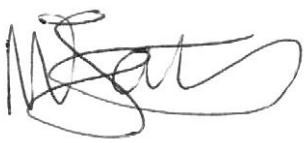
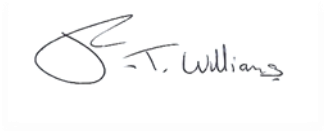
GROUND INVESTIGATION REPORT

for the site at

18 ORNAN ROAD, LONDON NW3 4PX

on behalf of

SOUTHFIELDS PROPERTY LTD

Report Reference: GWPR1313/GIR/August 2015		Status: FINAL
Issue:	Prepared By:	Verified By:
V1.01 August 2015		
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File Reference: Ground and Water/Project Files/ GWPR1313 18 Ornan Road, London NW3 4PX		

CONTENTS

FIGURES

APPENDICES

1.0 INTRODUCTION

1.1 General

Ground and Water Limited were instructed by Southfields Property Ltd on the 19th June 2015 to undertake a Ground Investigation on 18 Ornan Road, London NW3 4PX. The scope of the investigation was detailed within the Ground and Water Limited fee proposal ref.: GWQ2498, dated 12th June 2015.

1.2 Aims of the Investigation

The aim of the investigation was understood to be to supply the client and their designers with information regarding the ground conditions underlying the site to assist them in preparing an appropriate scheme for development.

The investigation was to be undertaken to provide parameters for the design of foundations by means of in-situ and laboratory geotechnical testing undertaken on soil samples recovered from trial holes.

The requirements of the London Borough of Camden, Camden Geological, Hydrogeological and Hydrological Study, Guidance for Subterranean Development (November 2010) was reviewed with respect to this report.

A Desk Study and full scale contamination assessment were not part of the remit of this report.

The techniques adopted for the investigation were chosen considering the anticipated ground conditions and development proposals on-site, and bearing in mind the nature of the site, limitations to site access and other logistical limitations.

1.3 Conditions and Limitations

This report has been prepared based on the terms, conditions and limitations outlined within Appendix A.

2.0 SITE SETTING

2.1 Site Location

The site comprised an approximately rectangular shaped plot of land, totalling ~300m^2 in area and orientated in a north-west to south-east direction. The site was located ~20m north-east of Ornan Road's junction with Percival Avenue and ~100m south-west of Haverstock Hill. The site was located in the Gospal Oak area of Hampstead, north-west London. The site was located within the London Borough of Camden.

The national grid reference for the centre of the site was approximately TQ 27093 85217. A site location plan is given within Figure 1. A plan showing the site area is given within Figure 2.

2.2 Site Description

The site comprised a three storey brick built semi-detached property with front garden accessed via a paved walkway. The front garden was elevated above Ornan Road by ~0.50 – 1.00m with a brick retaining wall fronting the site. A grassed rear garden was accessed via a paved path along the north-eastern side of the property.

From the study of online maps, an underground section/tunnel of the London Overground was noted adjacent to the south-western corner of the site. The Northern Underground Line was noted ~25m north-east of the site.

An aerial view of the site is provided within Figure 3.

2.3 Proposed Development

At the time of reporting, August 2015, it is understood the proposed development will comprise the excavation of a basement beneath the full footprint of the property. The basement will be formed at ~3.00 – 3.50m bgl. A plan and section view of the proposed development can be seen in Figure 4.

2.4 Geology

The BGS Geological Map (Solid and Drift) for the North London area (Sheet No. 256), and Figure 3 and 4 of the Camden Geological, Hydrogeological and Hydrological Study, revealed that the site was underlain by the London Clay Formation.

London Clay Formation

The London Clay Formation comprises stiff grey fissured clay, weathering to brown near surface. Concretions of argillaceous limestone in nodular form (Claystones) occur throughout the formation. Crystals of Gypsum (Selenite) are often found within the weathered part of the London Clay Formation, and precautions against sulphate attack to concrete are sometimes required. The lowest part of the formation is a sandy bed with black rounded gravel and occasional layers of sandstone and is known as the Basement Bed.

A BGS borehole ~150m east of the site revealed ~1.22m of Made Ground over clay.

No areas of Made Ground or Worked Ground were noted within a 250m radius of the site.

2.5 Slope Stability and Subterranean Developments

The site was not situated within an area where a natural or man-made slope of greater than 7^o was present (Figure 16 Camden Geological, Hydrogeological and Hydrological Study).

Figure 17 of the Camden Geological, Hydrogeological and Hydrological Study indicated that the site was not situated within an area prone to landslides.

Figure 18 of the Camden Geological, Hydrogeological and Hydrological Study indicated that an underground section/tunnel of the Thameslink was situated running south-west to north-east immediately south-west of the site's south-western corner. The Northern Underground Line was situated ~25m north-east of the site, running north-west to south-east. No other major subterranean infrastructure (including existing and proposed tunnels) were noted within close proximity to the site.

2.6 Hydrogeology and Hydrology

A study of the aquifer maps on the Environment Agency website, and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study, revealed the site to be located on **Unproductive Strata** relating to the bedrock deposits of the London Clay Formation. No designation was given for any superficial deposits due to their likely absence.

Superficial (Drift) deposits are permeable unconsolidated (loose) deposits, for example, sands and gravels.The bedrock is described as solid permeable formations e.g. sandstone, chalk and limestone.

Unproductive strata are rock layers with low permeability that have negligible significance for water supply or river base flow. These were formerly classified as non-aquifers.

Examination of the Environment Agency records, and Figure 8 of the Camden Geological, Hydrogeological and Hydrological Study, showed that the site did not fall within a Groundwater Source Protection Zone as classified in the Policy and Practice for the Protection of Groundwater.

No surface water features were noted within a 250m radius of the site.

From analysis of hydrogeological and topographical maps groundwater was anticipated to be encountered at depth (>10m below existing ground level (bgl)) and it was considered that the groundwater was flowing in a south-easterly direction in alignment with the local topography.

Examination of the Environment Agency records showed that the site was **not** situated within flood zone or flood warning area.

2.7 Radon

BRE 211 (2007) Map 5 of the London, Sussex and west Kent area revealed the site was located within an area where mandatory protection measures against the ingress of Radon were **unlikely to be** required. The site **was not** located within an area where a risk assessment was required.

3.0 FIELDWORK

3.1 Scope of Works

Fieldwork was undertaken on the 22nd June 2015 and comprised the drilling of two Window Sampler Boreholes (WS1 and WS2) to a depth of 5.00m bgl and the hand excavation of two trial pit foundation exposures (TP/FE1 and TP/FE2). A Heavy Dynamic Probe (HDP) (DP1) was undertaken adjacent to WS1 to a depth of 10.00m bgl.

A small diameter combined bio-gas and groundwater monitoring well was installed within WS1 to 5.00m bgl. The construction of the well installed can be seen tabulated below.

Combined Bio-gas and Groundwater Monitoring Well Construction				
Trial Hole	**Depth of Installation (m bgl)**	**Depth of slotted piping with gravel filter pack (m)**	**Depth of plain piping with bentonite seal (m bgl)**	**Piping external diameter (mm)**
WS1	5.00	4.00	1.00	63

The approximate locations of the trial holes can be seen within Figure 5.

Prior to commencing the ground investigation, a walkover survey was carried out to identify the presence of underground services and drainage. Where underground services/drainage were suspected and/or positively identified, exploratory positions were relocated away from these areas.

Upon completion of the site works, the trial holes were backfilled and made good/reinstated in relation to the surrounding area.

3.2 Sampling Procedures

Small disturbed samples were recovered from the trial holes at the depths shown on the trial hole records. Soil samples were generally retrieved from each change of strata and/or at specific areas of concern. Samples were also taken at approximately 0.5m intervals during broad homogenous soil horizons.

A selection of samples were despatched for geotechnical testing purposes.

4.0 ENCOUNTERED GROUND CONDITIONS

4.1 Soil Conditions

All exploratory holes were logged by James Dalziel of Ground and Water Limited generally in accordance with BS EN 14688 'Geotechnical Investigation and Testing – Identification and Classification of Soil'.

The ground conditions encountered within the trial holes constructed on the site generally conformed to that anticipated from examination of the geology map. Made Ground was noted to overlie the London Clay Formation.

The ground conditions encountered during the investigation are described in this section. For more complete information about the Made Ground and the London Clay Formation at particular points, reference must be made to the individual trial hole logs within Appendix B.

The trial hole location plan can be viewed in Figure 5.

For the purposes of discussion the succession of conditions encountered in the trial holes in descending order can be summarised as follows:

Made Ground
London Clay Formation

Made Ground

Made Ground was encountered from ground level to 1.25m and 1.75m bgl within WS1 and WS2 respectively and for the full depth of both TP/FE1 and TP/FE2. From ground level to a depth of 0.65m bgl within WS1 the soils comprised a dark brown silty clayey gravelly sand. The sand was noted to be fine to medium grained and the gravel was abundant, fine to medium, sub-angular to sub-rounded flint, brick, and concrete. From ground level to a depth beyond 1.30m bgl, a depth beyond 1.00m bgl, to 1.25m bgl and from 0.65 to 1.25m bgl within TP/FE1, TP/FE2, WS1 and WS2 respectively the Made Ground comprised a light brown, locally dark grey brown, sandy gravelly silty clay. The sand was fine to medium grained. The gravel was occasional to abundant, fine to medium, sub-angular to sub-rounded flint, brick, concrete, carbonaceous material (ash/clinker/lignite) and ceramic fragments. From 1.25m to 1.75m bgl within WS1 the Made Ground was described as a light brown sandy gravelly silty clay. The sand was fine grained. The gravel was abundant, medium to coarse, sub-angular brick and lignite.

London Clay Formation

Soils described as representative of the London Clay Formation were encountered underlying the Made Ground within WS1 and WS2 from 1.75m and 1.25m bgl respectively. Deposits of the London Clay Formation were proved for the remaining depths of both trial holes, a maximum of 5.00m bgl and comprised a light brown silty clay. Rare lignite inclusions were noted within WS2.

For details of the composition of the soils encountered at particular points, reference must be made to the individual trial hole logs within Appendix B.

4.2 Foundation Exposures

A description of the foundation layout and ground conditions encountered within the hand dug trial pit foundation exposures are given within this section of the report.

TP/FE1
Trial pit foundation exposure TP/FE1 was hand excavated from ground level at the front of the existing property. The exact location of the trial hole can be seen in Figure 5 with a section drawing of the foundation encountered in Figure 6.

The foundation layout encountered consisted of a brick wall to ground level. The brick wall continued from ground level to a depth of 0.50m bgl. The brick wall was noted to rest upon a concrete footing which stepped out by 0.30m and was 0.30m in thickness. The concrete footing was noted to step back in, towards the property, and was noted to extend to a depth beyond 1.30m bgl. The base of the foundation was not determined due to its depth. The ground conditions encountered directly surrounding the foundation are shown in Figure 6.

TP/FE2
Trial pit foundation exposure TP/FE2 was hand excavated from ground level to the rear of the existing property. The exact location of the trial hole can be seen in Figure 5 with a section drawing of the foundation encountered in Figure 7.

The foundation layout encountered consisted of a brick wall to ground level. The brick wall continued from ground level to a depth of 0.40m bgl. The brick wall was noted to rest upon a concrete footing which stepped out by 0.30m and was 0.30m in thickness. The foundation was noted to rest on Made Ground comprising a light to mid brown sandy gravelly clay. The ground conditions encountered directly surrounding the foundation are shown in Figure 7.

4.3 Roots Encountered
Roots were noted by the supervising engineer to 1.50m and 2.80m bgl within the samples of WS1 and WS2 respectively. Roots were observed by the driller to 2.00m and 2.80m bgl within WS1 and WS2 respectively with traces of roots noted at 4.80m bgl within WS1.

It must be noted that the chance of determining actual depth of root penetration through a narrow diameter borehole is low. Roots may be found to greater depths at other locations on the site, particularly close to trees and/or trees that have been removed both within the site and its close environs.

4.4 Groundwater Conditions
No groundwater was encountered within the trial holes. A return visit to dip the 5.00m deep combined bio-gas and groundwater monitoring well, by a Ground and Water Limited Engineer, on the 4th August 2015 revealed a standing groundwater level of 3.44m bgl.

Exact groundwater levels may only be determined through long term measurements from monitoring wells installed on-site. It should be noted that changes in groundwater level do occur for a number of reasons including seasonal effects and variations in drainage.

The site investigation was conducted in June and August 2015, when groundwater levels should be near their annual minimum (i.e. lowest). The long-term groundwater elevation might increase at some time in the future due to seasonal fluctuation in weather conditions. Isolated pockets of groundwater may be perched within any Made Ground found at other locations around the site.

4.5 Obstructions

No artificial or natural sub-surface obstructions were noted during construction of the trial holes.

5.0 INSITU AND LABORATORY GEOTECHNICAL TESTING

5.1 In-Situ Geotechnical Testing

A Heavy Dynamic Probe (HDP) (DP1) was undertaken adjacent to WS1 to a depth of 10.00m bgl. The test results are presented with the borehole logs within Appendix B.

Windowless Sampler Boreholes provide samples of the ground for assessment but they do not give any engineering data.

Heavy Dynamic Probing involves the driving of a metal cone into the ground via a series of steel rods. These rods are driven from the surface by a hammer system that lifts and drops a 50.0kg hammer onto the top of the rods through a set height (500mm), thus ensuring a consistent energy input. The numbers of hammer blows that are required to drive the cone down by each 100mm increment are recorded. These blow counts then provide a comparative assessment from which correlations have been published, based on dynamic energy, which permits engineering parameters to be generated. (The Dynamic Probe 'Heavy' (HDP) Tests were conducted in accordance with BS 1377; 1990; Part 9, Clause 3.2).

The cohesive soils of the London Formation were classified based on the table below.

Undrained Shear Strength from Field Inspection/equivalent 'SPT's derived from HDP results Cohesive Soils (EN ISO 14688-2:2004 & Stroud (1974))		
Classification	**Undrained Shear Strength (kPa)**	**Field Indications**
Extremely High	>300	-
Very High	150 – 300	Brittle or very tough
High	75 – 150	Cannot be moulded in the fingers
Medium	40 – 75	Can be moulded in the fingers by strong pressure
Low	20 – 40	Easily moulded in the fingers
Very Low	10 – 20	Exudes between fingers when squeezed in the fist
Extremely Low	<10	-

An interpretation of the in-situ geotechnical testing results is given in the table below.

Interpretation of In-situ Geotechnical Testing Results (DP1)					
Strata	**Equivalent 'SPT's derived from HDP results**	**Equivalent Undrained Shear Strength (kPa) Cohesive Soils**	**Soil Type**		**Trial Hole/s**
			Cohesive	**Granular**	
London Clay Formation	4 - 12	20 - 60	Low - Medium	-	WS/DP1(1.75m – 5.00m bgl)
Assumed London Clay Formation*	12 - 26	60 - 130	Medium - High	-	DP1 (5.00 – 10.00m bgl)

*Based on the results of the dynamic probing.

It must be noted that field measurements of undrained shear strength are dependent on a number of variables including disturbance of sample, method of investigation and also the size of specimen or test zone etc.

The test results are presented on the trial hole log within Appendix B.

5.2 Laboratory Geotechnical Testing

A programme of geotechnical laboratory testing scheduled by Ground and Water Limited and carried out by K4 Soils Laboratory and QTS Environmental Limited was undertaken on samples recovered from the London Clay Formation. The results of the tests are presented in Appendix C.

The test procedures used were generally in accordance with the methods described in BS1377:1990.

Details of the specific tests used in each case are given below:

Standard Methodology for Laboratory Geotechnical Testing		
Test	**Standard**	**Number of Tests**
Atterberg Limit Tests	BS1377:1990:Part 2:Clauses 3.2, 4.3 & 5	5
One Dimensional Consolidation Test	BS1377:1990:Part 5:Clause 3 & 4	1
Water Soluble Sulphate & pH	BS1377:1990:Part 3:Clause 5	1
BRE Special Digest 1 (incl. Ph, Electrical Conductivity, Total Sulphate, W/S Sulphate, Total Chlorine, W/S Chlorine, Total Sulphur, Ammonium as NH4, W/S Nitrate, W/S Magnesium)	BRE Special Digest 1 "Concrete in Aggressive Ground (BRE, 2005).	2

5.2.1 Atterberg Limit Tests

A précis of Atterberg Limit Tests undertaken on five samples of the London Clay Formation can be seen tabulated below.

Atterberg Limit Tests Results Summary							
Stratum/Trial Hole/Depth (m bgl)	**Moisture Content (%)**	**Passing 425 μm sieve (%)**	**Modified PI (%)**	**Soil Class**	**Consistency Index (Ic)**	**Volume Change Potential**	
						BRE	**NHBC**
London Clay Formation WS1/2.00m bgl (Brown CLAY with rare fine gravel and occasional black organic flecks)	35	98	56.84	CV	0.93	High	High
London Clay Formation WS1/4.00m bgl (Brown CLAY)	28	100	41.00	CH	0.85	High	High
London Clay Formation WS1/5.00m bgl (Brown CLAY)	31	100	42.00	CV	0.71	High	High
London Clay Formation WS2/1.50m bgl (Brown sandy silty CLAY with rare fine gravel)	23	99	18.81	MV	3.40	Low	Low
London Clay Formation WS2/5.00m bgl (Brown CLAY with orange brown sandy patches)	31	100	40.00	CH	0.85	High	Medium

NB: NP – Non-plastic
BRE Volume Change Potential refers to BRE Digest 240 (based on Atterberg results)
Soil Classification based on British Soil Classification System.
Consistency Index (Ic) based on BS EN IS0 14688-2:2004.

5.2.2 Comparison of Soil's Moisture Content with Index Properties

5.2.2.1 Liquidity Index Analyses

The results of the Atterberg Limit tests undertaken on five samples of the London Clay Formation were analysed to determine the Liquidity Index of the samples. This gives an indication as to whether the samples recovered showed a moisture deficit and their degree of consolidation. The results are tabulated below.

The test results are presented within Appendix C.

Liquidity Index Calculations Summary					
Stratum/Trial Hole/Depth	**Moisture Content (%)**	**Plastic Limit (%)**	**Modified Plasticity Index (%)**	**Liquidity Index**	**Result**
London Clay Formation WS1/2.00m bgl (Brown CLAY with rare fine gravel and occasional black organic flecks)	35	30	56.84	0.09	Heavily Overconsolidated
London Clay Formation WS1/4.00m bgl (Brown CLAY)	28	24	41	0.10	Heavily Overconsolidated
London Clay Formation WS1/5.00m bgl (Brown CLAY)	31	28	42	0.07	Heavily Overconsolidated
London Clay Formation WS2/1.50m bgl (Brown sandy silty CLAY with rare fine gravel)	23	16	18.81	0.37	Overconsolidated
London Clay Formation WS2/5.00m bgl (Brown CLAY with orange brown sandy patches)	31	26	40	0.13	Heavily Overconsolidated

The results in the table above indicated that there were no moisture deficits within the overconsolidated to heavily overconsolidated samples of the London Clay Formation tested.

5.2.2.2 Liquid Limit

A comparison of the soil moisture content and the liquid limit can be seen tabulated overpage.

Moisture Content vs. Liquid Limit				
Strata/Trial Hole/Depth/Soil Description	**Moisture Content (MC) (%)**	**Liquid Limit (LL) (%)**	**40% Liquid Limit (LL)**	**Result**
London Clay Formation WS1/2.00m bgl (Brown CLAY with rare fine gravel and occasional black organic flecks)	35	88	35.2	**MC < 0.4 x LL (Potential Significant Moisture Deficit)**
London Clay Formation WS1/4.00m bgl (Brown CLAY)	28	65	26	MC > 0.4 x LL (Not Significantly Desiccated)
London Clay Formation WS1/5.00m bgl (Brown CLAY)	31	70	28	MC > 0.4 x LL (Not Significantly Desiccated)
London Clay Formation WS2/1.50m bgl (Brown sandy silty CLAY with rare fine gravel)	23	35	14	MC > 0.4 x LL (Not Significantly Desiccated)
London Clay Formation WS2/5.00m bgl (Brown CLAY with orange brown sandy patches)	31	66	26.4	MC > 0.4 x LL (Not Significantly Desiccated)

The results in the table above indicated that a potential significant moisture deficit was present within one sample of the London Clay Formation tested (WS1/2.00m). The moisture content value was below 40% of the liquid limit.

The sample was described as a light brown silty clay. Roots were noted to 1.50m and to 2.00m bgl by the supervising engineer and the driller respectively. Consequently the apparent moisture deficit was likely to be related to a combination of the lithology of the soil (overconsolidated to heavily overconsolidated soils) and the water demand of roots from nearby trees.

The results in the table above indicate that the remaining samples of the London Clay Formation tested showed no evidence of a significant moisture deficit.

5.2.3 One Dimensional Consolidation Test

A one dimensional Swelling Test was undertaken on a disturbed sample obtained from WS1 at a depth of 3.50m bgl. The results of the test are tabulated below.

One Dimensional Consolidation Test - Swelling									
Stratum/Depth		**Height (mm)**	**Moisture Content (%)**	**Bulk Density (Mg/m^3)**	**Dry Density (Mg/m^3)**	**Void Ratio**	**Degree of Saturation (%)**	**Particle Density (Mg/m^3)**	**Swelling Pressure (kpa)**
London Clay Formation WS1/3.50m bgl (Brown silty CLAY)	Initial	15.90	29.9	1.89	1.45	0.857	94	2.70	50
	Final	16.63	37.1	-	-	-	-	-	-

It must be noted that the sample was remoulded and this must be taken into account in final design.

5.2.4 Sulphate and pH Tests

A Sulphate and pH test was undertaken on one sample from the London Clay Formation (WS2/4.00m bgl). A sulphate concentration of 1.98g/l with a pH of 7.69 was determined.

5.2.5 BRE Special Digest 1

In accordance with BRE Special Digest 1 'Concrete in Aggressive Ground' (BRE, 2005) two samples of the London Clay Formation (WS1/2.50m and WS2/3.50m bgl) were scheduled for laboratory analysis to determine parameters for concrete specification.

The results are given within Appendix C and a summary is tabulated below.

Summary of Results of BRE Special Digest Testing

Determinand	Unit	Minimum	Maximum
pH	-	7.5	7.7
Ammonium as NH_4	mg/kg	5.1	5.4
Sulphur	%	0.05	0.05
Chloride (water soluble)	mg/kg	8	12
Magnesium (water soluble)	g/l	16	20
Nitrate (water soluble)	mg/kg	<3	<3
Sulphate (water soluble)	mg/l	513	548
Sulphate (total)	%	0.12	0.21

6.0 ENGINEERING CONSIDERATIONS

6.1 Soil Characteristics and Geotechnical Parameters

Based on the results of the intrusive investigation and geotechnical laboratory testing the following interpretations have been made with respect to engineering considerations.

- Made Ground was encountered from ground level to a depth of 1.25 - 1.75m bgl.

  As a result of the inherent variability of Made Ground, it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should, therefore, be taken through any Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

  Made Ground may be found to deeper depth at other locations on the site, especially close to former structures/foundations and service runs.

- Soils described as the London Clay Formation were encountered underlying the Made Ground and was proved for the remaining depth of the trial holes, a maximum of 5.00m bgl.

  The deposits encountered were described as a light brown silty clay. Rare lignite inclusions were noted within WS2.

  The soils of the London Clay Formation were noted to have low to high undrained shear strength (20 – 130kpa).

  Geotechnical testing revealed the soils of the London Clay Formation to have a **low to high volume change potential** in accordance with both BRE240 and NHBC Standards Chapter 4.2. Consistency Index calculations indicated these soils to be firm to very stiff. The deposits of the London Clay Formation were shown to be overconsolidated to heavily overconsolidated cohesive soils.

  A potential significant moisture deficit was present within one sample of the London Clay Formation tested (WS1/2.00m). The apparent moisture deficit was likely to be related to a combination of the lithology of the soil (overconsolidated to heavily overconsolidated soils) and the water demand of roots from nearby trees.

  The overconsolidated and heavily overconsolidated cohesive soils of the London Clay Formation were considered a suitable bearing stratum for moderately loaded footings/foundations. Settlements on loading are likely to be moderate.

  The final design of foundations will need to take into account the volume change potential of the soil, the depth of root penetration and/or desiccation and the likely serviceability and settlement requirements of the proposed structure. These parameters for design are discussed in the next section of this report.

- No groundwater was encountered within the trial holes.

- Roots were noted by the supervising engineer to 1.50m and 2.80m bgl within the samples of WS1 and WS2 respectively. Roots were observed by the driller to 2.00m and 2.80m bgl

within WS1 and WS2 respectively with traces of roots noted at 4.80m bgl within WS1.

6.2 Basement Foundations

At the time of reporting, August 2015, it is understood that the proposed development will comprise the excavation of a basement beneath the full footprint of the property. The basement will be formed at ~3.00 – 3.50m bgl. A plan showing the proposed development can be seen in Figure 4.

The proposed development is likely to fall within Geotechnical Design Category 2 in accordance with Eurocode 7. The proposed foundation loads were not known to Ground and Water Limited at the time of reporting but are likely to range from 75 – 150kN/m^2.

Foundations constructed within the soils of the London Clay Formation should be designed in accordance with soils of **high volume change potential** in accordance with BRE Digest 240 and NHBC Chapter 4.2.

Given the cohesive nature of the shallow deposits, foundations must therefore **not** be placed within cohesive root penetrated and/or desiccated soils and the influence of the trees surrounding the site must be taken into account (NHBC Standards Chapter 4.2). It is recommended that foundations are taken at least 300mm into non-root penetrated strata.

It was considered unlikely the traces of roots noted at 4.80m bgl would prove a risk to the serviceability of the proposed structure, therefore given fresh roots were noted to 2.80m bgl a minimum foundation depth of 3.10m bgl is considered necessary.

It is considered likely the proposed basements will be constructed with load bearing concrete retaining walls with semi-ground bearing concrete floors.

The following bearing capacities could be adopted for 5.0m long by 0.75m and 1.0m wide footings, or 1.50m by 1.50m pads at depths of 3.10m and 3.50m bgl. The bearing capacities are tabulated below.

Limit State: Bearing Capacities Calculated (Based on DP1)		
Depth (m BGL)	**Foundation System**	**Limit Bearing Capacity (kN/m^2) (EC2)**
3.10m	5.00m by 0.75m Strip	166.25
	5.00m by 1.00m Strip	167.68
	1.50m by 1.50m Pad	182.67
3.50m	5.00m by 0.75m Strip	183.89
	5.00m by 1.00m Strip	185.46
	1.50m by 1.50m Pad	203.88

Serviceability State: Settlement Parameters Calculated (Based on DP1)			
Depth (m BGL)	**Foundation System**	**Limit Bearing Capacity (kN/m²)**	**Settlement (mm)**
3.1m	5.00m by 0.75m Strip	150	<23
	5.00m by 1.00m Strip	140	~23
	1.50m by 1.50m Pad	150	<23
3.5m	5.00m by 0.75m Strip	150	<20
	5.00m by 1.00m Strip	150	~23
	1.50m by 1.50m Pad	150	<20

It must be noted that a bearing capacity of less than 48kN/m^2 and 56kN/m^2 at 3.10m and 3.50m bgl respectively could result in heave due to a reduction in effective stress at depth. This will need to be taken into account in the final design. A swelling pressure of 50kpa was determined on a disturbed samples recovered from WS1 at 3.50m bgl.

Excavations must be kept dry and either concreted or blinded as soon after excavation as possible. If water were allowed to accumulate on the formation level for even a short time not only would an increase in heave occur resulting from the soil increasing in volume by taking up water, but also the shear strength and hence the bearing capacity would also be reduced.

Groundwater was not encountered in either trial hole. A return visit to dip the 5.00m deep combined bio-gas and groundwater monitoring well, by a Ground and Water Limited Engineer, on the 4th August 2015 revealed a standing groundwater level of 3.44m bgl. This was considered likely to represent perched water, within the Made Ground or silt/sand horizons within the London Clay Formation, or surface water ponding within the well installed.

Therefore, groundwater is unlikely to be encountered during excavation of the basement. However, perched water is likely to be encountered. The advice of a reputable dewatering contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the design of the excavation for the basement.

If the construction works take place during the winter months, when the groundwater level is expected to be at its higher elevation, additional perched water could accumulate.

General Recommendations for Spread Foundations:

- Foundation excavations must be carefully bottomed out and any loose soil or soft spots removed prior to the foundation concrete or blinding being placed. Failure to ensure that foundation excavations are suitably bottomed out could result in additional settlements.

- Inspection of foundation excavations, prior to concreting, must be made by a competent and suitably qualified person to check for any soft spots and to check for the presence of roots.

- The excavation must be kept dry as accumulation of water could result in increased settlements.

- Foundations must not be cast over foundations of former structures and/or other hard spots.

- Any groundwater or surface water ingress must be prevented from entering foundation

trenches.

- Isolated Pad Foundations must be at least 1.5 times the width of the widest pad apart to keep to the anticipated settlements.

- Special foundation precautions will be required to prevent possible future shrinkage/swelling within clay strata affecting the integrity of the ground beams. A void, void former or compressible layer must be provided to accommodate potential movement below all ground beams. Compressible material or a void former should also be provided against the inside faces of ground beams.

- Final designs for the foundations should be carried out by a suitably qualified Engineer based on the findings of this investigation and with reference to the anticipated loadings, serviceability requirements for the structure and the developments proximity to former, present and proposed trees.

6.3 Piled Foundations

Based on the results of the investigation it was considered unlikely that a piled foundations scheme would be required at this site.

6.4 Basement Excavations and Stability

Shallow excavations in the Made Ground and London Clay Formation are likely to be marginally stable at best. Long, deep excavations, through these strata are likely to become unstable.

The excavation of the basement must not affect the integrity of the adjacent structures beyond the boundaries. The excavation must be supported by suitably designed retaining walls. It is considered unlikely that battering the sides of the excavation, casting the retaining walls and then backfilling to the rear of the walls would be suitable given the close proximity of the party walls.

The retaining walls for the basement will need to be constructed based on cohesive soils with an appropriate angle of shear resistance (Φ') for the ground conditions encountered.

Based on the ground conditions encountered within DP1 the following parameters could be used in the design of retaining walls. These have been designed based the results of geotechnical classification tests and reference to literature.

Retaining Wall/Basement Design Parameters					
Strata	**Unit Volume Weight (kN/m³)**	**Cohesion Intercept (c') (kPa)**	**Angle of Shearing Resistance (Ø)**	**Ka**	**Kp**
Made Ground	~15	0	12	0.66	1.52
London Clay Formation	~20	0	24	0.42	2.37

Unsupported earth faces formed during excavation may be liable to collapse without warning and suitable safety precautions should therefore be taken to ensure that such earth faces are adequately supported before excavations are entered by personnel.

6.5 Hydrogeological Effects

A study of the aquifer maps on the Environment Agency website revealed the site to be located on **Unproductive Strata** relating to the bedrock deposits of the London Clay Formation. No designation was given for any superficial deposits due to their likely absence.

The ground conditions encountered within the trial holes constructed on the site generally conformed to that anticipated from examination of the geology map. Made Ground was noted to overlie the London Clay Formation.

Based on a visual appraisal of the soils encountered, the permeability of the cohesive London Clay Formation was considered to be low.

Groundwater was not encountered in either trial hole. A return visit to dip the 5.00m deep combined bio-gas and groundwater monitoring well, by a Ground and Water Limited Engineer, on the 4th August 2015 revealed a standing groundwater level of 3.44m bgl. This was considered likely to represent perched water, within the Made Ground or silt/sand horizons within the London Clay Formation, or surface water ponding within the well installed.

Therefore, groundwater is unlikely to be encountered during excavation of the basement. However, perched water is likely to be encountered. The advice of a reputable dewatering contractor, familiar with the type of ground and groundwater conditions encountered on this site, should be sought prior to finalising the design of the excavation for the basement.

Based on the above it is considered unlikely that groundwater will be encountered during basement construction. However, perched water could accumulate during basement construction, especially after a period of prolongued rainfall.

Higher groundwater levels during winter months or during inclement weather may affect basement construction.

Once constructed, the Made Ground and the London Clay Formation are unlikely to act as a porous medium for water to migrate through; therefore, additional drainage around the basement should be considered.

6.6 Sub-Surface Concrete

Sulphate concentrations were measured in 2:1 water/soil extracts taken from the London Clay Formation fell into class DS-1 – DS-3 of the BRE Special Digest 1, 2005, *'Concrete in Aggressive Ground'.*

Table C1 of the Digest indicated an ACEC (Aggressive Chemical Environment for Concrete) classification of AC-3. For the classification given, the "mobile" and "natural" case was adopted given the geology, London Clay Formation with silt bands, presence of Made Ground and standing water at 3.44m bgl during return visit, and the residential use of the site. The sulphate concentration in the samples ranged from 513 - 1980mg/l with a pH range of 7.5 – 7.7. The total potential sulphate concentrations ranged from 0.12 – 0.21%.

Concrete to be placed in contact with soil or groundwater must be designed in accordance with the recommendations of Building Research Establishment Special Digest 1, 2005, *'Concrete in Aggressive*

Ground' taking into account the pH of the soils.

It is prudent to note that pyrite nodules may be present within the London Clay Formation. Pyrite can oxidise to gypsum and this normally only occurs in the upper weathered layer, but excavation allows faster oxidation and water soluble sulphate values can rapidly increase during construction. Therefore rising sulphate values should be taken into account should ferruginous staining/pyrite nodules be encountered within the London Clay Formation.

6.7 Surface Water Disposal

Infiltration tests were beyond the scope of the investigation.

Soakaways constructed within the cohesive soils of the London Clay Formation are unlikely to prove satisfactory due to low anticipated infiltration rates. Therefore an alternative method of surface water disposal is required.

Consultation with the Environment Agency must be sought regarding any use that may have an impact on groundwater resources.

The principles of sustainable urban drainage system (SUDS) should be applied to reduce the risk of flooding from surface water ponding and collection associated with the construction of the basement.

6.8 Discovery Strategy

There may be areas of contamination that have not been identified during the course of the intrusive investigation. For example, there may have been underground storage tanks (UST's) not identified during the Ground Investigation for which there is no historical or contemporary evidence.

Such occurrences may be discovered during the demolition and construction phases for the redevelopment of the site.

Groundworkers should be instructed to report to the Site Manager any evidence for such contamination; this may comprise visual indicators, such as fibrous materials within the soil, discolouration, or odours and emission. Upon discovery advice must be taken from a suitably qualified person before proceeding, such that appropriate remedial measures and health and safety protection may be applied.

Should a new source of contamination be suspected or identified then the Local Authority will need to be informed.

6.9 Waste Disposal

Foundation excavations on-site are likely to produce waste which will require classification and then recycling or removal from site.

Under the Landfill (England and Wales) Regulations 2002 (as amended), prior to disposal all waste must be classified as;

- Inert;
- Non-hazardous, or;
- Hazardous.

The Environment Agency's Hazardous Waste Technical Guidance (WM2) document outlines the methodology for classifying wastes.

Once classified the waste can be removed to the appropriately licensed facilities, with some waste requiring pre-treatments prior to disposal.

INERT waste classification should be undertaken to determine if the proposed waste confirms to INERT or NON-HAZARDOUS Waste Acceptable Criteria (WAC).

6.10 Imported Material

Any soil which is to be imported onto the site must undergo chemical analysis to prove that it is suitable for the purpose for which it is intended.

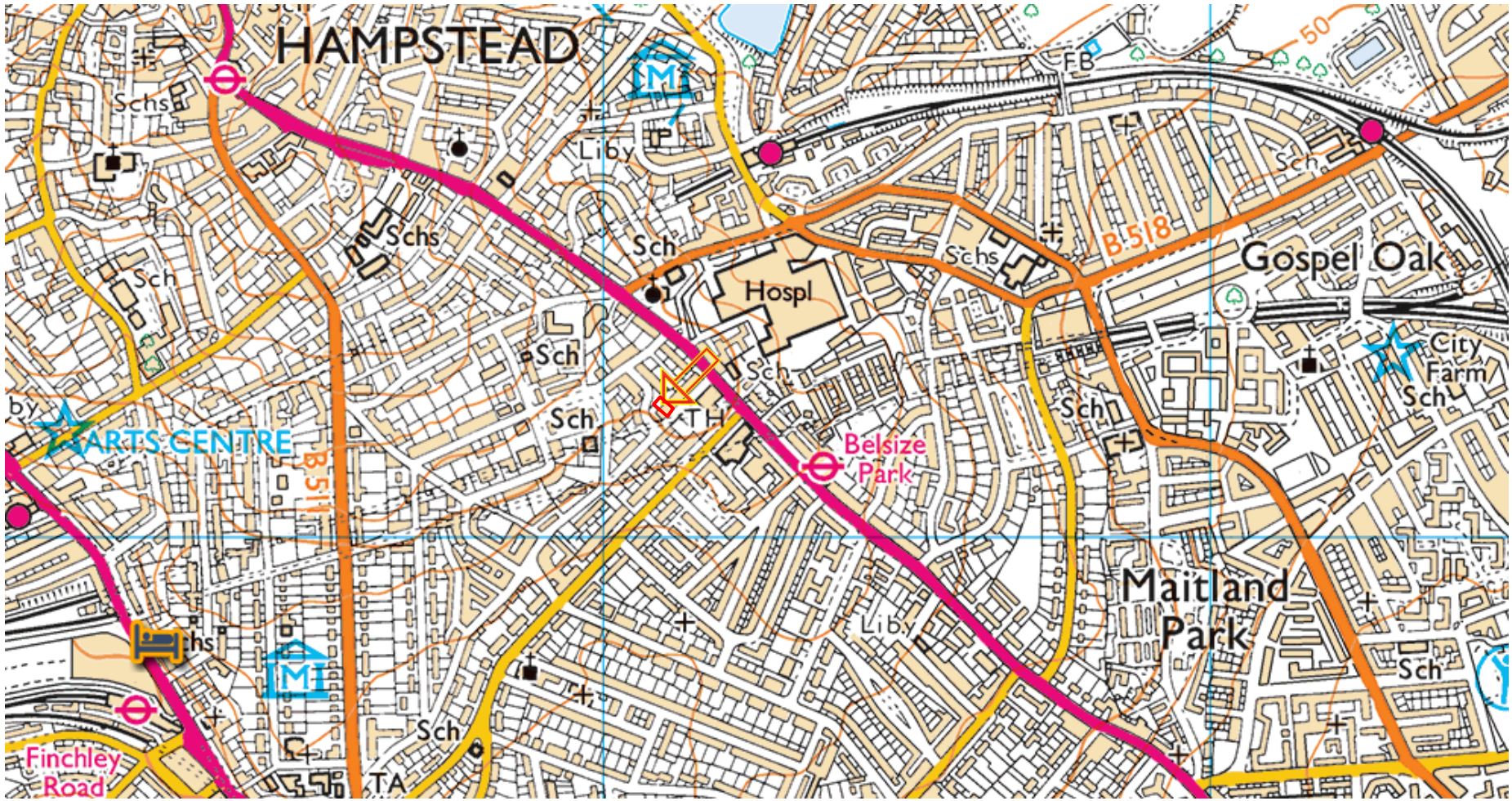
The Topsoil must be fit for purpose and must either be supplied with traceable chemical laboratory test certificates or be tested, either prior to placing (ideally) or after placing, to ensure that the human receptor cannot come into contact with compounds that could be detrimental to human health.

6.11 Duty of Care

Groundworkers must maintain a good standard of personal hygiene including the wearing of overalls, boots, gloves and eye protectors and the use of dust masks during periods of dry weather.

To prevent exposure to airborne dust by both the general public and construction personnel the site should be kept damp during dry weather and at other times when dust were generated as a result of construction activities.

The site should be securely fenced at all times to prevent unauthorised access. Washing facilities should be provided and eating restricted to mess huts.

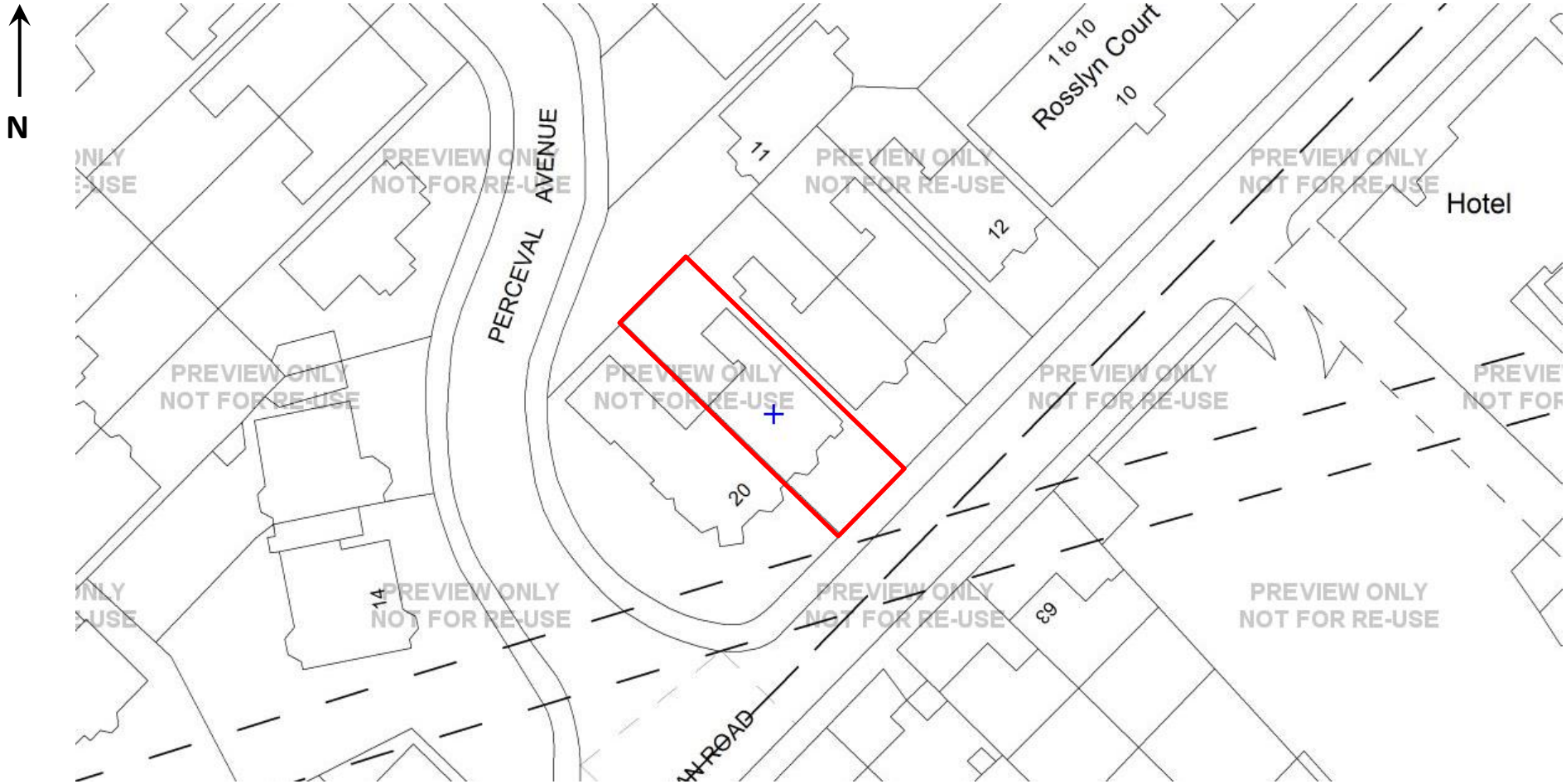


APPROXIMATE SITE BOUNDARY

NOTE: NOT TO SCALE

Project: 18 Ornan Road, London NW3 4PX	**Figure 1**
Client: Southfields Property Ltd	**Date:** August 2015
Site Location Plan	**Ref:** GWPR1313

ground&water



APPROXIMATE SITE BOUNDARY

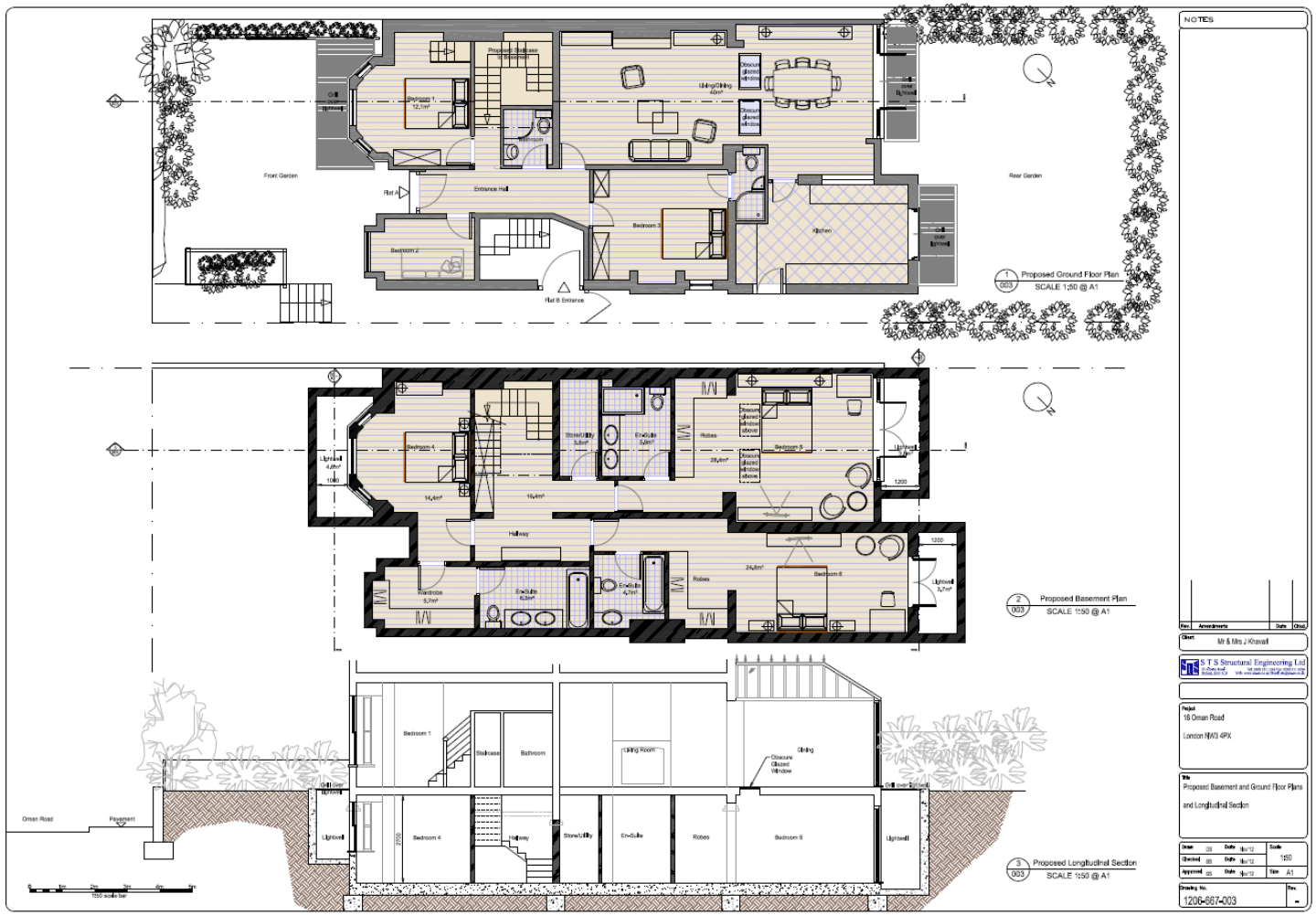
NOTE: NOT TO SCALE

Project: 18 Ornan Road, London NW3 4PX	**Figure 2**
Client: Southfields Property Ltd	**Date:** August 2015
Site Development Area	**Ref:** GWPR1313

ground&water

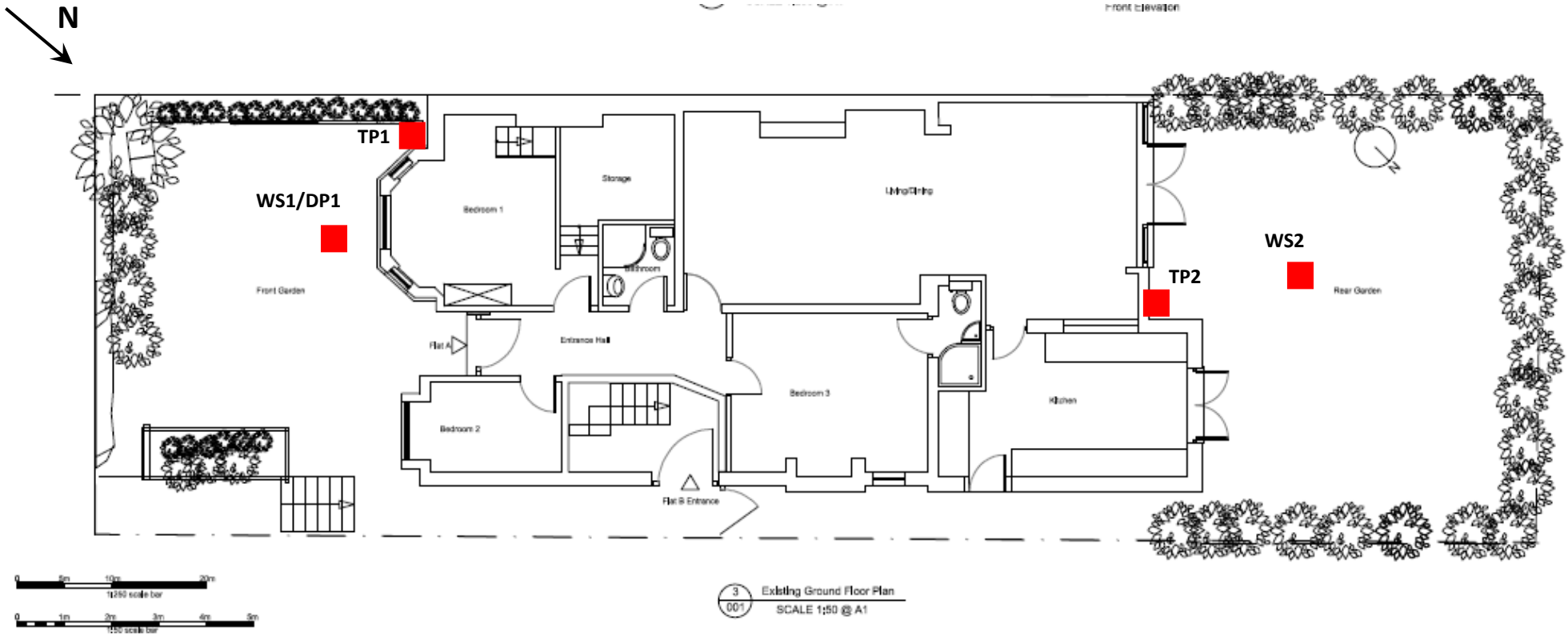
Project: 18 Ornan Road, London NW3 4PX		**Figure 3**
Client: Southfields Property Ltd	**Date:** August 2015	ground&water
Aerial View of the Site	**Ref:** GWPR1313	

N



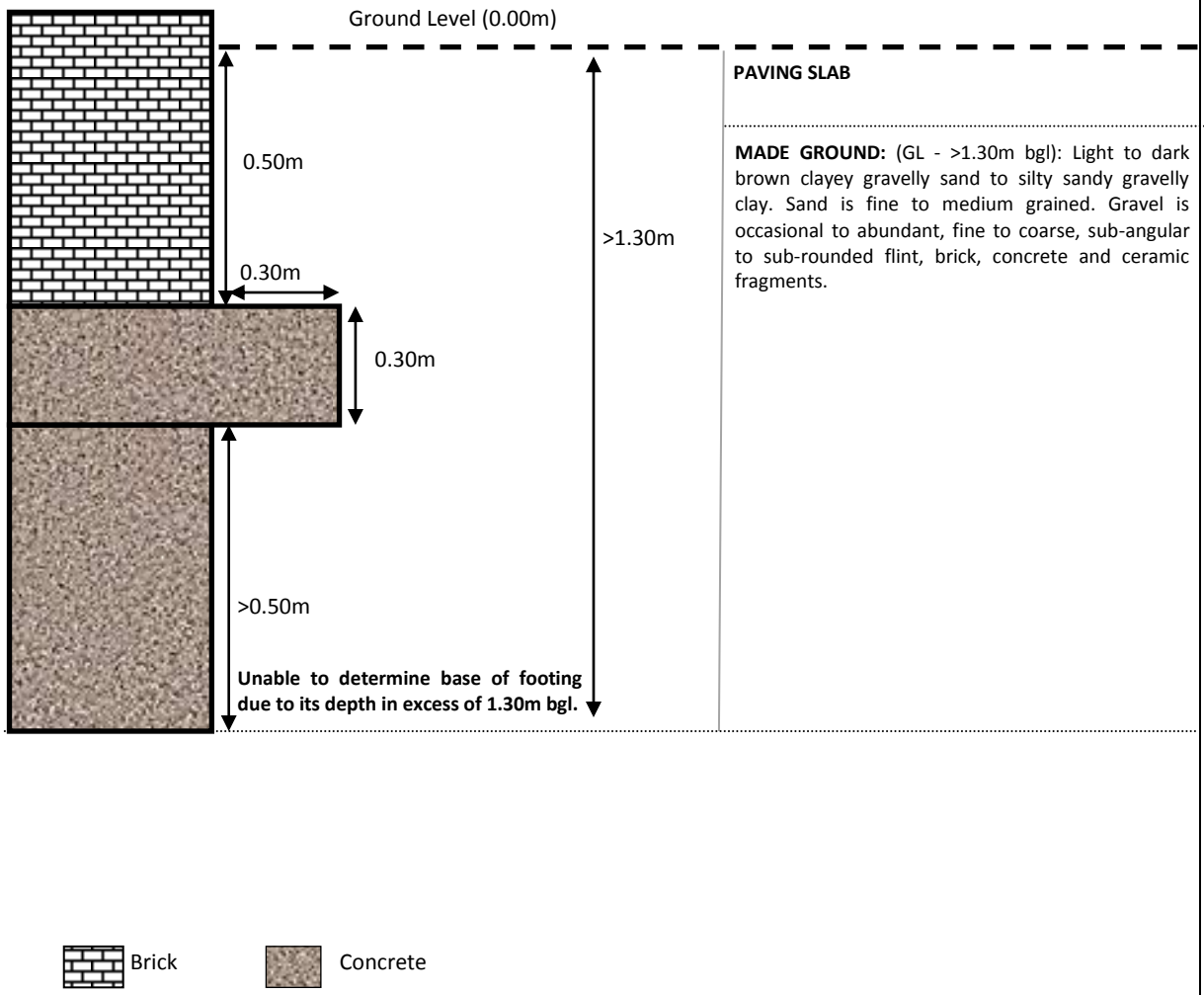
NOTE: NOT TO SCALE

Project: 18 Ornan Road, London NW3 4PX		**Figure 4**
Client: Southfields Property Ltd	**Date:** August 2015	ground&water
Proposed Development – Plan and Section View	**Ref:** GWPR1313	

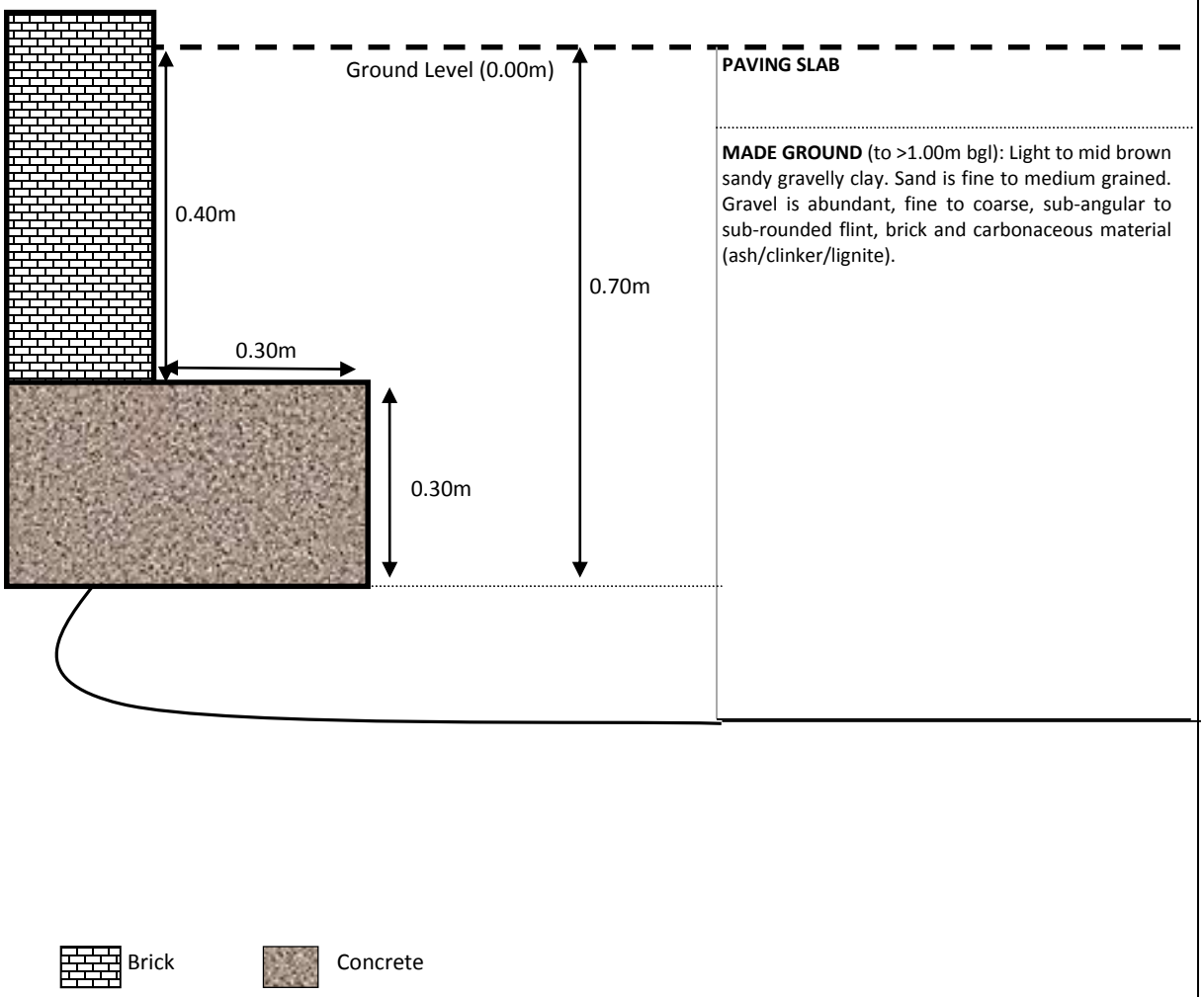


NOT TO SCALE

Project: 18 Ornan Road, London NW3 4PX		**Figure 5**
Client: Southfields Property Ltd	**Date:** August 2015	ground&water
Trial Hole Location Plan	**Ref:** GWPR1313	



Project: 18 Ornan Road, London NW3 4PX		**Figure 6**
Client: Southfields Property Ltd	**Date:** August 2015	ground&water
Section Drawing: Foundation Exposure TP/FE1	**Ref:** GWPR1313	



Project: 18 Ornan Road, London NW3 4PX		**Figure 7**
Client: Southfields Property Ltd	**Date:** August 2015	ground&water
Section Drawing: Foundation Exposure TP/FE2	**Ref:** GWPR1313	

APPENDIX A
Conditions and Limitations

The ground is a product of continuing natural and artificial processes. As a result, the ground will exhibit a variety of characteristics that vary from place to place across a site, and also with time. Whilst a ground investigation will mitigate to a greater or lesser degree against the resulting risk from variation, the risks cannot be eliminated.

The investigation, interpretations, and recommendations given in this report were prepared for the sole benefit of the client in accordance with their brief; as such these do not necessarily address all aspects of ground behaviour at the site. No liability is accepted for any reliance placed on it by others unless specifically agreed in writing.

Current regulations and good practice were used in the preparation of this report. An appropriately qualified person must review the recommendations given in this report at the time of preparation of the scheme design to ensure that any recommendations given remain valid in light of changes in regulation and practice, or additional information obtained regarding the site.

This report is based on readily available geological records, the recorded physical investigation, the strata observed in the works, together with the results of completed site and laboratory tests. Whilst skill and care has been taken to interpret these conditions likely between or below investigation points, the possibility of other characteristics not revealed cannot be discounted, for which no liability can be accepted. The impact of our assessment on other aspects of the development required evaluation by other involved parties.

The opinions expressed cannot be absolute due to the limitations of time and resources within the context of the agreed brief and the possibility of unrecorded previous in ground activities. The ground conditions have been samples or monitored in recorded locations and tests for some of the more common chemicals generally expected. Other concentrations of types of chemicals may exist. It was not part of the scope of this report to comment on environment/contaminated land considerations.

The conclusions and recommendations relate to 18 Ornan Road, London NW3 4PX.

Trial hole is a generic term used to describe a method of direct investigation. The term trial pit, borehole or window sampler borehole implies the specific technique used to produce a trial hole.

The depth to roots and/or of desiccation may vary from that found during the investigation. The client is responsible for establishing the depth to roots and/or of desiccation on a plot-by-plot basis prior to the construction of foundations. Where trees are mentioned in the text this means existing trees, recently removed trees (approximately 15 years to full recovery on cohesive soils) and those planned as part of the site landscaping.

APPENDIX B
Fieldwork Logs

Ground and Water Ltd
Tel: 0333 600 1221
email: enquiries@groundandwater.co.uk
www.groundandwater.co.uk

Borehole No
WS1
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
18 Ornan Road	GWPR1313		WS
Location: London NW3 4PX		Level: -	Scale 1:50
Client: Southfields Property Ltd		Dates: 22/06/2015	Logged By JD

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
		0.25	D					MADE GROUND: Dark brown silty clayey gravelly sand. Sand is fine to medium grained. Gravel is abundant, fine to medium, sub-angular to sub-rounded flint, brick, and concrete.
		0.50	D					
					0.65			
		0.80	D					MADE GROUND: Light brown gravelly sandy silty clay. Sand is fine to medium grained. Gravel is occasional to abundant, fine to medium, sub-angular to sub-rounded flint, brick, concrete, and ceramic waste.
		1.00	D					
					1.25			
		1.50	D					MADE GROUND: Light brown sandy gravelly silty clay. Sand is fine grained. Gravel is abundant, medium to coarse, sub-angular brick and lignite.
					1.75			
		2.00	D					LONDON CLAY FORMATION: Light brown silty CLAY.
		2.50	D					
		3.00	D					
		3.50	D					
		4.00	D					
		4.50	D					
		5.00	D		5.00			End of Borehole at 5.00 m
		Type		Results				

Remarks: No groundwater encountered.
Fine roots noted to 2.00m bgl by driller. Roots noted to 1.50m bgl by supervising engineer in samples. Roots traces noted at 4.80m bgl by driller.

ground &water
geotechnical and environmental consultants

Ground and Water Ltd
Tel: 0333 600 1221
email: enquiries@groundandwater.co.uk
www.groundandwater.co.uk

Borehole No
WS2
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
18 Ornan Road	GWPR1313		WS
Location: London NW3 4PX		Level: -	Scale 1:50
Client: Southfields Property Ltd		Dates: 22/06/2015	Logged By JD

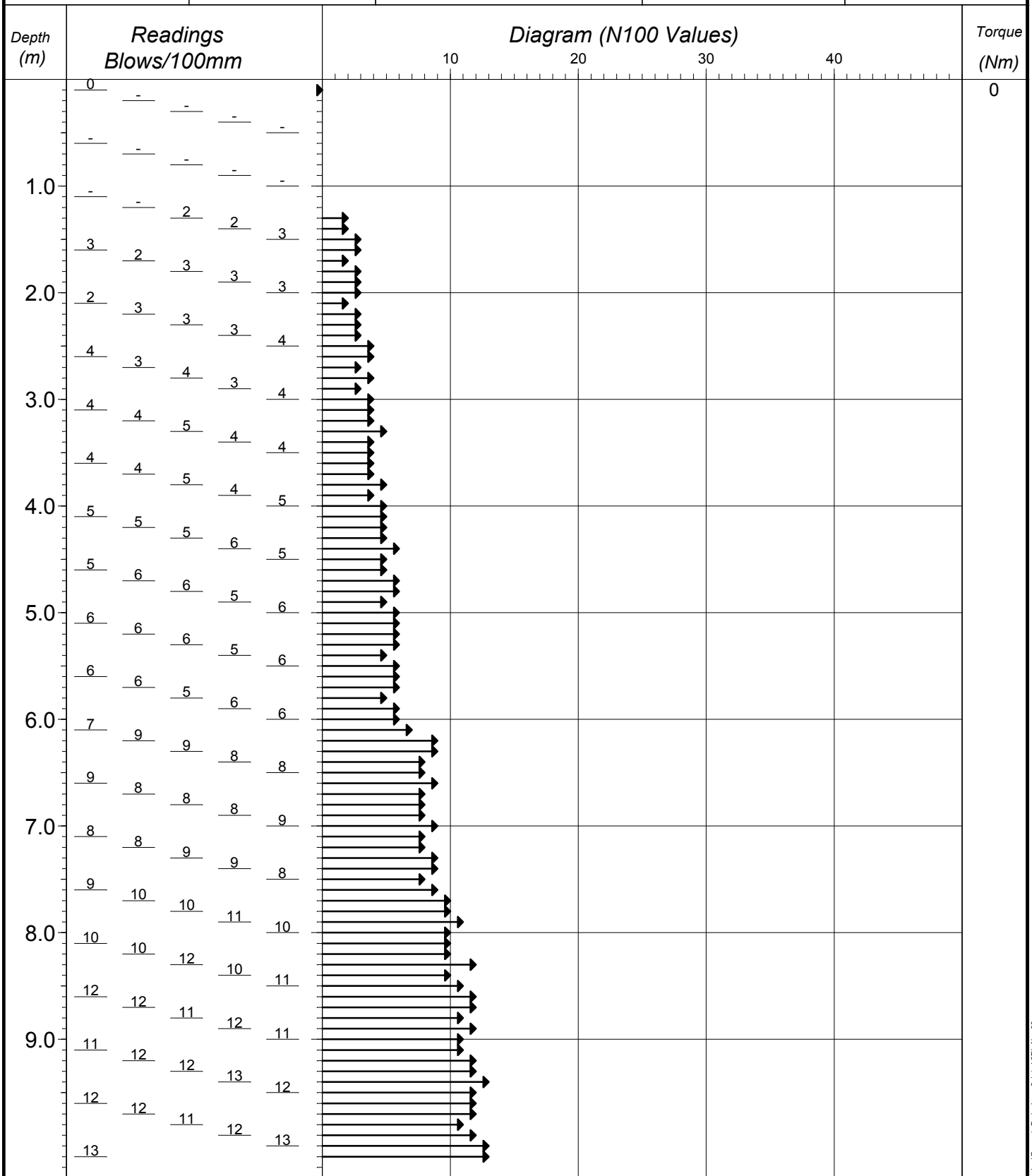
Well	Water Strikes	Samples & In Situ Testing Depth (m)	Type	Results	Depth (m)	Level (m AOD)	Legend	Stratum Description
		0.25	D					MADE GROUND: Dark grey brown sandy gravelly silty clay. Sand is fine to medium grained. Gravel is occasional to abundant, fine to medium, sub-angular to sub-rounded flint and brick.
		0.50	D					
		0.80	D					
		1.00	D					
					1.25			
		1.50	D					LONDON CLAY FORMATION: Light brown, with gry mottling, silty CLAY. Rare lignite inclusions noted.
		2.00	D					
		2.50	D					
		3.00	D					
		3.50	D					
		4.00	D					
		4.50	D					
		5.00	D		5.00			End of Borehole at 5.00 m
			Type	Results				

Remarks: Roots noted to 2.80m bgl.
No groundwater encountered.

AGS

DYNAMIC PROBING

Probe No **DP1**			
Client **Southfields Property Ltd**		Sheet 1 of 1	
Site **18 Ornan Road**		Project No **GWPR1313**	
E -	N -	Level -	Date **22/06/2015** Logged by **SJM**



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geotechnical and environmental consultants

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www.groundandwater.co.uk

Fall Height	500	Cone Base Diameter	43
Hammer Wt	50.00	Final Depth	10.00
Probe Type	DPH	Log Scale	1:50

AGS

APPENDIX C
Geotechnical Laboratory Test Results

Summary of Classification Test Results

Job No.	Project Name	Programme	
19103	18 Ornan Road, London, NW3 4PX	Samples received	29/06/2015
		Schedule received	26/06/2015
Project No.	Client	Project started	29/06/2015
GWPR1313	Ground and Water Ltd	Testing Started	13/07/2015

Hole No.	Sample				Soil Description	NMC	Passing 425µm	LL	PL	PI	Remarks
	Ref	Top	Base	Type		%	%	%	%	%	
WS1		2.00		D	Brown CLAY with rare fine gravel and occasional black organic flecks	35	98	88	30	58	
WS1		4.00		D	Brown CLAY	28	100	65	24	41	
WS1		5.00		D	Brown CLAY	31	100	70	28	42	
WS2		1.50		D	Brown sandy silty CLAY with rare fine gravel	23	99	35	16	19	
WS2		5.00		D	Brown CLAY with orange brown sandy patches	31	100	66	26	40	

Test Methods: BS1377: Part 2: 1990:
Natural Moisture Content : clause 3.2
Atterberg Limits: clause 4.3 and 5.0

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU

Tel: 01923 711 288
Email: James@k4soils.com

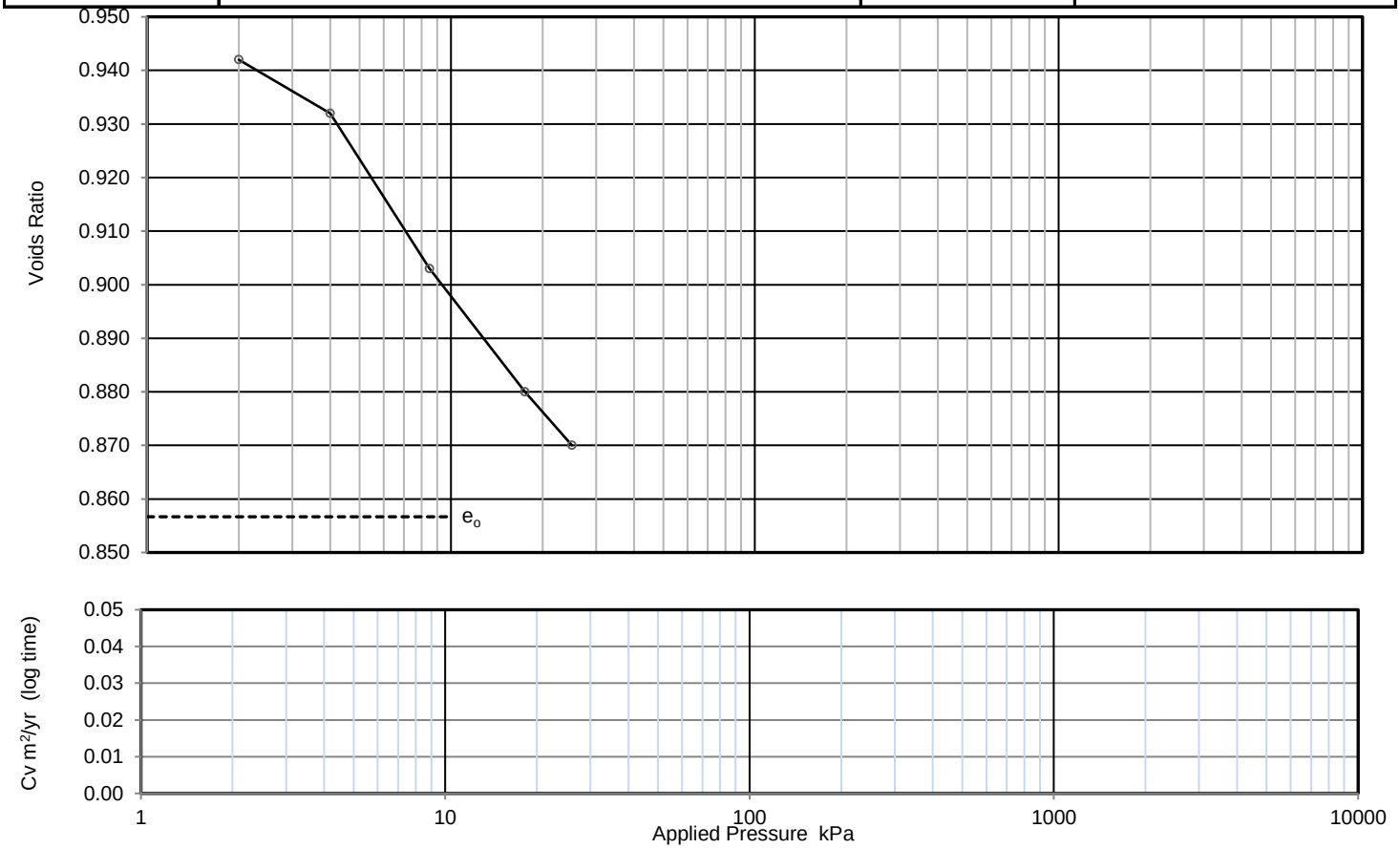
Checked and Approved

Initials **J.P**

Date: 16/07/2015

ONE DIMENSIONAL CONSOLIDATION TEST

				Job Ref	19103
				Borehole/Pit No.	WS1
Site Name	18 Ornan Road, London, NW3 4PX			Sample No.	-
Project ID	GWPR1313	Client	Ground and Water Ltd	Depth	3.50
Soil Description	Orangish brown silty CLAY with brown and yellow silt pockets			Sample Type	D
				Sample Received	29/06/2015
				Schedule received	26/06/2015
				Project Started	29/06/2015
Test Method	BS1377:Part 5:1990, clause 3			Date Test started	08/07/2015



Applied Pressure kPa	Voids ratio	M_v m^2/MN	C_v ($t_{50, log}$) m^2/yr	C_v ($t_{90, root}$) m^2/yr	C_{sec}
50	0.857	-	-	-	-
25	0.870	0.28			
18	0.880	0.70			
8.5	0.903	1.4			
4.0	0.932	3.4			
2.0	0.942	2.7			

Preparation

Orientation wthin sample: Vertical

Particle density: assumed 2.70 Mg/m^3

Specimen details	Initial	Final	
Diameter	74.75	-	mm
Height	15.90	16.63	mm
Moisture Content	29.9	37.1	%
Bulk density	1.89		Mg/m^3
Dry density	1.45		Mg/m^3
Voids Ratio	0.857		
Saturation	94		%
Average temperature for test			°C
Swelling Pressure	50		kPa
Settlement on saturation			%

Remarks

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

Checked and Approved

Initials

Date: 16/07/2015

Sulphate Content (Gravimetric Method) for 2:1 Soil: Water Extract and pH Value - Summary of Results

Tested in accordance with BS1377 : Part 3 : 1990, clause 5.3 and clause 9

Job No.	Project Name	Programme	
19103	18 Ornan Road, London, NW3 4PX	Samples received	29/06/2015
		Schedule received	26/06/2015
Project No.	Client	Project started	29/06/2015
GWPR1313	Ground and Water Ltd	Testing Started	10/07/2015

Hole No.	Sample				Soil description	Dry Mass passing 2mm	SO_3 Content	SO_4 Content	pH	Remarks
	Ref	Top	Base	Type		%	g/l	g/l		
WS2		4.00		D	Brown silty CLAY	100	1.65	1.98	7.69	

Test Report by K4 SOILS LABORATORY
Unit 8 Olds Close Olds Approach
Watford Herts WD18 9RU
Tel: 01923 711 288
Email: James@k4soils.com

Checked and Approved

Initials **J.P**

Date: **16/07/2015**

Francis Williams
Ground & Water Ltd
2 The Long Barn
Norton Farm
Selborne Road
Alton
Hampshire
GU34 3NB

QTS Environmental Ltd
Unit 1
Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Kent
ME17 2JN
t: 01622 850410
russell.jarvis@qtsenvironmental.com

QTS Environmental Report No: 15-32949

Site Reference:	18 Ornan Road, London, NW3 4PX
Project / Job Ref:	GWPR1313
Order No:	None Supplied
Sample Receipt Date:	30/06/2015
Sample Scheduled Date:	30/06/2015
Report Issue Number:	1
Reporting Date:	06/07/2015

Authorised by:

Russell Jarvis
Director
On behalf of QTS Environmental Ltd

Authorised by:

Kevin Old
Director
On behalf of QTS Environmental Ltd

QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate							
QTS Environmental Report No: 15-32949	**Date Sampled**	22/06/15	22/06/15				
Ground & Water Ltd	**Time Sampled**	None Supplied	None Supplied				
Site Reference: 18 Ornan Road, London, NW3 4PX	**TP / BH No**	WS1	WS2				
Project / Job Ref: GWPR1313	**Additional Refs**	None Supplied	None Supplied				
Order No: None Supplied	**Depth (m)**	2.50	3.50				
Reporting Date: 06/07/2015	**QTSE Sample No**	155273	155274				

Determinand	**Unit**	**RL**	**Accreditation**					
pH	pH Units	N/a	**MCERTS**	7.7	7.5			
Total Sulphate as SO_4	%	< 0.02	NONE	0.12	0.21			
W/S Sulphate as SO_4 (2:1)	mg/l	< 10	**MCERTS**	548	513			
Total Sulphur	%	< 0.02	NONE	0.05	0.05			
Ammonium as NH_4	mg/kg	< 0.5	NONE	5.1	5.4			
W/S Chloride (2:1)	mg/kg	< 1	**MCERTS**	12	8			
Water Soluble Nitrate (2:1) as NO_3	mg/kg	< 3	**MCERTS**	< 3	< 3			
W/S Magnesium	mg/l	< 0.1	NONE	20	16			

Analytical results are expressed on a dry weight basis where samples are dried at less than $30^{O}C$
Analysis carried out on the dried sample is corrected for the stone content
Subcontracted analysis $^{(S)}$

QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate - Sample Descriptions	
QTS Environmental Report No: 15-32949	
Ground & Water Ltd	
Site Reference: 18 Ornan Road, London, NW3 4PX	
Project / Job Ref: GWPR1313	
Order No: None Supplied	
Reporting Date: 06/07/2015	

QTSE Sample No	TP / BH No	Additional Refs	Depth (m)	Moisture Content (%)	Sample Matrix Description
155273	WS1	None Supplied	2.50	17.6	Light brown clay
155274	WS2	None Supplied	3.50	20.2	Light brown clay

Moisture content is part of procedure E003 & is not an accredited test

Insufficient Sample I/S

Unsuitable Sample U/S

QTS Environmental Ltd
Unit 1, Rose Lane Industrial Estate
Rose Lane
Lenham Heath
Maidstone
Kent ME17 2JN
Tel : 01622 850410

4480

Soil Analysis Certificate - Methodology & Miscellaneous Information
QTS Environmental Report No: 15-32949
Ground & Water Ltd
Site Reference: 18 Ornan Road, London, NW3 4PX
Project / Job Ref: GWPR1313
Order No: None Supplied
Reporting Date: 06/07/2015

Matrix	Analysed On	Determinand	Brief Method Description	Method No
Soil	D	Boron - Water Soluble	Determination of water soluble boron in soil by 2:1 hot water extract followed by ICP-OES	E012
Soil	AR	BTEX	Determination of BTEX by headspace GC-MS	E001
Soil	D	Cations	Determination of cations in soil by aqua-regia digestion followed by ICP-OES	E002
Soil	D	Chloride - Water Soluble (2:1)	Determination of chloride by extraction with water & analysed by ion chromatography	E009
Soil	AR	Chromium - Hexavalent	Determination of hexavalent chromium in soil by extraction in water then by acidification, addition of 1,5 diphenylcarbazide followed by colorimetry	E016
Soil	AR	Cyanide - Complex	Determination of complex cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Free	Determination of free cyanide by distillation followed by colorimetry	E015
Soil	AR	Cyanide - Total	Determination of total cyanide by distillation followed by colorimetry	E015
Soil	D	Cyclohexane Extractable Matter (CEM)	Gravimetrically determined through extraction with cyclohexane	E011
Soil	AR	Diesel Range Organics (C10 - C24)	Determination of hexane/acetone extractable hydrocarbons by GC-FID	E004
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of saturated calcium sulphate followed by electrometric measurement	E022
Soil	AR	Electrical Conductivity	Determination of electrical conductivity by addition of water followed by electrometric measurement	E023
Soil	D	Elemental Sulphur	Determination of elemental sulphur by solvent extraction followed by GC-MS	E020
Soil	AR	EPH (C10 – C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH Product ID	Determination of acetone/hexane extractable hydrocarbons by GC-FID	E004
Soil	AR	EPH TEXAS (C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C40)	Determination of acetone/hexane extractable hydrocarbons by GC-FID for C8 to C40. C6 to C8 by headspace GC-MS	E004
Soil	D	Fluoride - Water Soluble	Determination of Fluoride by extraction with water & analysed by ion chromatography	E009
Soil	D	FOC (Fraction Organic Carbon)	Determination of fraction of organic carbon by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	D	Loss on Ignition @ 450oC	Determination of loss on ignition in soil by gravimetrically with the sample being ignited in a muffle furnace	E019
Soil	D	Magnesium - Water Soluble	Determination of water soluble magnesium by extraction with water followed by ICP-OES	E025
Soil	D	Metals	Determination of metals by aqua-regia digestion followed by ICP-OES	E002
Soil	AR	Mineral Oil (C10 - C40)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge	E004
Soil	AR	Moisture Content	Moisture content; determined gravimetrically	E003
Soil	D	Nitrate - Water Soluble (2:1)	Determination of nitrate by extraction with water & analysed by ion chromatography	E009
Soil	D	Organic Matter	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	PAH - Speciated (EPA 16)	Determination of PAH compounds by extraction in acetone and hexane followed by GC-MS with the use of surrogate and internal standards	E005
Soil	AR	PCB - 7 Congeners	Determination of PCB by extraction with acetone and hexane followed by GC-MS	E008
Soil	D	Petroleum Ether Extract (PEE)	Gravimetrically determined through extraction with petroleum ether	E011
Soil	AR	pH	Determination of pH by addition of water followed by electrometric measurement	E007
Soil	AR	Phenols - Total (monohydric)	Determination of phenols by distillation followed by colorimetry	E021
Soil	D	Phosphate - Water Soluble (2:1)	Determination of phosphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Total	Determination of total sulphate by extraction with 10% HCl followed by ICP-OES	E013
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of sulphate by extraction with water & analysed by ion chromatography	E009
Soil	D	Sulphate (as SO4) - Water Soluble (2:1)	Determination of water soluble sulphate by extraction with water followed by ICP-OES	E014
Soil	AR	Sulphide	Determination of sulphide by distillation followed by colorimetry	E018
Soil	D	Sulphur - Total	Determination of total sulphur by extraction with aqua-regia followed by ICP-OES	E024
Soil	AR	SVOC	Determination of semi-volatile organic compounds by extraction in acetone and hexane followed by GC-MS	E006
Soil	AR	Thiocyanate (as SCN)	Determination of thiocyanate by extraction in caustic soda followed by acidification followed by addition of ferric nitrate followed by colorimetry	E017
Soil	D	Toluene Extractable Matter (TEM)	Gravimetrically determined through extraction with toluene	E011
Soil	D	Total Organic Carbon (TOC)	Determination of organic matter by oxidising with potassium dichromate followed by titration with iron (II) sulphate	E010
Soil	AR	TPH CWG (ali: C5- C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C34, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C35. C5 to C8 by headspace GC-MS	E004
Soil	AR	TPH LQM (ali: C5-C6, C6-C8, C8-C10, C10-C12, C12-C16, C16-C35, C35-C44, aro: C5-C7, C7-C8, C8-C10, C10-C12, C12-C16, C16-C21, C21-C35, C35-C44)	Determination of hexane/acetone extractable hydrocarbons by GC-FID fractionating with SPE cartridge for C8 to C44. C5 to C8 by headspace GC-MS	E004
Soil	AR	VOCs	Determination of volatile organic compounds by headspace GC-MS	E001
Soil	AR	VPH (C6-C8 & C8-C10)	Determination of hydrocarbons C6-C8 by headspace GC-MS & C8-C10 by GC-FID	E001

D Dried
AR As Received