees are to be removed and/or trees are to be planted then the guidelines given in the National House Building Council (NHBC) Standards Chapter 4.2, 'Building Near Trees', should be followed for clays of high shrinkage and swelling potential.

Further precautions might/ will need to be taken to protect walls and floor slabs from the effects of swelling following the removal of the trees or the cutting of the roots. Damage is likely to be caused when desiccated cohesive soils expand on taking up moisture previously taken by the roots; if for example, walls are constructed such as to constrain such soils to a limited volume.

Taking the results of the field tests we have determined the safe bearing capacity of the natural strata, as follows:

TABLE 1 SAFE BEARING CAPACITY

Expl Hole No.	Depth (m)	SPT 'N' Value	Shear Strength (kN/m ²)	Safe Bearing Pressure (kN/m ²)		Recommended Minimum Foundation Depth (m)
				Strip Footing	Square Pad	
M1	1.35	10	40	75	90	1.20
	1.80	-	84 [#]	160*	190*	
	2.15	8	32	60	70	
	2.60	-	100 [#]	190*	225*	
	3.15	14	56	105	125	
	3.80	-	90 [#]	170	205	
M2	1.35	10	40	75	90	1.00
	1.70	-	80 [#]	150*	180*	
	2.15	7	28	50	60	
	2.60	-	84 [#]	160*	190*	
	3.15	14	56	105	125	
	3.60	-	86 [#]	160	195	
M3	1.35	9	36	65	80	1.00
	1.70	-	74 [#]	140*	165*	
	2.15	8	32	60	70	
	2.70	-	66 [#]	125*	150*	
	3.15	11	44	80	100	
	3.60	-	90 [#]	170	205	
M4	1.35	12	48	90	105	1.20
	1.70	-	102 [#]	190*	230*	
	2.15	11	32	60	70	
	2.70	-	95 [#]	180*	215*	
	3.15	17	68	125	155	
	3.80	-	90 [#]	170	205	

- * Consideration must be given to weaker underlying strata which might be overstressed if loading is not reduced.

Shear strength determined by hand shear vane test.

Appreciable variations in safe bearing capacity are indicated in Table 1 and as a consequence of this, and the need to utilise a generally applicable safe bearing pressure to enable designs to be reasonably formulated, we recommend that values of 65kN/m^2 for strip footings and 80kN/m^2 for square pads should not be exceeded for the recommended minimum foundation depth given.

If greater loadings are required, the test results indicate for foundations taken down to 2.50m depth safe bearing pressures of 125kN/m² for strip footings and 150kN/m² for square pads could be adopted.

All formation levels should be carefully inspected by an experienced and qualified engineer to confirm the appropriateness of the design figures used with any soft zones removed and replaced with lean mix concrete. The formation should then be blinded with lean mix concrete as soon as possible after exposure, if there is to be a delay before construction, to prevent water softening or disturbance.

It should be noted that the safe bearing pressures given for the cohesive strata do not take into consideration settlement. Settlement is dependent upon loading intensity, the width of the foundation and the coefficient of volume compressibility (Mv) of the compressible strata. When details of the foundations are formulated we recommend that total and differential settlements are assessed to ensure that they are within acceptable limits.

Should granular and cohesive strata be present at the proposed formation level we recommend that foundation excavations should be locally deepened in order that the formation is entirely within similar strata. If this is not possible we recommend that reinforcement in foundations is provided to give adequate strength to bridge or cantilever over areas of significantly differing rates of settlement and to induce an increase in the settlement where relatively low settlements are expected.

4.3 Floor Slab Construction

With regard to the design and construction of floor slabs we would recommend the removal of any topsoil and/ or made ground and the level brought up as required using a graded granular hardcore placed and compacted in layers of not greater than 150mm followed by the construction of a concrete ground bearing floor slab.

In view of the proximity of trees to the proposed building and potential for heave, should tree roots be cut for foundations and services excavations, we recommend using a suspended slab with under floor void designed in accordance with NHBC Standards Chapter 4.2 with either traditional shallow foundations or piles and capping beams designed on the same basis as the main foundations where the spans are too large for economic single suspended slab design.

4.4 Excavations and Groundwater

There should be no particular difficulties in excavating the strata indicated in the exploratory holes utilising an appropriate and suitably sized mechanical excavator.

It is recommended that all excavations to greater than 1.20m depth, or for shallower excavations where groundwater is encountered above this level, are closely supported, especially where man entry is required. Alternatively, where space permits, the excavations might be battered back to an appropriate angle.

We understand that deep excavations in the order of 2.00m to 2.50m are required for the lower ground floor. The boreholes encountered granular strata to a maximum depth of 1.20m underlain by soft to firm clays generally becoming stiff at depths of 1.70m. The ground conditions would indicate there would be no problem regarding stability of the excavation sides assuming they are to be battered back or provided with close support over the zone of granular strata.

Groundwater seepages were encountered in M1 and M3 at depths of 3.50m and 2.50m, respectively. No groundwater was encountered in the remainder of the exploratory holes although it should be noted that they were only left open for a short period of time and groundwater levels and rates of inflow may be subject to seasonal and/ or climatic variations.

Monitoring of standpipes installed in boreholes M1 to 4.00m and M3 to 5.00m found groundwater to be at depth ranging from 1.00m to 1.34m and 0.70m to 0.76m, respectively.

In our opinion it is probable that the groundwater encountered in the standpipes is due to localised inflows from perched groundwater within the granular drift deposits overlying the clay, which is generally of low permeability. Where groundwater is encountered to about 1.50m depth and accumulates in open excavations it is considered that it should be able to be removed by pumping from a filtered sump. However below this depth more sophisticated dewatering measures are likely to be required.

Care will need to be taken when reducing groundwater levels to ensure that adjoining/ nearby buildings, structures and services are not affected.

4.5 Buried Concrete

For the design of buried concrete the recommendations given in Building Research Establishment (BRE) Special Digest 1 (February 2017 revision), "Concrete in Aggressive Ground", should be followed. Determination of pH on the soil samples gave values in the range of 7.5 to 7.9. Soluble sulphate concentrations were also determined for the soil samples and the results ranged from 0.01g/l to 1.40g/l. The results indicate that the Design Sulphate Class for the site should be DS-2.

Our knowledge of the site and ground conditions indicates that the site is "brownfield"/ and with mobile groundwater. Consequently, in accordance with the Design Sulphate Class for the site together with the site and groundwater conditions an Aggressive Chemical Environment for Concrete (ACEC) classification of AC-2 should be used as detailed on the appended extract.

4.6 General

In the preparation of this report no consideration has been given to

- the historical, geological and/ or environmental setting of the site
- the possible presence of contamination
- the possible presence of ground gas

as this was outside our brief.

We trust that this report fulfils your present requirements but if you have any queries or we can be of further assistance please contact the undersigned or Mr Gurbinder Singh Mann at our High Wycombe office.

SUB SURFACE CONSULTANTS LIMITED
REPORT No. SE1447
APRIL 2018



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INSITU TEST RESULTS



SUB SURFACE

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Standard Penetration Test Results

Site : 37 THE DRIVE, ICKENHAM, GREATER LONDON

Client : SQUARE HOUSE LTD

Architect: JPB ARCHITECTS

Job Number
SE1447

Sheet
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Borehole Number	Base of Borehole (m)	End of Seating Drive (m)	End of Test Drive (m)	Test Type	Seating Blows per 75mm		Blows for each 75mm penetration				Result	Comments
					1	2	1	2	3	4		
M1	1.20	1.35	1.65	SPT	3	2	2	2	3	3	N=10	
M1	2.00	2.15	2.45	SPT	4	2	1	2	2	3	N=8	
M1	3.00	3.15	3.45	SPT	2	2	3	3	4	4	N=14	
M1	4.00	4.15	4.45	SPT	3	4	5	6	7	7	N=25	
M1	5.00	5.15	5.45	SPT	4	5	6	6	6	7	N=25	
M2	1.20	1.35	1.65	SPT	1	2	2	2	3	3	N=10	
M2	2.00	2.15	2.45	SPT	1	2	1	2	2	2	N=7	
M2	3.00	3.15	3.45	SPT	2	2	3	3	4	4	N=14	
M2	4.00	4.15	4.45	SPT	1	3	4	3	3	5	N=15	
M2	5.00	5.15	5.45	SPT	2	3	3	3	4	6	N=16	
M3	1.20	1.35	1.65	SPT	1	1	2	2	2	3	N=9	
M3	2.00	2.15	2.45	SPT	3	1	1	2	2	3	N=8	
M3	3.00	3.15	3.45	SPT	1	1	3	3	2	3	N=11	
M3	4.00	4.15	4.45	SPT	1	2	3	3	4	4	N=14	
M3	5.00	5.15	5.45	SPT	2	3	3	3	6	6	N=18	
M4	1.20	1.35	1.65	SPT	2	2	2	3	3	4	N=12	
M4	2.00	2.15	2.45	SPT	2	2	2	3	3	3	N=11	
M4	3.00	3.15	3.45	SPT	3	4	4	4	4	5	N=17	
M4	4.00	4.15	4.45	SPT	2	3	4	5	4	4	N=17	
M4	5.00	5.15	5.45	SPT	3	5	5	5	5	6	N=21	



SUB SURFACE

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Insitu Test Results

Site: 37 THE DRIVE, ICKENHAM, GREATER LONDON
Client: SQUARE HOUSE LTD
Engineer: JPB ARCHITECTS

Job Number
SE1447

Sheet: 1 / 1

Groundwater Monitoring Results Sheet

Remarks:

*Boreholes purged of groundwater following monitoring

LABORATORY TEST RESULTS



SUB SURFACE

SITE INVESTIGATION, GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
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Laboratory Test Results

Site	: 37 THE DRIVE, ICKENHAM, GREATER LONDON	Job Number
Client	: SQUARE HOUSE LTD	SE1447
Architect:	JPB ARCHITECTS	Sheet 1 / 1

DETERMINATION OF MOISTURE CONTENT, LIQUID LIMIT AND PLASTIC LIMIT AND DERIVATION OF PLASTICITY AND LIQUIDITY INDEX

Borehole/ Trial Pit	Depth (m)	Sample	Natural Moisture Content %	Sample Passing 425µm Sieve		Liquid Limit %	Plastic Limit %	Plasticity Index %	Liquidity Index	Group Symbol	Laboratory Description
				Percentage %	Moisture Content %						
M1	1.50	C	25	92	27	61	25	36	0.06	CH	Brown with grey mottling silty CLAY.
M1	3.50	C	28	90	31	67	28	39	0.08	CH	Brown with grey mottling silty CLAY.
M2	4.50	C	32	90	36	66	26	40	0.25	CH	Brown silty CLAY.
M3	2.50	C	31	95	33	70	28	42	0.12	CH/CV	Brown and grey mottled silty CLAY.
M4	3.50	C	28	90	31	64	26	38	0.13	CH	Brown silty CLAY.

Method of Preparation: BS 1377:PART 1:1990:7.4 Preparation of samples for classification tests BS 1377:PART 2:1990:4.2 & 5.2 Sample preparations

Method of Test : BS 1377:PART 2:1990:3 Determination of moisture content 1990:4 Determination of the liquid limit BS 1377:PART 2:1990:5 Determination of the plastic limit and plasticity index

Remarks :



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Laboratory Test Results

Site	: 37 THE DRIVE, ICKENHAM, GREATER LONDON	Job Number
Client	: SQUARE HOUSE LTD	SE1447
Architect:	JPB ARCHITECTS	Sheet 1 / 1

DETERMINATION OF THE pH VALUE AND THE SULPHATE CONTENT OF SOIL AND GROUNDWATER

Borehole/ Trial Pit	Depth (m)	Sample	Concentration of Soluble Sulphate		Percentage of sample passing 2mm Sieve %	pH	Classification	Laboratory Description
			Soil					
			Total S03 %	S04 in 2:1 water:soil g/l				
M1	1.50	C		0.01		7.5	DS-1	Brown with grey mottling silty CLAY.
M1	3.50	C		1.40		7.6	DS-2	Brown with grey mottling silty CLAY.
M2	4.50	C		1.30		7.6	DS-2	Brown silty CLAY.
M3	2.50	C		0.24		7.7	DS-1	Brown and grey mottled silty CLAY.
M4	3.50	C		0.02		7.9	DS-1	Brown silty CLAY.

Method of Preparation: BS 1377:PART 1:1990:7.5 Preparation of soil for chemical tests BS 1377:PART 3:1990:5.2, 5.3, 5.4 & 9.4

Method of Test : Laboratory in-house methods based on BS1377: Part 3 for contents of water soluble sulphate, total sulphate and pH.

Remarks : Classification relates to Design Sulphate Class of BRE Special Digest 1 (2005)



AGGRESSIVE CHEMICAL ENVIRONMENT FOR CONCRETE (ACEC) SITE CLASSIFICATION

Table C1 Aggressive Chemical Environment for Concrete (ACEC) classification for natural ground locations^a

Sulfate Design Sulfate Class for Location	Groundwater						ACEC Class for location
	2:1 water/soil extract ^b	Groundwater	Total potential sulfate ^c	Static water	Mobile water		
1	2 (SO ₄ mg/l)	3 (SO ₄ mg/l)	4 (SO ₄ %)	5 (pH)	6 (pH)	7	
DS-1	<500	<400	<0.24	≥2.5	>5.5d 2.5 - 5.5	AC-1s AC-1d AC-2z	
DS-2	500 - 1500	400 - 1400	0.24 - 0.6	>3.5 2.5-3.5	>5.5 2.5 - 5.5	AC-1s AC-2 AC-2s AC-3z	
DS-3	1600-3000	1500-3000	0.7 - 1.2	>3.5 2.5 - 3.5	>5.5 2.5 - 5.5	AC-2s AC-3 AC-3s AC-4	
DS-4	3100 - 6000	3100 - 6000	1.3 - 2.4	>3.5 2.5 - 3.5	>5.5 2.5 - 5.5	AC-3s AC-4 AC-4s AC-5	
DS-5	>6000	>6000	>2.4	>3.5 2.5 - 3.5	>5.5 2.5 - 5.5 ≥2.5	AC-4s AC-5	

Notes

a Applies to locations on sites that comprise either undisturbed ground that is in its natural state (ie not brownfield - Table C2) or clean fill derived from such ground
b The limits of Design Sulfate Classes based on 2:1 water/soil extracts have been lowered relative to previous Digests (Box C7).
c Applies only to locations where concrete will be exposed to sulfate ions (SO₄) which may result from the oxidation of sulfides (eg pyrite) following ground disturbance (Appendix A1 and Box C8).
d For flowing water that is potentially aggressive to concrete owing to high purity or an aggressive carbon dioxide level greater than 15mg/l (Section C2.2.3), increase the ACEC Class to AC-2z.

Explanation of suffix symbols to ACEC Class

- Suffix 's' indicates that the water has been classified as static
- Concrete placed in ACEC Classes that included the suffix 'z' primarily have to resist acid conditions and may be made with any of the cements or combinations listed in Table D2 on page 42.

Table C2 Aggressive Chemical Environment for Concrete (ACEC) classification for brownfield locations^a

Sulfate Design Sulfate Class for Location	Groundwater						ACEC Class for location	
	2:1 water/soil extract ^b	Groundwater	Total potential sulfate ^c	Static water	Mobile water			
1	2 (SO ₄ mg/l)	3 (Mg mg/l)	4 (SO ₄ mg/l)	5 (Mg mg/l)	6 (SO ₄ %)	7 (pH) ^d	8 (pH) ^d	9
DS-1	<500	<400	<0.24	≥2.5	>6.5 ^d 5.5 - 6.5 4.5 - 5.5 2.5 - 4.5	AC-1s AC-1 AC-2z AC-3z AC-4z		
DS-2	500 - 1500	400 - 1400	0.24 - 0.6	>5.5 2.5 - 5.5 5.5 - 6.5 4.5 - 5.5 2.5 - 5.5	>6.5 5.5 - 6.5 4.5 - 5.5 2.5 - 5.5	AC-1s AC-2 AC-2s AC-3z AC-4z AC-5z		
DS-3	1600 - 3000	1500 - 3000	0.7 - 1.2	>5.5 2.5 - 5.5 5.5 - 6.5 4.5 - 5.5 2.5 - 5.5	>6.5 5.5 - 6.5 4.5 - 5.5 2.5 - 5.5	AC-2s AC-3 AC-3s AC-4 AC-5		
DS-4	3100 - 6000	≤1200	3100 - 6000	≤1000	1.3 - 2.4	>5.5 2.5 - 5.5 2.5 - 6.5	AC-3s AC-4 AC-4s AC-5	
DS-4m	3100 - 6000	>1200 ^e	3100 - 6000	>1000 ^e	1.3 - 2.4	>5.5 2.5 - 5.5 2.5 - 6.5	AC-3s AC-4m AC-4ms AC-5m	
DS-5	>6000	≤1200	>6000	≤1000	>2.4	>5.5 2.5 - 5.5 2.5 - 6.5	AC-4s AC-5 AC-4ms	
DS-5m	>6000	>1200 ^e	>6000	>1000 ^e	>2.4	>5.5 2.5 - 5.5 ≥2.5	AC-4ms AC-5m	

Notes

a Brownfield sites are those sites, or parts of sites, that might contain chemical residues produced by or associated with industrial production (Section C5.1.3).
b The limits of Design Sulfate Classes based on 2:1 water/soil extracts have been lowered relative to previous Digests (Box C7).
c Applies only to locations where concrete will be exposed to sulfate ions (SO₄) which may result from the oxidation of sulfides (eg pyrite) following ground disturbance (Appendix A1 and Box C8).
d An additional account is taken of hydrochloric and nitric acids by adjustment to sulfate content (Section C5.1.3).
e The limit on water-soluble magnesium does not apply to brackish groundwater (chloride content between 12 000 mg/l and 17 000 mg/l). This allows 'm' to be omitted from the relevant ACEC Classification. Seawater (chloride content about 18 000 mg/l) and stronger brines are not covered by this table.

Explanation of suffix symbols to ACEC Class

- Suffix 's' indicates that the water has been classified as static
- Concrete placed in ACEC Classes that included the suffix 'z' primarily have to resist acid conditions and may be made with any of the cements or combinations listed in Table D2 on page 42.
- Suffix 'm' relates to the higher levels of magnesium in Design Sulfate Classes 4 and 5.

MINI BOREHOLE RECORD SHEETS

 SUB SURFACE SITE INVESTIGATION, GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS 3 Peel Street, Preston, PR2 2QS. Tel. (01772) 561135 Fax (01772) 204907							Site 37 THE DRIVE, ICKENHAM, GREATER LONDON			Borehole Number M1		
Boring Method MINI PERCUSSIVE		Casing Diameter			Ground Level (mOD)		Client SQUARE HOUSE LTD			Job Number SE1447		
		Location AS PLAN			Dates 07/03/2018		Architect JPB ARCHITECTS			Sheet 1/2		
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description		Legend	Water	Instr	
0.20	B					(0.30)	MADE GROUND: grass over greyish brown and brown slightly organic clayey gravelly sand. Gravel sized fragments are fine to coarse stone.					
0.50	B					0.30	Brown sandy angular to subrounded fine to coarse flint, sandstone and quartz GRAVEL with low cobble content.					
1.20-1.65 1.20-1.65 1.20-2.00	SPT N=10 D C			3,2/2,2,3,3 1.20m to 2.00m - 100% recovery		(0.90)						
2.00-2.45 2.00-2.45 2.00-3.00	SPT N=8 D C			HV@1.80m, c=84kPa 4,2/1,2,2,3 2.00m to 3.00m - 100% recovery		1.20	Soft to firm low to medium strength locally stiff high strength light brown to brown with grey mottling silty CLAY with occasional very thin bands of orangish brown silty fine sand.					
3.00-3.45 3.00-3.45 3.00-4.00	SPT N=14 D C			HV@2.60m, c=100kPa 2,2/3,3,4,4 3.00m to 4.00m - 100% recovery		(2.40) at 1.80m : stiff high strength at 2.10m : thin band of brown sandy flint gravel at 2.60m : stiff high strength from 3.00m : firm to stiff medium strength					
4.00-4.45 4.00-4.45 4.00-5.00	SPT N=25 D C			Seepage(1) at 3.50m. HV@3.80m, c=90kPa 3,4/5,6,7,7 4.00m to 5.00m - 75% recovery		3.60	Stiff high strength brown and occasional light brown and grey silty CLAY.					
5.00-5.45	SPT N=25			4,5/6,6,6,7		(1.85)						
Remarks Hand dug inspection pit from GL to 1.20m to check for services. C = Plastic lined core sample Core diameter : 86mm to 2.00m, 78mm to 3.00m, 68mm to 4.00m and 56mm to 5.00m HV = Hand Shear Vane test On completion backfilled with arisings and installed a 50mm dia slotted standpipe with a gas valve and a gravel surround to 4.00m, a Bentonite seal from 1.00m to 0.20m and a concreted in lockable steel protective cover from 0.20m to GL.,,									Scale (approx) 1:25	Logged By TP/SJ		
									Figure No. SE1447.M1			



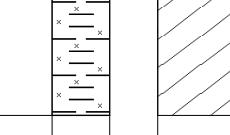
SUB SURFACE

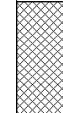
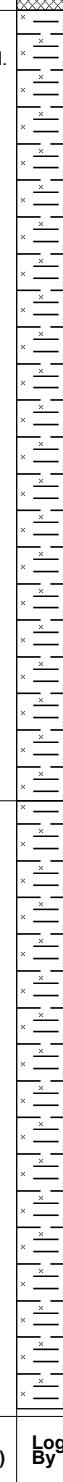
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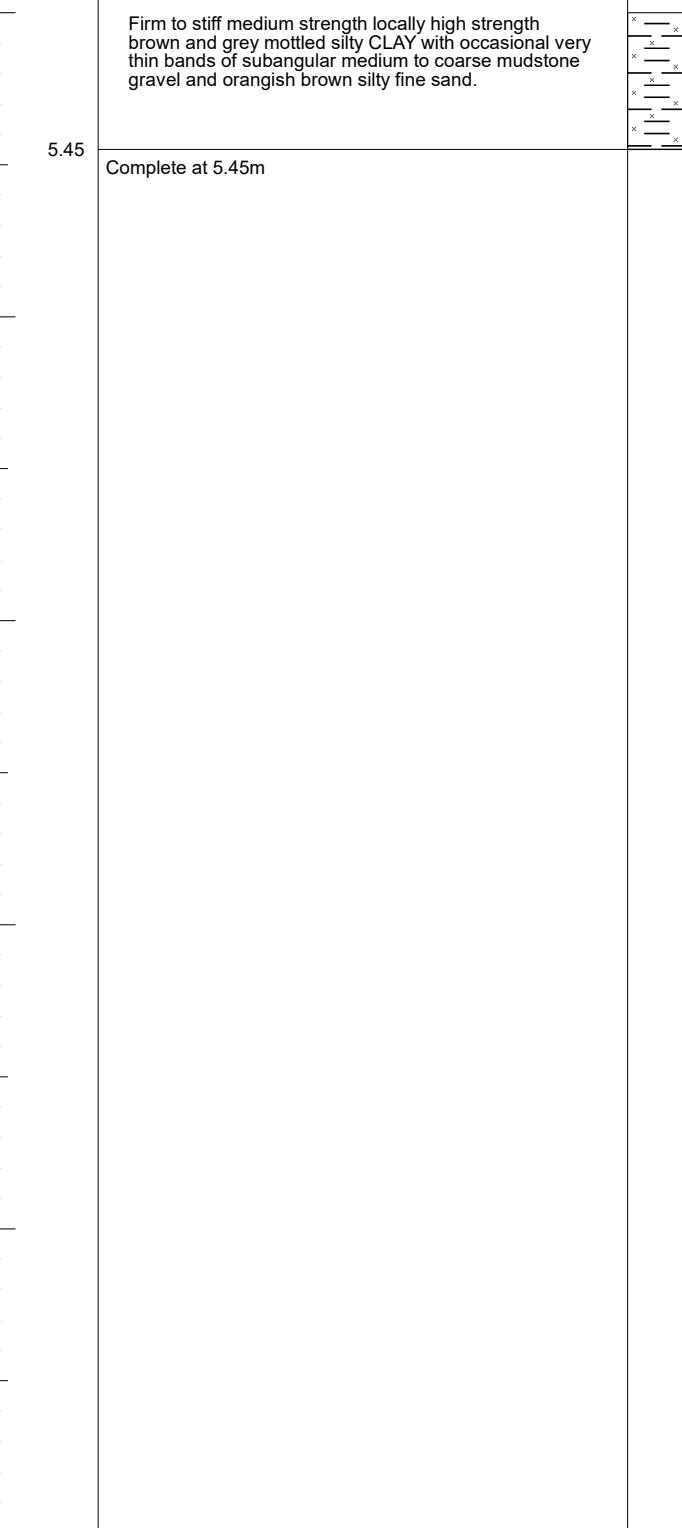
Site

37 THE DRIVE, ICKENHAM, GREATER LONDON

Borehole Number
M1

Boring Method MINI PERCUSSIVE		Casing Diameter			Ground Level (mOD)		Client SQUARE HOUSE LTD	
		Location AS PLAN			Dates 07/03/2018		Architect JPB ARCHITECTS	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend
5.00-5.45	D			07/03/2018: _____		5.45	Stiff high strength brown and occasional light brown and grey silty CLAY. Complete at 5.45m	
Remarks							Scale (approx) 1:25	Logged By TP/SJ
							Figure No. SE1447.M1	

 SUB SURFACE SITE INVESTIGATION, GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS 3 Peel Street, Preston, PR2 2QS. Tel. (01772) 561135 Fax (01772) 204907							Site 37 THE DRIVE, ICKENHAM, GREATER LONDON		Borehole Number M2
Boring Method MINI PERCUSSIVE		Casing Diameter			Ground Level (mOD)		Client SQUARE HOUSE LTD		Job Number SE1447
		Location AS PLAN			Dates 07/03/2018		Architect JPB ARCHITECTS		Sheet 1/2
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description		Legend Water
0.20	B					(0.40)	MADE GROUND: grass over dark greyish brown slightly organic slightly gravelly sandy silty clay with some rootlets. Gravel sized fragments are fine to coarse stone and occasional concrete.		
0.50	B					0.40	Soft to firm low to medium strength locally stiff high strength light brown to brown with grey mottling silty CLAY with occasional very thin bands of orangish brown silty fine sand.		
1.20-1.65 1.20-1.65 1.20-2.00	SPT N=10 D C			1,2/2,2,3,3 1.20m to 2.00m - 100% recovery		(2.60) at 1.70m : stiff high strength		
2.00-2.45 2.00-2.45 2.00-3.00	SPT N=7 D C			HV@1.70m, c=80kPa 1,2/1,2,2,2 2.00m to 3.00m - 95% recovery		 at 2.60m : stiff high strength		
3.00-3.45 3.00-3.45 3.00-4.00	SPT N=14 D C			HV@2.60m, c=84kPa 2,2/3,3,4,4 3.00m to 4.00m - 90% recovery		3.00	Firm to stiff medium strength locally high strength brown and grey mottled silty CLAY with occasional very thin bands of subangular medium to coarse mudstone gravel and orangish brown silty fine sand.		
4.00-4.45 4.00-4.45 4.00-5.00	SPT N=15 D C			HV@3.60m, c=86kPa 1,3/4,3,3,5 4.00m to 5.00m - 95% recovery		(2.45) at 3.60m : stiff high strength from 4.00m : brown		
5.00-5.45	SPT N=16			2,3/3,3,4,6					
Remarks Hand dug inspection pit from GL to 1.20m to check for services. C = Plastic lined core sample Core diameter : 86mm to 2.00m, 78mm to 3.00m, 68mm to 4.00m and 56mm to 5.00m HV = Hand Shear Vane test On completion backfilled with arisings.								Scale (approx)	Logged By
								1:25	TP/SJ
								Figure No. SE1447.M2	

 SUB SURFACE SITE INVESTIGATION, GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS 3 Peel Street, Preston, PR2 2QS. Tel. (01772) 561135 Fax (01772) 204907						Site 37 THE DRIVE, ICKENHAM, GREATER LONDON		Borehole Number M2			
Boring Method MINI PERCUSSIVE		Casing Diameter			Ground Level (mOD)		Client SQUARE HOUSE LTD				
		Location AS PLAN			Dates 07/03/2018		Architect JPB ARCHITECTS				
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description				
5.00-5.45	D			07/03/2018:DRY		5.45	Firm to stiff medium strength locally high strength brown and grey mottled silty CLAY with occasional very thin bands of subangular medium to coarse mudstone gravel and orangish brown silty fine sand.  Complete at 5.45m				
Remarks								Scale (approx) 1:25	Logged By TP/SJ		
Figure No. SE1447.M2											

 SUB SURFACE SITE INVESTIGATION, GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS 3 Peel Street, Preston, PR2 2QS. Tel. (01772) 561135 Fax (01772) 204907							Site 37 THE DRIVE, ICKENHAM, GREATER LONDON			Borehole Number M3		
Boring Method MINI PERCUSSIVE		Casing Diameter			Ground Level (mOD)		Client SQUARE HOUSE LTD			Job Number SE1447		
		Location AS PLAN			Dates 07/03/2018		Architect JPB ARCHITECTS			Sheet 1/2		
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description		Legend	Water	Instr	
0.20	B					(0.30)	MADE GROUND: grass over dark brown and dark greyish brown slightly organic slightly gravelly sandy silty clay with some rootlets. Gravel sized fragments are fine to coarse stone.					
0.50	B					0.30 (0.50)	Brownish grey slightly clayey sandy angular to rounded fine to coarse flint, sandstone and quartz GRAVEL.					
1.20-1.65 1.20-1.65 1.20-2.00	SPT N=9 D C			1,1/2,2,2,3 1.20m to 2.00m - 100% recovery		0.80 (1.80)	Soft to firm low strength locally medium strength light brown with grey mottling silty CLAY.					
2.00-2.45 2.00-2.45 2.00-3.00	SPT N=8 D C			HV@1.70m, c=74kPa 3,1/1,2,2,3 2.00m to 3.00m - 90% recovery		2.60 at 1.70m : firm medium strength at 2.50m : flint cobble					
3.00-3.45 3.00-3.45 3.00-4.00	SPT N=11 D C			Seepage(1) at 2.50m. HV@2.70m, c=66kPa 1,1/3,3,2,3 3.00m to 4.00m - 100% recovery		2.60 (2.85)	Firm to stiff medium strength locally high strength thinly laminated brown and grey mottled silty CLAY with occasional thin laminations of silt and very thin bands of subangular medium to coarse mudstone gravel.				▽1	
4.00-4.45 4.00-4.45 4.00-5.00	SPT N=14 D C			HV@3.60m, c=90kPa 1,2/3,3,4,4 4.00m to 5.00m - 100% recovery		2.85 at 3.60m : high strength					
5.00-5.45	SPT N=18			2,3/3,3,6,6								
Remarks Hand dug inspection pit from GL to 1.20m to check for services. C = Plastic lined core sample Core diameter : 86mm to 2.00m, 78mm to 3.00m, 68mm to 4.00m and 56mm to 5.00m HV = Hand Shear Vane test On completion backfilled with arisings and installed a 50mm dia slotted standpipe with a gas valve and a gravel surround to 5.00m, a Bentonite seal from 1.00m to 0.20m and a concreted in lockable steel protective cover from 0.20m to GL.									Scale (approx)	Logged By		
									1:25	TP/SJ		
									Figure No. SE1447.M3			



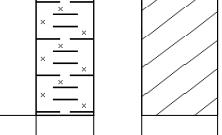
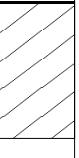
SUB SURFACE

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Site

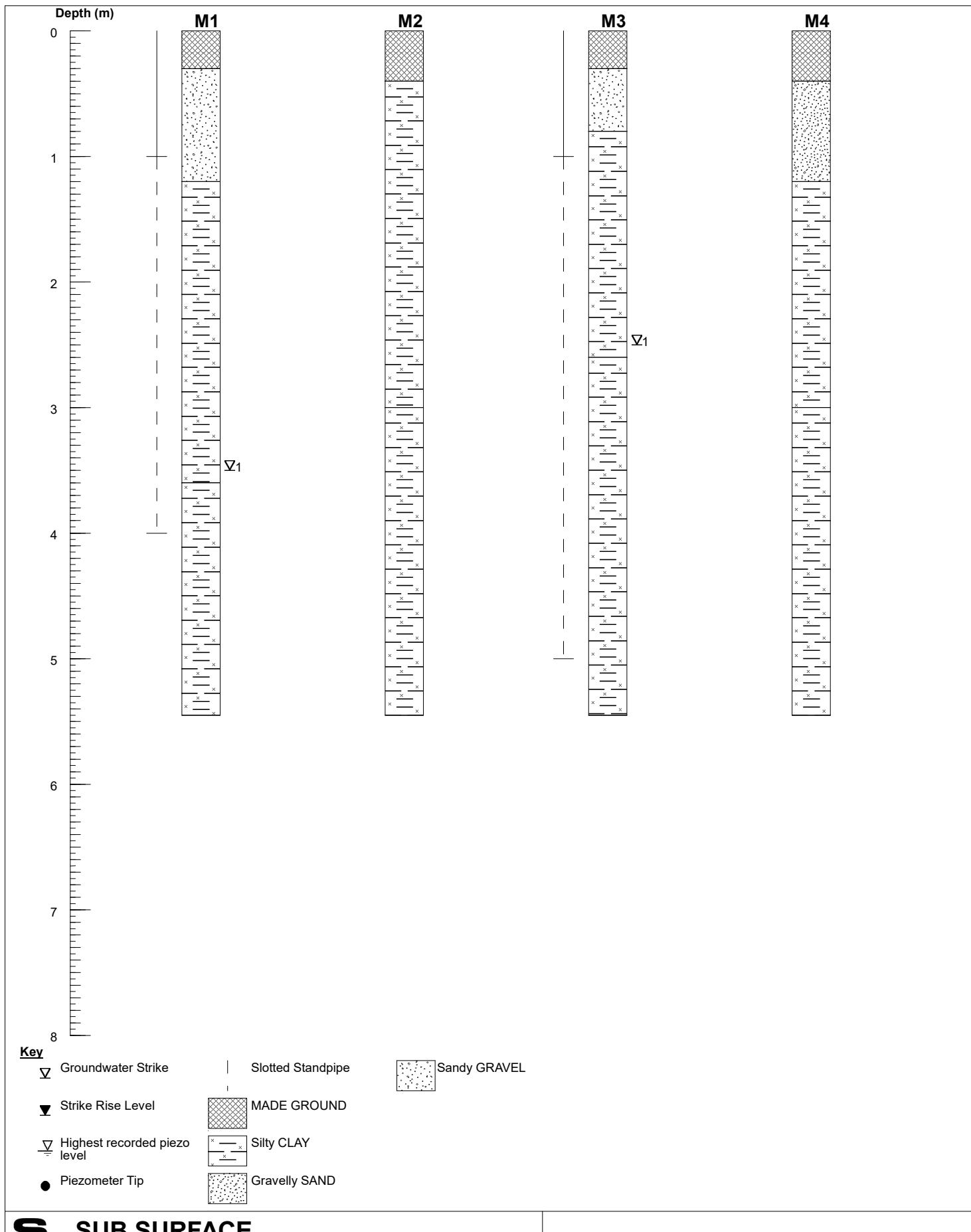
37 THE DRIVE, ICKENHAM, GREATER LONDON

Borehole Number
M3

						Client SQUARE HOUSE LTD			Job Number SE1447	
Boring Method MINI PERCUSSIVE		Casing Diameter			Ground Level (mOD)		Architect JPB ARCHITECTS			Sheet 2/2
		Location AS PLAN			Dates 07/03/2018					
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description		Legend	Water Instr
5.00-5.45	D			07/03/2018: _____		5.45	Firm to stiff medium strength locally high strength thinly laminated brown and grey mottled silty CLAY with occasional thin laminations of silt and very thin bands of subangular medium to coarse mudstone gravel.			
Complete at 5.45m										
Remarks								Scale (approx)	Logged By	
								1:25	TP/SJ	
								Figure No. SE1447.M3		

 SUB SURFACE SITE INVESTIGATION, GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS 3 Peel Street, Preston, PR2 2QS. Tel. (01772) 561135 Fax (01772) 204907							Site 37 THE DRIVE, ICKENHAM, GREATER LONDON		Borehole Number M4
Boring Method MINI PERCUSSIVE		Casing Diameter			Ground Level (mOD)		Client SQUARE HOUSE LTD		Job Number SE1447
		Location AS PLAN			Dates 07/03/2018		Architect JPB ARCHITECTS		Sheet 1/2
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description		Legend Water
0.20	B					(0.40)	MADE GROUND: grass over dark greyish brown slightly organic gravelly sandy silty clay with some rootlets. Gravel sized fragments are fine to coarse stone and occasional glass.		
0.60	B					0.40 (0.80)	Brown slightly silty gravelly medium SAND. Gravel is angular to subrounded fine to coarse flint.		
1.20-1.65 1.20-1.65 1.20-2.00	SPT N=12 D C			2,2/2,3,3,4 1.20m to 2.00m - 100% recovery		1.20	Firm to stiff medium strength locally high strength light brown with grey mottling silty CLAY. at 1.70m : high strength		
2.00-2.45 2.00-2.45 2.00-3.00	SPT N=11 D C			HV@1.70m, c=102kPa 2,2/2,3,3,3 2.00m to 3.00m - 100% recovery		(1.80) at 2.10m : very thin band of silty fine sand at 2.60m : high strength		
3.00-3.45 3.00-3.45 3.00-4.00	SPT N=17 D C			HV@2.70m, c=95kPa 3,4/4,4,4,5 3.00m to 4.00m - 100% recovery		3.00	Firm to stiff medium strength locally high strength thinly laminated brown silty CLAY with occasional thin laminations of silt and very thin bands of subangular medium to coarse mudstone gravel. at 3.80m : high strength		
4.00-4.45 4.00-4.45 4.00-5.00	SPT N=17 D C			HV@3.80m, c=90kPa 2,3/4,5,4,4 4.00m to 5.00m - 90% recovery		(2.45)			
5.00-5.45	SPT N=21			3,5/5,5,5,6					
Remarks Hand dug inspection pit from GL to 1.20m to check for services. C = Plastic lined core sample Core diameter : 86mm to 2.00m, 78mm to 3.00m and 68mm to 5.00m HV = Hand Shear Vane test On completion backfilled with arisings.								Scale (approx)	Logged By
								1:25	TP/SJ
								Figure No. SE1447.M4	

 SUB SURFACE SITE INVESTIGATION, GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS 3 Peel Street, Preston, PR2 2QS. Tel. (01772) 561135 Fax (01772) 204907						Site 37 THE DRIVE, ICKENHAM, GREATER LONDON		Borehole Number M4	
Boring Method MINI PERCUSSIVE		Casing Diameter			Ground Level (mOD)		Client SQUARE HOUSE LTD		Job Number SE1447
		Location AS PLAN		Dates 07/03/2018		Architect JPB ARCHITECTS		Sheet 2/2	
Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description		Legend
5.00-5.45	D			07/03/2018:DRY		5.45 at 5.00m : high strength Complete at 5.45m		
Remarks								Scale (approx) 1:25	Logged By TP/SJ
Figure No. SE1447.M4									



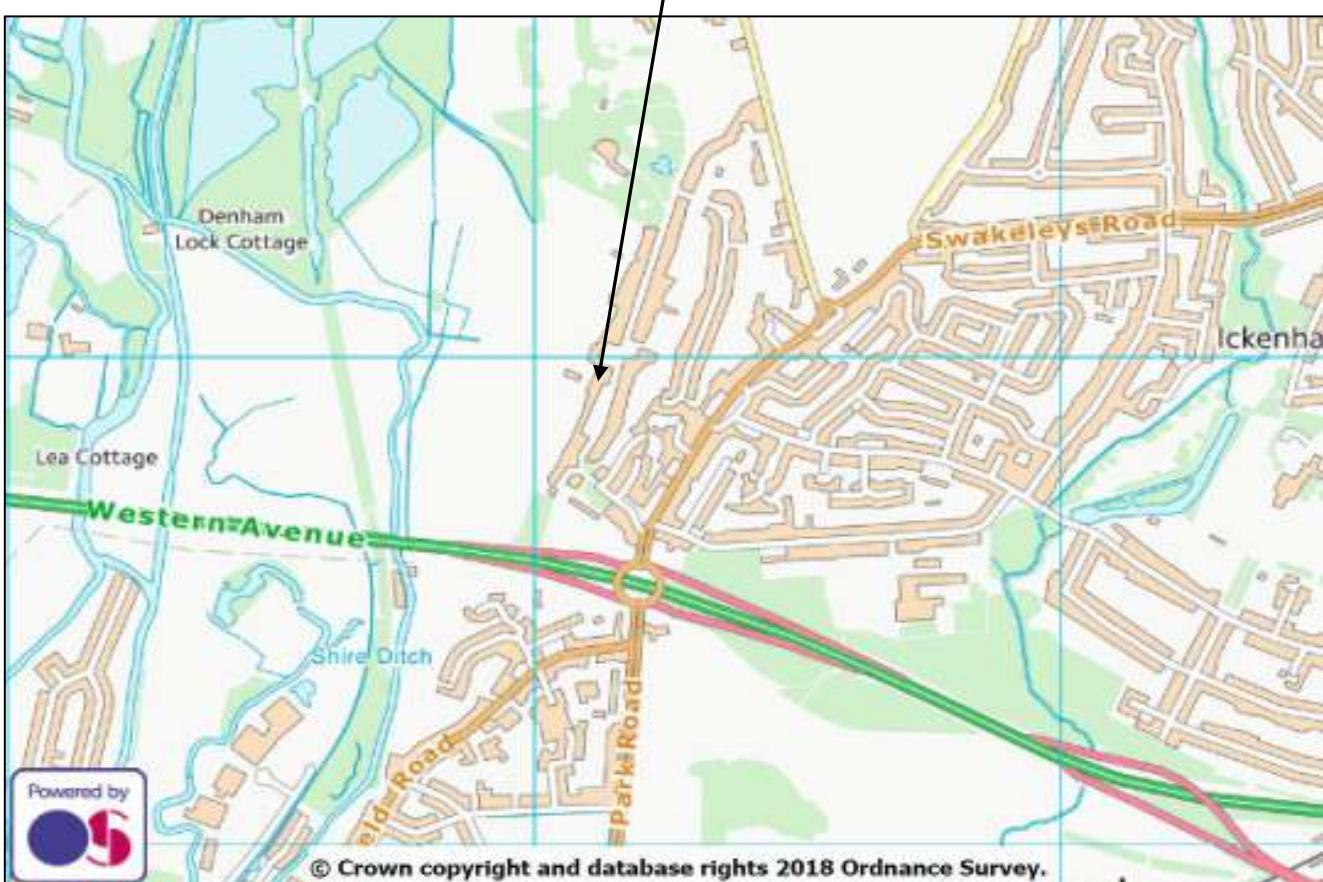
SUB SURFACE

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Nominal Section

Site	Date Drawn	Date Checked	Sheet	Job Number
37 THE DRIVE, ICKENHAM, GREATER LONDON	06/04/2018		1/1	SE1447
Client	Drawn By	Checked By	Scale	Figure No.
SQUARE HOUSE LTD			1:40[V]	SE1447.1

FIGURES



S SUB SURFACE SITE INVESTIGATION AND SPECIALIST GEOTECHNICAL CONSULTANTS 3 Peel Street, Preston, PR2 2QS. Tel. (01772) 56135 Fax (01772) 204907	General Site Location			
Site 37 THE DRIVE, ICKENHAM, LONDON	Date Drawn 30-Apr-18	Date Checked	Orientation N	Job No. SE1447
Client SQUARE HOUSE LTD	Drawn By TP	Checked By	Scale —	Figure No. 1



SUB SURFACE

SITE INVESTIGATION AND SPECIALIST GEOTECHNICAL CONSULTANTS
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Proposed Development

3 Peel Street, Preston, PR2 2QS. Tel. (01772) 56135 Fax (01772) 204907				
Site 37 THE DRIVE, ICKENHAM, LONDON	Date Drawn 30-Apr-18	Date Checked	Orientation 	Job No. SE1447
Client SQUARE HOUSE LTD	Drawn By TP	Checked By	Scale —	Figure No. 3