Chelmer
Consultancy Services
'Groundbreaking Services'

Geo-environmental Interpretative Report

Site 76 Fleet Road
London
NW3 2QT

Client Matthew Godfrey
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Our Ref GENV/5839

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CONTENTS

APPENDICES

EXECUTIVE SUMMARY

76 Fleet Road London NW3 2QT	
Ground Conditions	The current work encountered Made Ground to a maximum depth of 2.9m below existing ground level (bgl). Within borehole BH1 the Made Ground was found to be underlain by a gravel stratum, thought to be River Terrace Deposits between 1.8m and 2.4m bgl. The Made Ground and gravel was underlain by the London Clay Formation which was not penetrated at the maximum borehole termination depth of 8.0m bgl.
Groundwater	A groundwater seepage was observed in trial pit TP3 at foundation underside at a depth of 1.25m bgl. During the return monitoring visits to borehole BH1 groundwater depths of 3.60m and 3.27m bgl were recorded and within borehole BH2 groundwater depths of 2.26m and 1.45m bgl were recorded.
Roots	Roots of live and dead appearance up to 4mm in diameter were observed within trial pit TP2 to the maximum trial pit depth of 0.65m bgl.
Foundations	Due to the recorded relatively high water table and the concomitant issues associated with managing the high water table during basement construction, it is considered that an embedded pile retaining wall will be best approach. A secant piled wall (using hard-soft construction technique) could be constructed around the perimeter of the basement which will offer an effective means of managing and controlling groundwater ingress whilst also providing structural foundation to support. Piles are anticipated to penetrate into and support London Clay. It is assumed that the basement ground bearing floor slab will be set approximately 3.50-4.00m below existing ground level and will be set across two levels. At this depth the basement slab would be set within the London Clay Formation. Based on the results of the in-situ testing, it is recommended that a safe allowable bearing pressure of approximately 125 kN/m^2 be adopted for the ground bearing floor slab set at a depth of 3.50m below existing ground level.
Buried Concrete	Chemical testing has been carried out to determine the nature of the soils in the context of the durability of buried concrete. Based on the available test data the soluble sulphate content of the soils is noted to be variable and ranges between 283 and 2630 mg/l (measured as soluble SO_4) with a pH of 7.6 to 8.0. Taking the worst case data, the soils are classified as DS-4 in accordance with BRE guidance (Ref 6) with a corresponding ACEC class of AC-3s.
Swelling/ Shrinkage	The London Clay Formation has been confirmed to possess 'high' volume change potential in accordance with the National House Building Councils (NHBC) classification system given in Part 4 of their Standards (Ref. 5). The gravel stratum encountered within borehole BH1 would be classed as 'non-shrinkable'.
Ground Gas	During the return gas/groundwater monitoring visits, the maximum concentration of methane was recorded at 0.0%v/v and the maximum carbon dioxide concentration was recorded at 3.8%v/v. A maximum flow rate of 0.6l/hr was recorded. The full land-borne gas assessment details are appended. Given the low gas concentrations and flow recorded during the return monitoring visit, the site would thus be classified as **Characteristic Situation 1** (following modified Wilson & Card Methodology)). On this basis no special precautions are deemed necessary to safeguard against ground gas, however this is should be agreed with the applicable Local Authority Building Control Officer.
Soil Contamination	A single elevated lead concentration (2,160 mg/kg) was identified within the tested Made Ground sample from BH1, when compared against Residential with Plant Uptake criteria (200 mg/kg). Further works are therefore recommended to help reduce the risk to future end users.
Soil Disposal	The results of the WAC tests indicate that the samples of Made Ground from BH1 would probably be classified as "Stable Non-reactive".
Further Works	A clean cover system may be adopted within areas of proposed soft landscaping. This will involve excavation of the existing site soils to an agreed depth and replaced with clean soils. This will effectively break the contamination pathway between the source and receptor and thus reduce the risk to future residents. Alternatively, raised flower beds could be adopted, with imported soils above ground level and an impermeable layer separating from the underlying soils

1.0 INTRODUCTION

1.1 This report has been prepared by Chelmer Site Investigation Laboratories Limited (CSI) to the instructions of the Architect for the project, Tal Arc Ltd on behalf of the client Matthew Godfrey.

1.2 The site address is 76 Fleet Road, London NW3 2QT and is located at approximate Ordnance Survey grid reference (OSNGR) 527599E, 185445N. The site under consideration comprised a three storey terraced property split into two flats, one at ground floor level and one split across first and second floor levels, with associated rear garden. The ground and first floors are split over two levels. *Existing Plans, Sections and Elevations (76FR-PP1-01 to 03)* have been appended to this report.

1.3 It is understood that the proposed development will comprise the construction of a single storey basement beneath 76 Fleet Road, extending beneath the proposed footprint of the property, with a light well to both front and rear. The development will also include a side extension to ground floor level at the rear of the property and extension to first floor level as well as an additional 'loft' level. The proposed basement will be split across two levels. *Proposed Plans, Sections and Elevations (76FR-PP1-04 to 06)* have been appended to this report.

1.4 A Phase I Desk Top Study was not requested by the client.

1.5 The current site investigation was commissioned to provide information on the sub-soil conditions of the site in order to provide information to support foundation design, together with preliminary contamination assessment, testing for waste disposal purposes and a preliminary ground gas risk assessment.

1.6 In addition to the investigation fieldwork a limited groundwater/ground gas monitoring survey was also carried out using monitoring standpipes installed during the current investigation in boreholes BH1 & BH2.

1.7 This report presents the work carried out and discusses the findings.

2.0 SUMMARY OF FIELDWORK EXECUTED

2.1 All fieldwork and contamination sampling was generally executed in accordance with applicable British Standard and accepted industry good practice (Ref 1 & 2).

2.2 The work at this site was undertaken between the 17th and 21st September 2015 and comprised the following elements:

<u>*C.f.a. Boreholes*</u>

2.3 Two c.f.a. boreholes (BH1 & BH2) were drilled at the positions indicated on the appended *Sketch Fieldwork Location Plan*. Borehole BH1 was undertaken internally to the front of the property and advanced to a depth of 5.1m below existing ground level (bgl); the borehole was terminated at this depth due to encountering a suspected claystone band. Borehole BH2 was undertaken externally in the rear garden and advanced to a depth of 8.0m bgl.

2.4 Disturbed samples were taken from the boreholes at regular depth intervals as the boreholes were advanced, within each stratum and when a change of stratum was encountered.

2.5 Mackintosh Probes and Shear Vane tests were also undertaken throughout the boreholes in order to provide additional information on the consistency and strength of the material encountered.

2.6 Upon completion of boreholes BH1 & BH2 standpipes were installed to depths of 5.1m and 6.0m bgl respectively.

2.7 Full details of the borehole findings are given on the appended borehole record sheets.

<u>*Hand Excavated Trial Pits*</u>

2.8 In addition to the above, the scope of works also included the excavation of three trial pits (TP1-TP3) at the positions indicated on the *Sketch Fieldwork Location Plan.*

2.9 Trial pit TP1 was undertaken internally, adjacent to the party wall with No.78 Fleet Road and found the brick wall to rest onto brick corbels at a depth of 0.7m bgl. The brick corbels were 225mm thick and were set directly onto Made Ground at a depth of 0.925m bgl.

2.10 Trial pit TP2 was undertaken externally, in the rear garden, adjacent to the party wall with No.78 Fleet Road and found the brick wall to rest onto brick corbels above ground level. The brick corbels were 200mm thick and were set onto a concrete foundation at a depth of 0.15m bgl. The concrete foundation was found to be 300mm thick and rest within Made Ground at a depth of 0.45m bgl.

2.11 Trial pit TP3 was undertaken internally, adjacent to the party wall with No.74 Fleet Road and found the brick wall to rest onto a concrete foundation at a depth of 0.35m bgl. The concrete foundation was 900mm thick and was set within Made Ground at a depth of 1.25m bgl.

2.12 Full details of the trial pit findings are given on the appended trial pit record sheets.

Groundwater & Ground Gas Monitoring

2.13 Following the initial site work, two monitoring visits were undertaken on 26th October and 4th November 2015 to measure groundwater and ground gas within the site using the installations fitted within boreholes BH1 & BH2.

2.14 The barometric pressure was recorded together with the level of Carbon Dioxide, Oxygen and Methane within the borehole. In addition, gas flow measurements were taken and depth to groundwater recorded.

2.15 Full details of the readings are included on the appended Groundwater/Ground Gas Monitoring Record Sheet.

3.0 GEOLOGICAL SETTING

3.1 According to information published by the British Geological Survey (BGS) the underlying geology at this site is shown as the London Clay Formation. No superficial deposits were recorded.

3.2 It is inferred that the London Clay Formation was deposited during a period of sea inundation in the area up to 200m in depth. The London Clay can be up to 150m thick beneath south Essex thinning across London to about 90m near Reading.

When exposed to the weathering process the upper regions of the London Clay oxidise to brown in colour. It usually contains selenite crystals, often grouped in bands or layers, which are thought to have originated from the decomposition of shell fragments. London Clay contains clay minerals in the form of illite, kaolinite and smectite. The presence of smectite renders the London Clay particularly susceptible to changes in moisture content and is prone to shrinkage and swelling (settlement and heave) caused by alternate wetting and drying near the surface. In addition, weathering and possible slight transportation of semi-frozen material "en-masse" in glacial or peri-glacial regions is believed to have occured. This action often completely destroys the structure of the material and can involve a serious loss of strength. As the soil composition is derived mostly from materials local to the point of deposition, the lithology can be variable and reflects that of the parent strata.

4.0 SUMMARY OF GROUND CONDITIONS ENCOUNTERED

4.1 Full details of the ground conditions encountered are presented on the borehole records appended to this report and can be summarised as follows:

Depth to top of stratum (m)	Depth to base of stratum (m)	Stratum
0.00	0.05/0.80	Floor boards over void/concrete
0.05/0.80	1.80/2.90	MADE GROUND
1.80	2.40	*Medium dense, brown/orange, silty very sandy fine to medium GRAVEL (BH1)*
2.40	5.10+/5.20	Weathered London Clay – *stiff, brown/grey, slightly sandy silty CLAY (BH1) with occasional fine gravel (BH2)*
5.20	5.80	Weathered London Clay – *stiff, brown/grey, slightly sandy silty CLAY with partings of brown and orange silt and fine sand*
5.80	8.00+	London Clay – *very stiff, grey, slightly sandy silty CLAY with partings of brown and orange silt and fine sand*

4.2 It should be noted that the MADE GROUND depths recorded above are those encountered within the boreholes undertaken during the current work. Owing to the variable nature and unknown provenance of MADE GROUND it is possible that deeper or more extensive areas of MADE GROUND may exist at this site which have not been revealed by the current work.

4.3 The gravel stratum within borehole BH1 is assumed to be Head deposits. A similar stratum of 'orange-brown sandy clay with stones' was recorded in BGS borehole TQ28NE79, approximately 90m north/north west of the site.

4.4 In-situ testing within the gravel indicated that the consistency of this material is 'loose' to 'medium dense' in consistency.

4.5 In-situ shear vane testing within the London Clay Formation indicated that this material is 'firm' to 'stiff'/'very stiff' in consistency.

4.6 A groundwater seepage was observed in trial pit TP3 at foundation underside at a depth of 1.25m bgl. During the return monitoring visits to borehole BH1 groundwater depths of 3.60m and 3.27m bgl were recorded and within borehole BH2 groundwater depths of 2.26m and 1.45m bgl were recorded.

4.7 Roots of live and dead appearance up to 4mm in diameter were observed within trial pit TP2 to the maximum trial pit depth of 0.65m bgl.

5.0 LABORATORY TESTING

5.1 The following geotechnical laboratory testing has been carried out on samples recovered from the boreholes undertaken at this site.

5.2 Unless otherwise stated, the geotechnical tests have generally been carried out in accordance with applicable British Standard (Ref 3).

5.3 The chemical testing was carried out in accordance with standard industry methods in a UKAS approved laboratory which is also currently accredited in accordance with MCERTS for the majority of its testing. Further information regarding this accreditation is available on request together with a full list of test methods if required.

5.4 *Atterberg Limits and Moisture Content Tests*

The Atterberg Limits and moisture content have been determined for six samples of the London Clay Formation.

For the samples tested, the liquid limit (LL) was found to range between 73% and 79%, the plastic limit (PL) was found to range between 21% and 25%, the plasticity index between 51% and 54% and the modified plasticity index between 48% and 52%. The moisture content of these samples was found to range between 29% and 35%.

These results indicate that the samples tested would be classified as Clay of 'very high' plasticity (CV) in accordance with the Casagrande Geotechnical classification system.

5.5 *Particle Size Distribution*

The particle size distribution has been determined for a single sample of the more granular soils encountered at this site.

The results are presented as a grading curve appended to this report.

5.6 *pH and Sulphate Tests*

The pH and sulphate content has been determined for six samples recovered from the site.

The pH value was found range between 7.6 and 8.0 with the sulphate content, on a 2:1 water:soil extract found to vary between 283 and 2630 mg/l.

5.7 *Chemical Analysis*

4 N^{o}. representative samples of the underlying soils encountered across the site were selected and tested for a suite of key chemical species used to identify and assess the nature of the soil in the context of it being contaminated and potentially presenting a risk to end users of the site, building fabric and the wider environment.

The testing suite applied included selected critical heavy metals, US EPA 16 priority Polycyclic Aromatic Hydrocarbons (PAH), speciated Total Petroleum Hydrocarbons in accordance with TPHCWG recommended carbon bandings for both aliphatic and aromatic compounds, BTEX (benzene, toluene, ethylbenzene, xylene) and MTBE (Methyl tertiary-butyl ether).

No groundwater samples were obtained or tested during the current investigation.

5.8 *Waste Classification Tests*

In order to assist with the classification of soils in the context of their possible off-site disposal, two samples were collected from borehole BH1 and BH2 and tested for Waste Acceptance Criteria (WAC) in accordance with BS EN 12457 Part 3.

Full details of the results are given on the appended results sheets.

6.0 GEOTECHNICAL ASSESSMENT

SUMMARY OF PROPOSED DEVELOPMENT

6.1 It is understood that the proposed development will comprise the construction of a single storey basement beneath 76 Fleet Road, extending beneath the proposed footprint of the property, with a light well to both front and rear. The development will also include a side extension to ground floor level at the rear of the property and extension to first floor level as well as an additional 'loft' level. The proposed basement will be split across two levels. *Proposed Plans, Sections and Elevations (76FR-PP1-04 to 06)* have been appended to this report.

6.2 Full details of the proposed construction are not yet developed and it assumed that they will be subject to the findings of this investigation. As a consequence the foundation design discussed below is, by necessity, general in nature and is subject to confirmation following the results of this investigation and further design.

6.3 Should ground conditions during construction be found to differ significantly from those described in our report Chelmer Site Investigation Laboratories Limited should be contacted immediately and that the below noted allowable bearing pressures or recommended foundation type may need to be altered accordingly.

FOUNDATIONS

6.4 Due to the recorded relatively high water table and the concomitant issues associated with managing the high water table during basement construction, it is considered that an embedded pile retaining wall will be best approach. A secant piled wall (using hard-soft construction technique) could be constructed around the perimeter of the basement which will offer an effective means of managing and controlling groundwater ingress whilst also providing structural foundation to support. Piles are anticipated to penetrate into and support London Clay.

6.5 Given the nature of the ground conditions encountered and the proximity to adjacent residential buildings, a non-displacement pile type (e.g. bored cast-in-place, hollow stem auger CFA, or similar) is considered most appropriate. This type of pile construction will generate pile arisings and therefore the piling technique should be selected to minimise spoil and otherwise the arisings will need to appropriately managed.

6.6 It is beyond the scope of this investigation to provide a full and detailed pile design and the advice of a specialist piling contractor should be sought in this respect. However, the following soil engineering parameters listed below are given for guidance purposes only. These soil parameters/assumptions relate to "static design" for vertically loaded single piles:

Made Ground	
Bulk unit weight, γ_b	18 kN/m^3
Effective angle of internal friction, φ'	0
Undrained shear strength, Su	0
Gravel Deposits	
Bulk unit weight, γ_b	19 kN/m^3
Effective angle of internal friction, φ'	30^0 (based on Mackintosh Probe results and research by Peck, Hanson & Thorburn)
Undrained shear strength, Su	0
London Clay	
Bulk unit weight, γ_b	20 kN/m^3
Effective angle of internal friction, φ'	18-22^0
Undrained shear strength, Su	65 -120 kN/m^2 (based on in situ testing)

6.7 The following are estimated safe working loads (axial capacity) for a range of typical diameters for single bored piles extending to 6.00m and 8.00m below existing ground level.

Pile Type	Depth (mbgl)	Diameter (m)	Estimated safe pile capacity (kN)
Bored	6.00	0.30	50-100
Bored	6.00	0.45	100-150
Bored	6.00	0.60	200-250
Bored	8.00	0.30	100-150
Bored	8.00	0.45	150-200
Bored	8.00	0.60	250-300

6.8 It is recommended that the advice of competent piling contractors be sought as to the most suitable pile type at this site and for confirmation of the order of working load achievable given the ground conditions encountered and the proprietary pile type selected.

6.9 Made Ground has been identified within this site and contamination has been noted (see Chapter 7 below). With regard to the possible downward migration of contaminants the recommendations given in the Environment Agency in respect of piling in contaminated land should be followed.

RETAINING WALL & BASEMENT CONSTRUCTION

6.10 It is assumed that the basement ground bearing floor slab will be set approximately 3.50-4.00m below existing ground level and will be set across two levels. At this depth the basement slab would be set within the London Clay Formation. Based on the results of the in-situ testing, it is recommended that a safe allowable bearing pressure of approximately 125 kN/m^2 be adopted for the ground bearing floor slab set at a depth of 3.50m below existing ground level.

6.11 The full design of temporary and permanent retaining structures is beyond the scope of this investigation. Retaining structures and basements should be designed in accordance with accepted good practice such as that set out within CIRIA guidance C580 (Ref 4) or similar (e.g. BRE GBG72). The calculation of permanent lateral pressures against the sides should relate to long-term (effective) stress analysis.

6.12 Based on the findings of the site investigation undertaken the following soil parameters are recommended for use in the retaining wall design:

Made Ground	
Bulk unit weight, γ_b	18 kN/m^3
Earth pressure coefficient at rest, K_0	0.3-0.4
Undrained shear strength, Su	0
Effective shear strength, c'	0
Effective angle of internal friction, φ'	25^0
Gravel Deposits	
Bulk unit weight, γ_b	19 kN/m^3
Earth pressure coefficient at rest, K_0	0.3-0.6
Effective shear strength, c'	0
Effective angle of internal friction, φ'	30^0
London Clay	
Bulk unit weight, γ_b	20 kN/m^3
Earth pressure coefficient at rest, K_0	1.0
Undrained shear strength, Su	65 -120 kN/m^2 (based on shear vane tests)
Effective shear strength, c'	15kN/m^2
Effective angle of internal friction, φ'	18-22^0

6.13 A groundwater seepage was observed in trial pit TP3 at foundation underside at a depth of 1.25m bgl. During the return monitoring visits to borehole BH1 groundwater depths of 3.60m and 3.27m bgl were recorded and within borehole BH2 groundwater depths of 2.26m and 1.45m bgl were recorded. Groundwater may be subject to seasonal variation and may be present at higher levels within the site at other times of the year or under different circumstances to those prevailing at the time of investigation. Current geotechnical design standards require use of a 'worst credible' approach to selection of groundwater pressures. Further recommendations on groundwater is addressed in Basement Impact Assessment (BIA) ref. BIA/5839.

6.14 Design of the retaining walls should include allowance for groundwater in accordance with accepted good design practice and allowance for hydrostatic forces to both the ground bearing floor slab and retaining walls should be based on site specific hydrological and hydrogeological assessment. In addition the basement design should include appropriate waterproofing systems compliant with current standards and good practice (BS8102:2009 and applicable NHBC guidance) compatible with the retaining wall and foundation design.

6.15 Groundwater/surface water should be prevented from accumulating at the base of foundation excavations. It is important that the base of foundation excavations is kept dry and the exposed formation is protected to prevent softening by exposure to surface water. In the event that the formation is exposed, the material should be inspected immediately prior to floor slab construction and any soft spots are excavated and materials replaced and compacted prior to pouring foundation concrete. Alternatively 'blinding' concrete may be used to preserve the formation prior to foundation being constructed.

6.16 In view of the expected presence of groundwater within the excavated depth and notwithstanding the use of secant piled walls which should be an effective means of controlling significant groundwater ingress, there may be a need for local groundwater control during construction cognisant of the prevailing site conditions. In this regard local sump pumping should suffice. However, with groundwater control there is a concomitant risk that there may be a loss of fines from the soil as the water flows and enters the excavation. Whilst this is likely to be minimised by the piles, care should be exercised to ensure that loss of fines is reduced and avoided as far as possible.

ANTICIPATED GROUND MOVEMENTS

6.17 During excavation of the basement the stress conditions within the soil will be modified and this stress release or 'relaxation' in the ground will inevitably result in ground movement. Lateral stress release in the ground surrounding the excavation by both foundation construction (piling) and excavation in front of the retaining structure will manifest itself in lateral and associated vertical ground movement at the edge of excavation and line of foundations/retaining structure and extending back from the edge of the excavation/line of basement wall. The magnitude of lateral and vertical movement and the limit of its extent beyond the excavation will depend on the nature of the soils, the foundation system, and the construction methodology. There is published empirical data available to predict the degree of movement that can be expected (CIRIA C580) (Ref 4).

6.18 Ground movements associated with relatively shallow excavations in granular soils are generally of small magnitude and occur immediately such as they are accommodated within the construction process and their consequence is not usually significant. On the other hand London Clay can be a particularly challenging soil. It is an overconsolidated material, making it stiff and typically almost impermeable. The clay is generally competent and resists further compression under compressional loading. Below a depth of about 50m this clay gives way to substantial amounts of water-bearing silt and sand. When the clay is unloaded by excavations in-situ stress is relieved and it has a potential to expand. Similar to granular soils any immediate rebound is generally small in magnitude and is 'lost' in the excavation process. However following excavation the material has a potential to continue to swell. This can produce significant uplift at excavated formation level. The uplift forces need to be properly assessed and accounted for within the structural design of the basement.

6.19 It is important to ensure that the construction sequence and construction method statement (CMS) is developed based on the specific development system proposed and with full recognition of anticipated ground movements as assessed from site specific Ground Movement Analysis (GMA). It is implicit within this that good standards of workmanship will be maintained throughout so as to minimise and otherwise ameliorate the effects of ground movement associated with basement construction. This may include, inter alia, control on pile installation, sequencing of installation to minimise ground movement, use of necessary temporary support, and adequate control of groundwater.

SWELLING AND SHRINKAGE

6.20 The London Clay Formation has been confirmed to possess 'high' volume change potential in accordance with the National House Building Councils (NHBC) classification system given in Part 4 of their Standards (Ref. 5). The gravel stratum encountered within borehole BH1 would be classed as 'non-shrinkable'.

BURIED CONCRETE

6.21 Chemical testing has been carried out to determine the nature of the soils in the context of the durability of buried concrete. Based on the available test data the soluble sulphate content of the soils is noted to be variable and ranges between 283 and 2630 mg/l (measured as soluble SO_4) with a pH of 7.6 to 8.0. Taking the worst case data, the soils are classified as DS-4 in accordance with BRE guidance (Ref 6) with a corresponding ACEC class of AC-3s.

7.0 PRELIMINARY CONTAMINATION ASSESSMENT

BACKGROUND AND TERMS OF REFERENCE

7.1 In the UK, contaminated land is assessed and managed through a number of integrated policies and guidance. Contaminated land is defined in legislation enacted under Part IIA of the Environmental Protection Act 1990 and guidance issued by DEFRA under CLR11 and sister documentation published in 2012 advises on how the legislative framework dealing with contaminated land should be implemented.

7.2 Distinct from the strict and onerous legal definition and classification of "statutory contaminated land" but a corollary to the legislation and associated statutory guidance, the National Planning Policy Framework (NPPF) makes provision or assessing and managing contaminated land in the context of redevelopment which is subject to planning control. Earlier published guidance (PPS23) identified contamination as being a material consideration within any planning application and current policy under NPPF states that land which *"is affected by contamination or land stability issues" must be correctly assessed such that planning decisions should ensure that "the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation".*

7.3 The assessment process requires that *"adequate site investigation information, prepared by a competent person, is presented."* The guidance provided in NPPF also states that *"all investigations of land potentially affected by contamination should be carried out in accordance with established procedures, such as BS10175 (2001)."*

7.4 The NPPF and statutory provisions for dealing with contaminated land are clear in ensuring that where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the *"developer and/or landowner."*

7.5 Fundamental to the assessment of contaminated land is the development of a Conceptual Site Model (CSM). This is an evaluation of the site conditions and its particular characteristics with respect to so called Source-Pathway-Receptor relationships, or plausible pollutant linkages. The CSM can then be used to assess and define risk and in turn it provides a basis for determining the condition of the land in the context of the proposed development and what, if any, action needs to be taken to allow the proposed development to proceed safely and without detrimental impact to the site itself or the wider environment.

7.6 A plausible pollutant linkage is defined by three elements;

Source A hazard which exists within the site or its environs which has the potential to cause harm (e.g. contaminated soil, ground gas, unstable ground, etc.)

Receptor Something associated with the site (e.g. end-user, building, off-site feature, etc.) which can be harmed.

Pathway A plausible linkage between the Source and Receptor such that harm can be realised (e.g. end-user coming into direct contact with contaminated soil, mobile contamination adversely impacting groundwater, etc.).

7.7 By definition a pollutant linkage can only exist where the three elements, source-pathway-receptor, are present and co-exist. If one of the elements that make up the pollutant linkage are not present then it follows that there can be no related risk. The breaking of pollutant linkages is a fundamental principal in the management of contaminated land risk and where the risk is identified and deemed to be unacceptable the appropriate action taken be "breaking" the pollutant linkage in some way.

7.8 Risk in the context of contaminated land is considered in terms of its significance and this is qualitatively assessed on the basis of magnitude of harm that may occur and likelihood of that harm occurring. The risk assessment follows the general principles as set out within BS10175:2001 and CIRIA C552.

7.9 The CSM is used to provide both a context and framework for undertaking any intrusive site investigation which may be deemed necessary to characterise the site with respect to contamination. Where a pollutant linkage is identified further investigation may be needed to confirm or quantify specific conditions, validate the existence of the pollutant linkage and thereby confirm and quantify the degree of risk. This is an important element of the assessment process and under the principles of risk assessment constitutes "*hazard identification*" and "*hazard assessment*".

CONCEPTUAL SITE MODEL & PLAUSIBLE POLLUTANT LINKAGES

Hazards

7.10 Made Ground was identified during the current investigation to a maximum depth of 2.90m bgl. Made Ground should always be viewed as being a potential source of contamination which may have adverse impacts to a number of different receptors.

7.11 Ground gas (carbon dioxide, methane, and possibly other related gases and vapours) are ubiquitous within the subsoil environment. Low concentration of either, or both, carbon dioxide and methane may not be problematic. However, elevated concentrations of ground gas and/or conditions where ground gas is being actively generated (e.g. filled ground, landfill, organic rich natural soils, etc.) may present a significant hazard to the site development or the wider environment. Ground gas may be present from sources either within the site itself or maybe being generated from an off-site source and migrating on to the site.

7.12 Groundwater present within a site may itself be contaminated or may liberate and be a source of (and pathway for) mobile contamination. Contaminated groundwater can impact on various receptors but most notably controlled waters either on the site or offsite.

Receptors

7.13 From the intended end site use the following potential receptors have been identified.

- *Construction workers on the site during development.*
- *Neighbouring sites and site users*
- *Controlled Waters both within the site and off-site*
- *Future residents/users of the proposed development, including young children.*
- *Vegetation within proposed development (landscaping).*
- *Building fabric for the proposed development.*

Pathways

7.14 Contamination within the soil could reach receptors by direct contact with the soils where there is a potential for contamination to be ingested by some means (direct ingestion, inhalation, dermal contact). This is most acute during site development although contact, albeit limited, is also possible for current site users and future site users. The proposed end-use is residential and as such represents a sensitive type of end-use.

7.15 Mobile contamination, present either within the groundwater or otherwise liberated by contact with groundwater (leachable contaminants), may exist, especially given the identified permeable underlying geology.

7.16 Ground gas may migrate through or on/offsite through preferential pathways most likely in the superficial Made Ground.

7.17 Elements of the building fabric for the proposed development may be in direct contact with contamination which may have adverse impacts. Plastic potable water supply pipelines may be susceptible to certain organic contamination if present.

SOIL CONTAMINATION EVALUATION

7.18 In accordance with current good practice (DEFRA guidance and CLR11) a Tier 1 assessment has been undertaken to determine the significance of the contamination present within the site in the context of the CSM. In this regard the contamination present within the soils sampled and determined from the program of chemical testing (see paragraph 5) has been compared to published guidance either UK Soil Guideline Values (SGV) as derived from current CLEA publications or other generic assessment criteria (GAC) derived from other applicable and relevant sources.

7.19 It should be noted SGV criteria is derived from a risk-based modelling software which has limited functionality, is based on assumptions and contains algorithms which the DEFRA and Environment Agency (EA) has publicly expressed its intention to update. As a consequence of this, some of the screening values generated by the CLEA software may not adequately reflect specific site conditions and in some instances are unduly conservative. In addition, it should also be noted that the figures given in the appended table are based on a 6% soil organic matter content.

7.20 DEFRA/EA previously published a number of Soil Guideline Values (SGVs) for certain determinands, (common toxic metals) for assessing the risks to human health from chronic exposure to soil contamination for standard land-use functions. However, these were withdrawn in late 2008 and DEFRA/EA have now issued a new set of guidance documents. Currently SGV figures have only been issued for Arsenic, Cadmium, Mercury, Nickel, Phenols and Selenium.

7.21 In the absence of currently published SGV values for the remaining contaminants, GAC screening values have been used. In this regard W. S. Atkins have derived ATRISKsoil Soil Screening Values (SSVs) based on the new 2009 guidance (SC050021/SR3 (the CLEA Report) and SC050021/SR2 (the TOX report)) for a commercial/industrial, residential without homegrown produce, residential with homegrown produce and allotment land uses. These have been based on the default assumptions provided in the CLEA report which it is understand will be used in the development of future Soil Guideline Values by DEFRA and the Environment Agency. Atkins SSVs have been derived in line with the new guidance using CLEA model v1.04. As the inhalation of vapour pathway contributes less than ten percent of total exposure, this is unlikely to significantly affect the combined assessment criterion and the SSV values used are the combined assessment criterion given by CLEA if free product is not observed.

7.22 Neither CLEA or ATRISK currently publish values for Hexavalent Chromium. Therefore, both Total Chromium and Hexavalent Chromium values have been compared against the Land Quality Management/Chartered Institute of Environmental Health (LQM/CIEH) Generic Assessment Criteria published in 2009 and based on CLEA v1.04 with Total Chromium values based on Chromium III.

7.23 The SGV and SSV levels represent “intervention” levels above which the levels of contamination may pose an unacceptable risk to the health of site-users such that further investigation and/or remediation is required.

7.24 Total Petroleum Hydrocarbons are considered in accordance with the fractions proposed by The Environment Agency, drawing on the TPHCWG methodology. These are contained in Table 4.2 – Petroleum hydrocarbon fractions for use in UK human health risk assessment, based on Equivalent Carbon (EC) number, contained in Science Report P5-080/TR3, *The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soils.*

7.25 Considering the end usage of the site, the chemical results would generally be compared against the ***Residential with Plant Uptake*** criteria, due to the proposed end use.

ASSESSMENT OF CONTAMINATION RESULTS

Soils

7.26 A single elevated lead concentration (2,160 mg/kg) was identified within the tested Made Ground sample from BH1, when compared against *Residential with Plant Uptake* criteria (200 mg/kg).

7.27 No other constituents within the soil sampled and tested exceeded the criteria set out by the ATRISK contaminated Land Screening Values (SSVs), the CLEA Soil Guideline Values (SGVs) and the LQM/CIEH Generic Assessment Criteria (GAC) for *Residential with Plant Uptake* criteria.

7.28 Based on the results of the chemical testing there is not considered to be a significant impact or constraint to the proposed development, however further works are recommended, in the form of a clean cover system within areas of proposed soft landscaping, to help reduce the risk to end users.

Ground Gas

7.29 During the return gas/groundwater monitoring visits, the maximum concentration of methane was recorded at 0.0%v/v and the maximum carbon dioxide concentration was recorded at 3.8%v/v. A maximum flow rate of 0.6l/hr was recorded. The full land-borne gas assessment details are appended.

7.30 Given the low gas concentrations and flow recorded during the return monitoring visit, the site would thus be classified as **Characteristic Situation 1** (following modified Wilson & Card Methodology) (Ref 7). On this basis no special precautions are deemed necessary to safeguard against ground gas, however this is should be agreed with the applicable Local Authority Building Control Officer.

SOIL DISPOSAL & WASTE ACCEPTANCE CRITERIA

7.31 Two EN 14473/02 Waste Acceptance Criteria (WAC) tests have been undertaken to classify for waste disposal purposes, from samples collected from BH1 at 1.50m bgl and BH2 at 2.00m bgl.

7.32 The results of the WAC tests indicate that the samples of Made Ground from BH1 would probably be classified as “Stable Non-reactive”.

7.33 However, acceptance of any waste stream is the responsibility of the landfill operator and we therefore strongly recommend that the WAC data should be presented to potential Waste Management Companies in order for them to confirm the waste classification of surplus soils to be removed from this site and to determine its acceptability at appropriate landfill sites for disposal/treatment.

RISK ASSESSMENT

7.34 The following diagram summarises the potential pollution linkages identified for this site in the form of a diagrammatic Conceptual Model.

		CIRIA Contaminated Land Risk Assessment Table			
		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**High Likelihood**	Very High Risk	High Risk	Moderate Risk	Moderate/Low Risk
	Likely	High Risk	Moderate Risk	Moderate/Low Risk	Low Risk
	Low Likelihood	Moderate Risk	Moderate/Low Risk	Low Risk	Very Low Risk
	Unlikely	Moderate/Low Risk	Low Risk	Very Low Risk	Very Low Risk

*Extracted from CIRIA Publication C552 Contaminated Land Risk Assessment

Source	Pathway	Receptor	Assessment of Risk	Comments
Contaminated soil	Dermal contact with contaminated soils and inhalation/ingestion of soil vapours, soil derived dust and other airborne particulates	Site-end users	Moderate/Low	No elevated concentration were identified relative to applicable guidance to the proposed development. Much of the site will be covered by the footprint of buildings or areas of hardstanding, removing the risk of harm to site end users via human health exposure pathways. However the risk will still remain within areas of proposed soft landscaping and therefore a clean cover system is recommended.
		Construction /maintenance workers	Very Low	As a preventative measure, appropriate Personal Protective Equipment (PPE) and other measures (e.g. good standards of hygiene, washing facilities) are utilised to mitigate the risk.
	Leaching	Surface water and groundwater	Very Low	Given the relatively insoluble nature of the identified lead within the Made Ground, the risks are considered very low if not negligible.
	Plant uptake	Vegetation (not for consumption)	Low	The soil at this site is not considered to present a phytotoxic risk to new vegetation (not for consumption).
	Direct contact	Construction materials	Moderate/Low	In accordance with BRE Special Digest 1 2005 (Concrete in Aggressive Ground) the site is given an overall Design Sulphate Classification of DS-4 and an ACEC Classification of AC-3s.
Contaminated surface water or groundwater	Direct contact	Site end users / Construction /maintenance workers	Very Low	Given the relatively insoluble nature of the identified lead and the Made Ground, the risks are considered very low if not negligible.
	Direct contact	Construction materials	Very Low	
	Vertical /lateral migration	Controlled waters / Adjacent properties	Very Low	
	Surface water run-off	Controlled waters / Adjacent Properties	Very Low	
Ground Gas and Vapour	Migration	Proposed development and adjacent sites	Very Low	The gas monitoring data indicates Characteristic Situation 1 (Low Risk) and no special precautions are deemed necessary to safeguard the development.
	Inhalation of vapours	Site end users/ Construction and future maintenance workers	Very Low	The gas monitoring data indicates Characteristic Situation 1 (Low Risk) and no special precautions are deemed necessary to safeguard the development. Very low concentrations of hydrocarbons have been identified there the volatilisation risks are considered very low if not negligible.

8.0 SUMMARY & RECOMMENDATIONS

Geotechnical

8.1 Due to the recorded relatively high water table and the concomitant issues associated with managing the high water table during basement construction, it is considered that an embedded pile retaining wall will be best approach. A secant piled wall (using hard-soft construction technique) could be constructed around the perimeter of the basement which will offer an effective means of managing and controlling groundwater ingress whilst also providing structural foundation to support. Piles are anticipated to penetrate into and support London Clay.

8.2 It is assumed that the basement ground bearing floor slab will be set approximately 3.50-4.00m below existing ground level and will be set across two levels. At this depth the basement slab would be set within the London Clay Formation. Based on the results of the in-situ testing, it is recommended that a safe allowable bearing pressure of approximately 125 kN/m^2 be adopted for the ground bearing floor slab set at a depth of 3.50m below existing ground level.

8.3 Design of the retaining walls should include allowance for groundwater in accordance with accepted good design practice and allowance for hydrostatic forces to both the ground bearing floor slab and retaining walls should be based on site specific hydrological and hydrogeological assessment. In addition the basement design should include appropriate waterproofing systems compliant with current standards and good practice (BS8102:2009 and applicable NHBC guidance) compatible with the retaining wall and foundation design.

8.4 It is important to ensure that the construction sequence and construction method statement (CMS) is developed based on the specific development system proposed and with full recognition of anticipated ground movements as assessed from site specific Ground Movement Analysis (GMA). It is implicit within this that good standards of workmanship will be maintained throughout so as to minimise and otherwise ameliorate the effects of ground movement associated with basement construction. This may include, inter alia, control on pile installation, sequencing of installation to minimise ground movement, use of necessary temporary support, and adequate control of groundwater.

Contaminated Land

8.5 A single elevated lead concentration (2,160 mg/kg) was identified within the tested Made Ground sample from BH1, when compared against *Residential with Plant Uptake* criteria (200 mg/kg). Further works are therefore recommended to help reduce the risk to future end users.

8.6 A clean cover system may be adopted within areas of proposed soft landscaping. This will involve excavation of the existing site soils to an agreed depth and replaced with clean soils. This will effectively break the contamination pathway between the source and receptor and thus reduce the risk to future residents. Alternatively, raised flower beds could be adopted, with imported soils above ground level and an impermeable layer separating from the underlying soils

8.7 We would recommend that Health and Safety precautions be taken with regard to any ground workers/future maintenance at this site. These should include suitable PPE (gloves, overalls, dust masks etc.) to prevent dermal contact and inhalation of the soils/dust. Washing facilities should be made available on-site to reduce extended contact with site soils.

8.8 With regard to the installation of any future water supply pipe work, reference should be made to the UK Water Industry Research (UKWIR) published "Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites" (Ref 10/WM/03/21; the 'UKWIR Guidance'). This publication supersedes the Water Regulations Advisory Scheme (WRAS) Information and Guidance Note 9-04-03 "Laying Pipes in Contaminated Land", which has been withdrawn. It is recommended that the results of the soil chemical analyses undertaken on the site should be provided to the potable water supply company in order to ensure that any pipe provided complies with their requirements.

8.9 As always, it must be noted that the above recommendations are based on a selected number of representative samples and further testing may be required if any other contamination is suspected or encountered during future groundworks.

Prepared By : Jack Hunter BSc (Hons)
Geo-environmental Engineer

Prepared By : Alexandra Ash MEng (Hons)
Graduate Geotechnical Engineer

Reviewed By:

End of report

References

1. BS 5930:1999+A2:2010 (2010) Code of practice for site investigations.
2. BS 10175:2011 (2011) Code of Practice for the Investigation of Potentially Contaminated Sites.
3. BS 1377:1990 (1990) Methods of Test for Soils for Civil Engineering Purposes.
4. CIRIA (2003) C580. Embedded Retaining Walls – Guidance for Economic Design
5. NHBC (2011) NHBC Standards
6. BRE (2005). Concrete in aggressive ground. Special Digest 1.
7. CIRIA (2007). Assessing risks posed by hazardous ground gases in buildings.

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b) Save for the client no duty is undertaken or warranty or representation made to any party in respect of the opinions, advice, recommendations or conclusions herein set out.
c) All work carried out in preparing this report has used, and is based upon, our professional knowledge and understanding of the current relevant English and European Community standards, approved codes of practice, technology and legislation.
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Chelmer Site Investigations 'Groundbreaking Services'

Client: Matt Godfrey		**Scale:** N.T.S.		**Sheet No:** 1 of 1		**Weather:** Internal		**Date:** 21.09.15	
Site: 76 Fleet Road, London, NW3 2QT		**Job No:** 5839		**Borehole No:** 1		**Boring method:** CFA 100mmØ Secondman			

Depth Mtrs.	Description of Strata	Thick-ness	Legend	Sample	Test Type	Test Result	Root Information	Depth to Water	Depth Mtrs
F.L.	Floor boards over floor space	0.8					No roots observed.		
				D					0.5
0.8	MADE GROUND: medium compact, brown/grey, slightly gravelly very clayey silt with occasional brick and concrete fragments.	0.6		D	M	09 13 17 17			1.0
1.4	MADE GROUND: medium compact, brown/grey, silty sandy fine to coarse gravelly with brick and concrete fragments.	0.4		D					1.5
1.8	Medium dense, brown/orange, silty very sandy fine to medium GRAVEL.	0.6		D	M	11 17 19 17			2.0
2.4	Stiff, brown/grey, slightly sandy silty CLAY.	2.7		D					2.5
				D	V	104 108			3.0
				D					3.5
	Becoming very stiff from 3.7m.								
				D	V	120+ 120+			4.0
				D					4.5
5.1	Borehole refused at 5.1m Too dense for drill to penetrate Suspected claystone			D	V	120+ 120+			5.0

Drawn by: DB **Approved by:** JH

Remarks: *Borehole dry and open on completion. Metal standpipe installed to 5.1m.*

Key: T.D.T.D. Too Dense to Drive
D Small Disturbed Sample J Jar Sample
B Bulk Disturbed Sample V Pilcon Vane (kPa)
U Undisturbed Sample (U100) M Mackintosh Probe
W Water Sample N Standard Penetration Test Blow Count

Chelmer Site Investigations 'Groundbreaking Services'

Client: Matt Godfrey	Scale: N.T.S.	Sheet No: 1 of 1	Weather: Fine	Date: 17.09.15
Site: 76 Fleet Road, London, NW3 2QT	Job No: 5839	Borehole No: 2	Boring method: CFA 100mmØ Secondman	

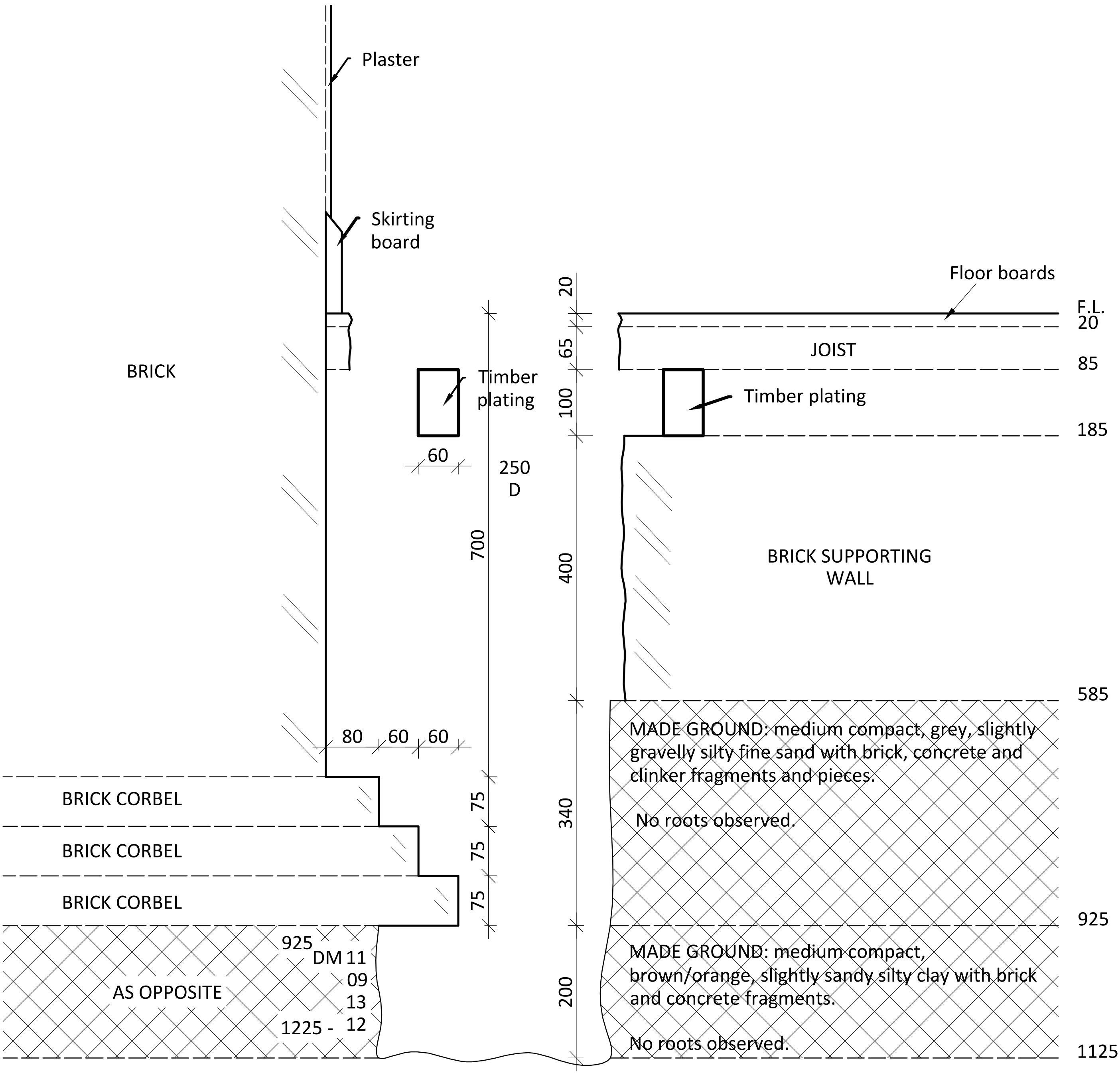
Depth Mtrs.	Description of Strata	Thick-ness	Legend	Sample	Test Type	Test Result	Root Information	Depth to Water	Depth Mtrs
G.L.	CONCRETE	0.05					No roots observed.		
0.05	MADE GROUND: medium compact, moist, brown/orange, sandy silty clay with gravel and numerous brick, concrete and clinker fragments and pieces.	0.95							
1.0	MADE GROUND: firm, moist, brown, stained grey, slightly pungent slightly sandy very silty clay with occasional gravel, brick and clinker fragments and pieces.	1.9		D	M	12 12 13 15			1.0
				D					1.5
				D	M	15 15 17 17			2.0
				D					2.5
2.9	Stiff, brown, slightly sandy silty CLAY with occasional fine gravel.	2.3		D	V	88 90			3.0
				D					3.5
				D	V	98 100			4.0
				D					4.5
				D	V	110 112			5.0
5.2	Stiff, brown/grey, slightly sandy silty CLAY with partings of brown and orange silt and fine sand.	0.6		D					5.5
5.8	Very stiff, grey, slightly sandy silty CLAY with partings of brown and orange silt and fine sand.	2.3		D	V	120+ 120+			6.0
				D	V	120+ 120+			7.0
									7.5
8.0	Borehole ends at 8.0m			D	V	120+ 120+			8.0

Drawn by: DB **Approved by:** JH

Remarks: *Borehole dry and open on completion. Standpipe installed to 6.0m.*

Key: T.D.T.D. Too Dense to Drive
D Small Disturbed Sample J Jar Sample
B Bulk Disturbed Sample V Pilcon Vane (kPa)
U Undisturbed Sample (U100) M Mackintosh Probe
W Water Sample N Standard Penetration Test Blow Count

Client: Matt Godfrey	**Scale:** N.T.S.	**Sheet No:** 1 of 1	**Date:** 17.09.15
Location: 76 Fleet Road, London, NW3 2QT	**Job No:** 5839	**Trial Pit No:** 1	**Weather:** Fine
Excavation Method: Hand Tools		**Drawn by:** DB	**Checked by:** JH

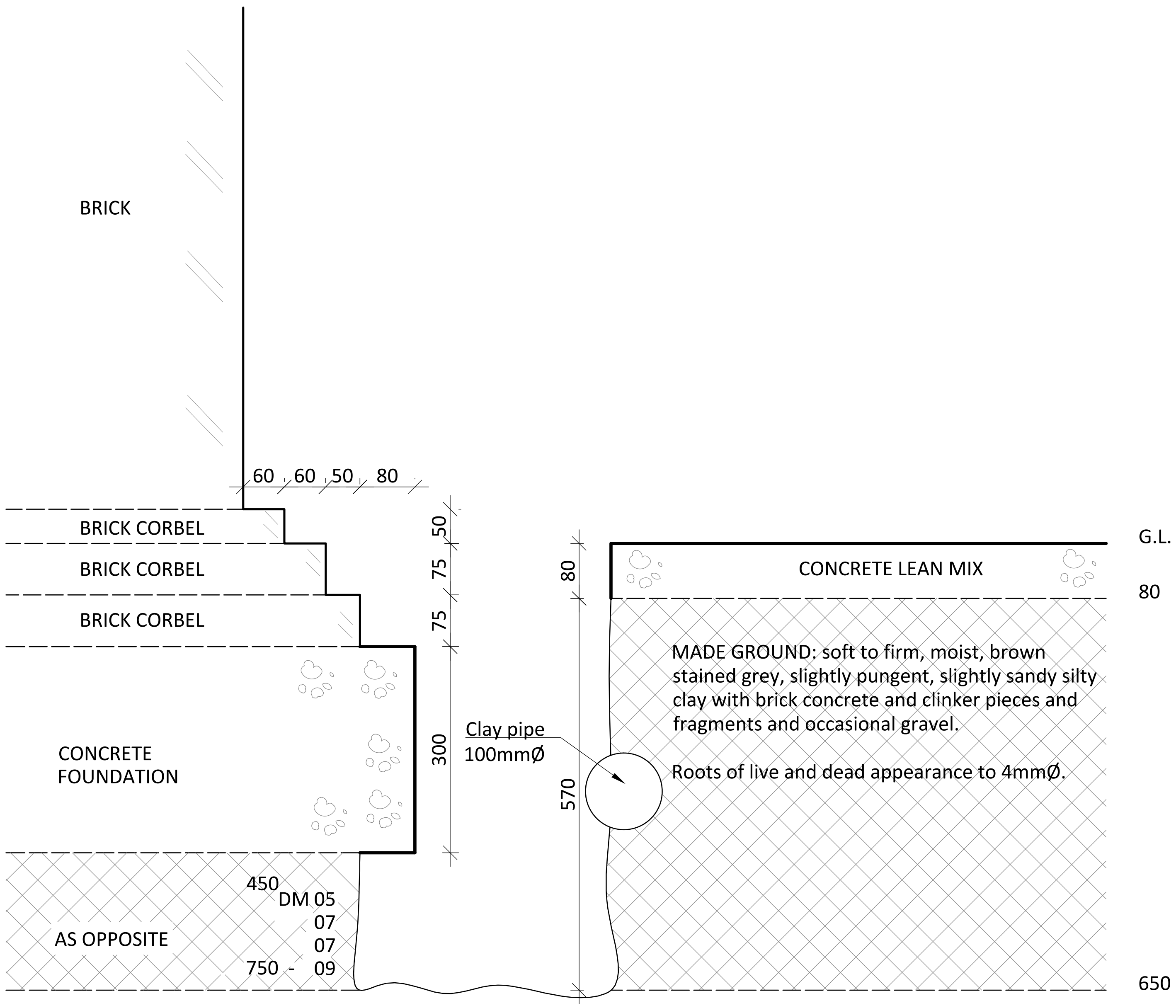


TP1 ENDS AT 1125mm

Remarks:

Key:
- **D** Small disturbed sample
- **B** Bulk disturbed sample
- **U** Undisturbed sample (U100)
- **N** Standard Penetration Test Blow Count
- **J** Jar sample
- **V** Pilcon Vane (kPa)
- **M** Mackintosh Probe
- **W** Water Sample

Client: Matt Godfrey	**Scale:** N.T.S.	**Sheet No:** 1 of 1	**Date:** 17.09.15
Location: 76 Fleet Road, London, NW3 2QT	**Job No:** 5839	**Trial Pit No:** 2	**Weather:** Fine
Excavation Method: Hand Tools		**Drawn by:** DB	**Checked by:** JH

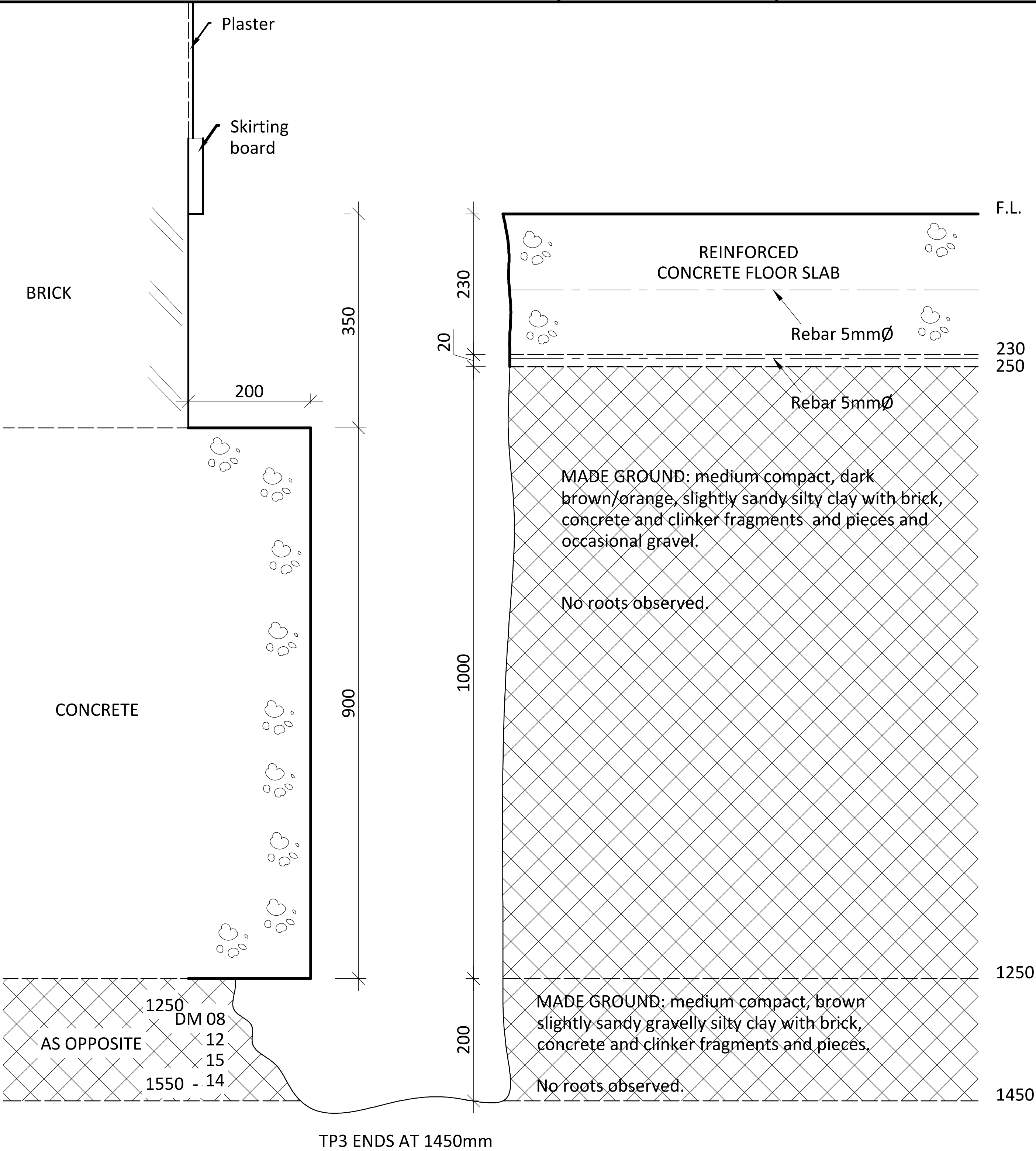


TP2 ENDS AT 650mm

Remarks: Clay pipe in poor condition.

Key:
- **D** Small disturbed sample
- **B** Bulk disturbed sample
- **U** Undisturbed sample (U100)
- **N** Standard Penetration Test Blow Count
- **J** Jar sample
- **V** Pilcon Vane (kPa)
- **M** Mackintosh Probe
- **W** Water Sample

Client:	Matt Godfrey	**Scale:**	N.T.S.	**Sheet No:**	1 of 1	**Date:**	17.09.15
Location:	76 Fleet Road, London, NW3 2QT	**Job No:**	5839	**Trial Pit No:**	3	**Weather:**	Fine
Excavation Method:	Hand Tools			**Drawn by:**	DB	**Checked by:**	JH



Remarks: Water seepage at U/S.

Key:

- **D** Small disturbed sample
- **B** Bulk disturbed sample
- **U** Undisturbed sample (U100)
- **N** Standard Penetration Test Blow Count
- **J** Jar sample
- **V** Pilcon Vane (kPa)
- **M** Mackintosh Probe
- **W** Water Sample

Chelmer
Geotechnical Laboratories
'Groundbreaking Services'

UKAS TESTING 8284

Laboratory Report

Site	**76 Fleet Road**
Client	**Matt Godrey**
Date	**29-Sep-15**
Our Ref	**CSI5839**
CGL Ref	**CGL5839**

Chelmer Site Investigation Laboratories Ltd
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Essex: 01245 400930 | London: 0203 6409136 |info@siteinvestigations.co.uk | www.siteinvestigations.com

UKAS TESTING
8284

Chelmer Geotechnical Laboratories
'Groundbreaking Services'

Content Summary

This report contains all test results as indicated on the test instruction/summary.

CGL Reference :	CGL5839
Client Reference :	CSI5839
For the attention of :	Matt Godrey

Notes :

General

Please refer to report summary notes for details pertaining to methods undertaken and their subsequent accreditations

Samples were supplied by Chelmer Site Investigations

All tests performed in-house unless otherwise stated

Deviant Samples

Samples were received in suitable containers	Yes
A date and time of sampling was provided	Yes
Arrived damaged and/or denatured	No

Laboratory Testing Results

BS 1377 : 1990

Chelmer
Geotechnical Laboratories
'Groundbreaking Services'

Job Number : CGL5839
Client : Matt Godrey
Client Reference : CSI5839
Site Name : 76 Fleet Road

Date Received : 24/09/2015
Date Testing Started : 24/09/2015
Date Testing Completed : 29/09/2015
Laboratory Used : Chelmer Geotechnical, CM3 8AB

Sample Ref			Sample Type	*Moisture Content (%) [1]	*Soil Faction > 0.425mm (%) [2]	*Liquid Limit (%) [3]	*Plastic Limit (%) [4]	*Plasticity Index (%) [5]	*Liquidity Index (%) [5]	*Modified Plasticity Index (%) [6]	*Soil Class [7]	Filter Paper Contact Time (h) [8]	*Soil Sample Suction (kPa)	Insitu Shear Vane Strength (kPa) [9]	Organic Content (%) [10]	*pH Value [11]	*Sulphate Content (g/l)		
BH/TP/WS	Depth (m)	UID															SO_3 [12]	SO_4 [13]	Class [14]
BH1	2.5	66596	D	29	<5	75	23	52	0.12	50	CV								
BH1	3.5	66597	D	32	<5	79	25	54	0.14	52	CV								

Notes :- *UKAS Accredited Tests

[1] BS 1377 : Part 2 : 1990, Test No 3.2

[2] Estimated if <5%, otherwise measured

[3] BS 1377 : Part 2 : 1990, Test No 4.4

[4] BS 1377 : Part 2 : 1990, Test No 5.3

[5] BS 1377 : Part 2 : 1990, Test No 5.4

[6] BRE Digest 240 : 1993

[7] BS 5930 : 1981 : Figure 31 - Plasticity Chart for the classification of fine soils

[8] In-house method S9a adapted from BRE IP 4/93

[9] Values of shear strength were determined in situ by Chelmer Site Investigations using a Pilcon hand vane or Geonor vane (GV).

[10] BS 1377 : Part 3 : 1990, Test No 4

[11] BS 1377 : Part 2 : 1990, Test No 9

[12] BS 1377 : Part 3 : 1990, Test No 5.6

[13] $SO_4 = 1.2 \times SO_3$

[14] BRE Special Digest One (Concrete in Aggressive Ground) 2005

Note that if the SO_4 content falls into the DS-4 or DS-5 class, it would be prudent to consider the sample as falling into the DS-4m or DS-5m class respectively unless water soluble magnesium testing is undertaken to prove otherwise

Key

D - Disturbed sample
B - Bulk sample
U - U100 (undisturbed sample)
W - Water sample
ENP - Essentially Non-Plastic
U/S - Underside Foundation

UKAS TESTING
8284

Comments :-

Technician :- SW
Checked By :- MC
Date Checked :- 29-Sep-15

Laboratory Testing Results

BS 1377 : 1990

Chelmer Geotechnical Laboratories "Groundbreaking Services"

Job Number : CGL5839
Client : Matt Godrey
Client Reference : CSI5839
Site Name : 76 Fleet Road

Date Received : 24/09/2015
Date Testing Started : 24/09/2015
Date Testing Completed : 29/09/2015
Laboratory Used : Chelmer Geotechnical, CM3 8AB

Sample Ref			Sample Type	*Moisture Content (%) [1]	*Soil Faction > 0.425mm (%) [2]	*Liquid Limit (%) [3]	*Plastic Limit (%) [4]	*Plasticity Index (%) [5]	*Liquidity Index (%) [5]	*Modified Plasticity Index (%) [6]	*Soil Class [7]	Filter Paper Contact Time (h) [8]	*Soil Sample Suction (kPa)	Insitu Shear Vane Strength (kPa) [9]	Organic Content (%) [10]	*pH Value [11]	*Sulphate Content (g/l)		
BH/TP/WS	Depth (m)	UID															SO_3 [12]	SO_4 [13]	Class [14]
BH2	3.5	66599	D	35	<5	74	22	52	0.25	50	CV								
BH2	4.5	66600	D	32	<5	73	22	51	0.20	49	CV								
BH2	5.5	66601	D	31	<5	73	22	51	0.17	48	CV								
BH2	8.0	66602	D	30	<5	74	21	53	0.17	51	CV			120+					

Notes :- *UKAS Accredited Tests

[1] BS 1377 : Part 2 : 1990, Test No 3.2
[2] Estimated if <5%, otherwise measured
[3] BS 1377 : Part 2 : 1990, Test No 4.4
[4] BS 1377 : Part 2 : 1990, Test No 5.3
[5] BS 1377 : Part 2 : 1990, Test No 5.4
[6] BRE Digest 240 : 1993
[7] BS 5930 : 1981 : Figure 31 - Plasticity Chart for the classification of fine soils
[8] In-house method S9a adapted from BRE IP 4/93
[9] Values of shear strength were determined in situ by Chelmer Site Investigations using a Pilcon hand vane or Geonor vane (GV).
[10] BS 1377 : Part 3 : 1990, Test No 4
[11] BS 1377 : Part 2 : 1990, Test No 9
[12] BS 1377 : Part 3 : 1990, Test No 5.6
[13] $SO_4 = 1.2 \times SO_3$
[14] BRE Special Digest One (Concrete in Aggressive Ground) 2005

Note that if the SO_4 content falls into the DS-4 or DS-5 class, it would be prudent to consider the sample as falling into the DS-4m or DS-5m class respectively unless water soluble magnesium testing is undertaken to prove otherwise

Key

D - Disturbed sample
B - Bulk sample
U - U100 (undisturbed sample)
W - Water sample
ENP - Essentially Non-Plastic
U/S - Underside Foundation

UKAS TESTING 8284

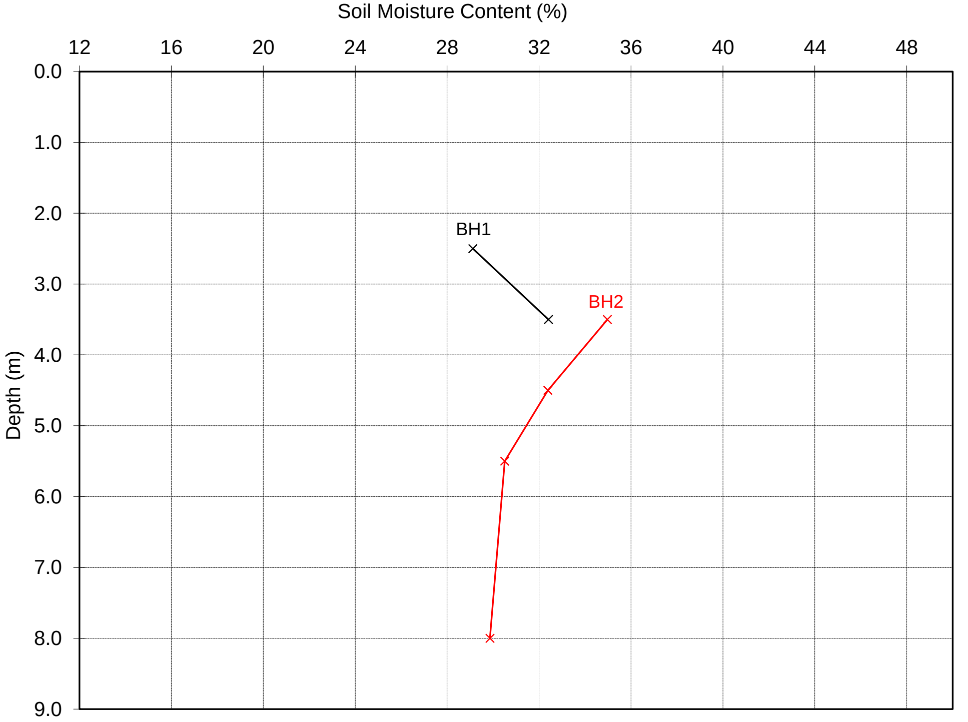
Comments :-

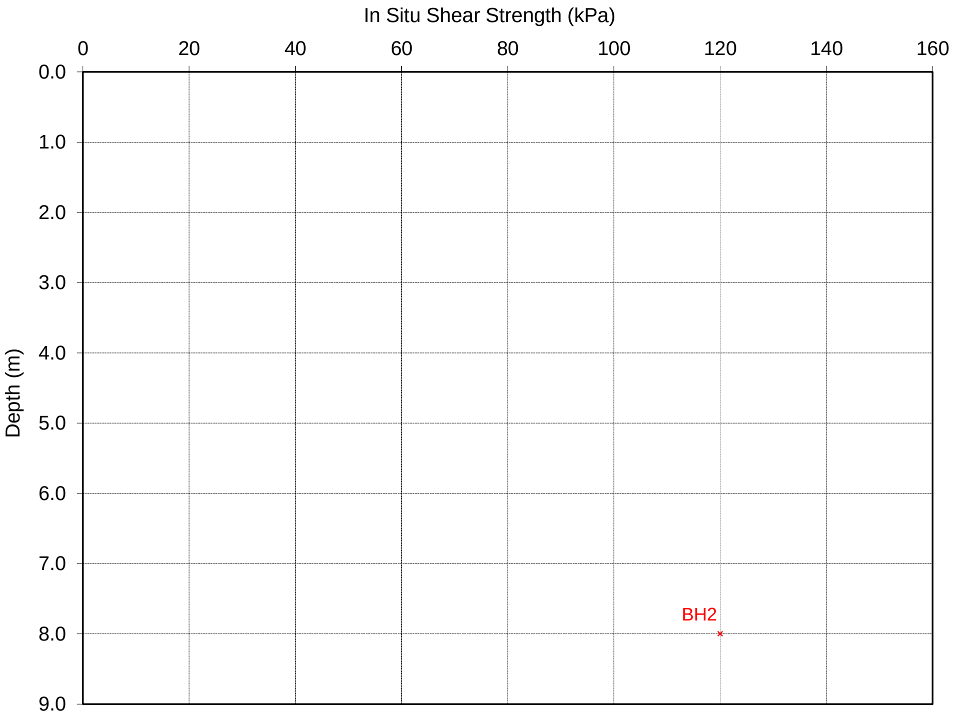
Technician :- SW
Checked By :- MC
Date Checked :- 29-Sep-15

Laboratory Testing Results

Moisture Content/Shear Strength Profile

Job Number :	CGL5839	Date Received :	24/09/2015
Client :	Matt Godrey	Date Testing Started :	24/09/2015
Client Reference :	CSI5839	Date Testing Completed :	29/09/2015
Site Name :	76 Fleet Road	Laboratory :	Chelmer Geotechnical Laboratories, CM3 8AB





Notes :-

1. If the Soil Fraction > 0.425mm exceeds 5% the Equivalent Moisture Content of the remainder (calculated in accordance with BS 1377: Part 2 : 1990, cl.3.2.4 note 1) is also plotted and the alternative profile additionally shown as an appropriately coloured broken line.
2. If plotted, 0.4 LL and PL+2 (after Driscoll, 1983) should only be applied to London Clay (and similarly over consolidated clays) at shallow depths.

Unless otherwise stated, values of Shear Strength were determined in situ by Chelmer Site Investigations using a Pilcon Hand Vane the calibration of which is limited to a maximum reading of 140 kPa. (Not UKAS accredited)

UKAS TESTING 8284

Comments :-

Checked By :- MC

Date Checked :- 29-Sep-15

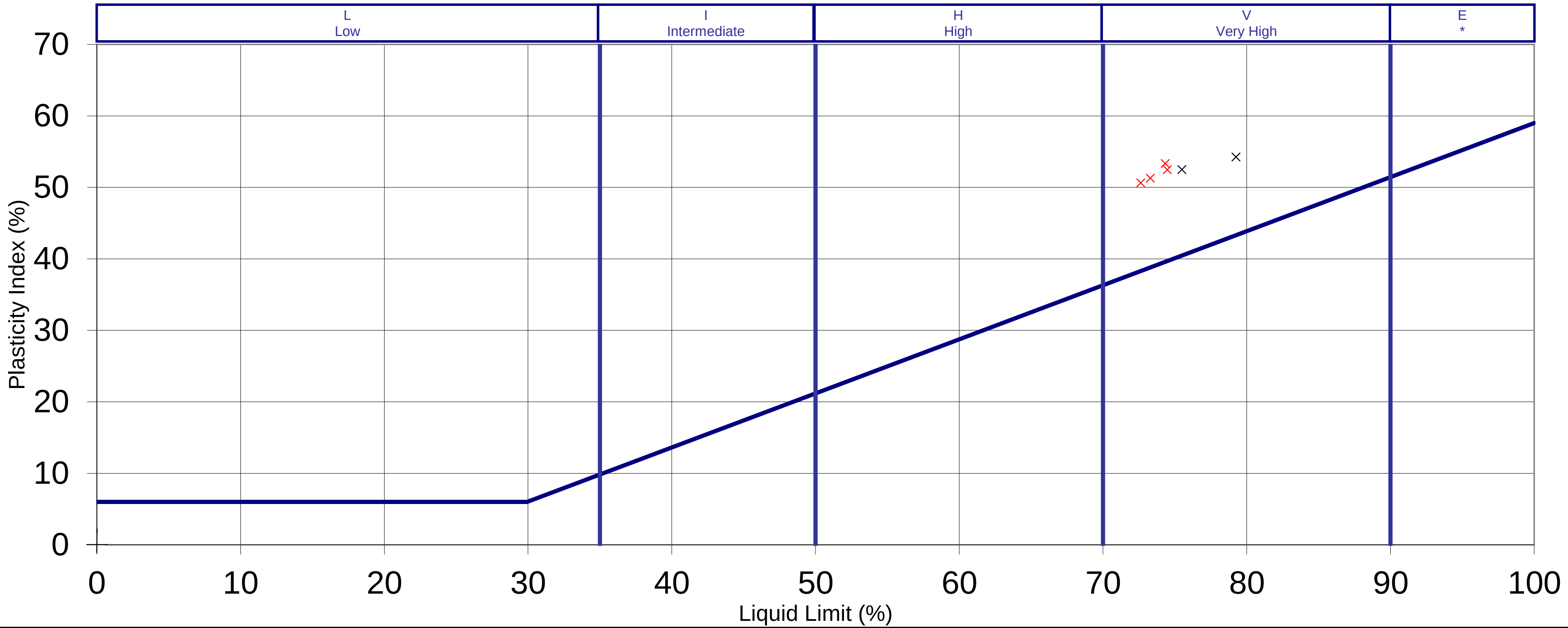
Laboratory Testing Results

Plasticity Chart for the classification of fine soils and the finer part of coarse soils

In Compliance with BS5930 : 1999

Chelmer Geotechnical Laboratories 'Groundbreaking Services'

Job Number :	CGL5839	Date Received :	24/09/2015
Client :	Matt Godrey	Date Testing Started :	24/09/2015
Client Reference :	CSI5839	Date Testing Completed :	29/09/2015
Site Name :	76 Fleet Road	Laboratory :	Chelmer Geotechnical Laboratories, CM3 8AB



Notes :-

SILT (M-SOIL), M, plots below A-Line

CLAY, C, plots above A-Line }M and C may be combined as FINE SOIL, F.

Key :- BH1

BH2

UKAS TESTING 8284

Comments :-

Checked By :- MC

Date Checked :- 29-Sep-15

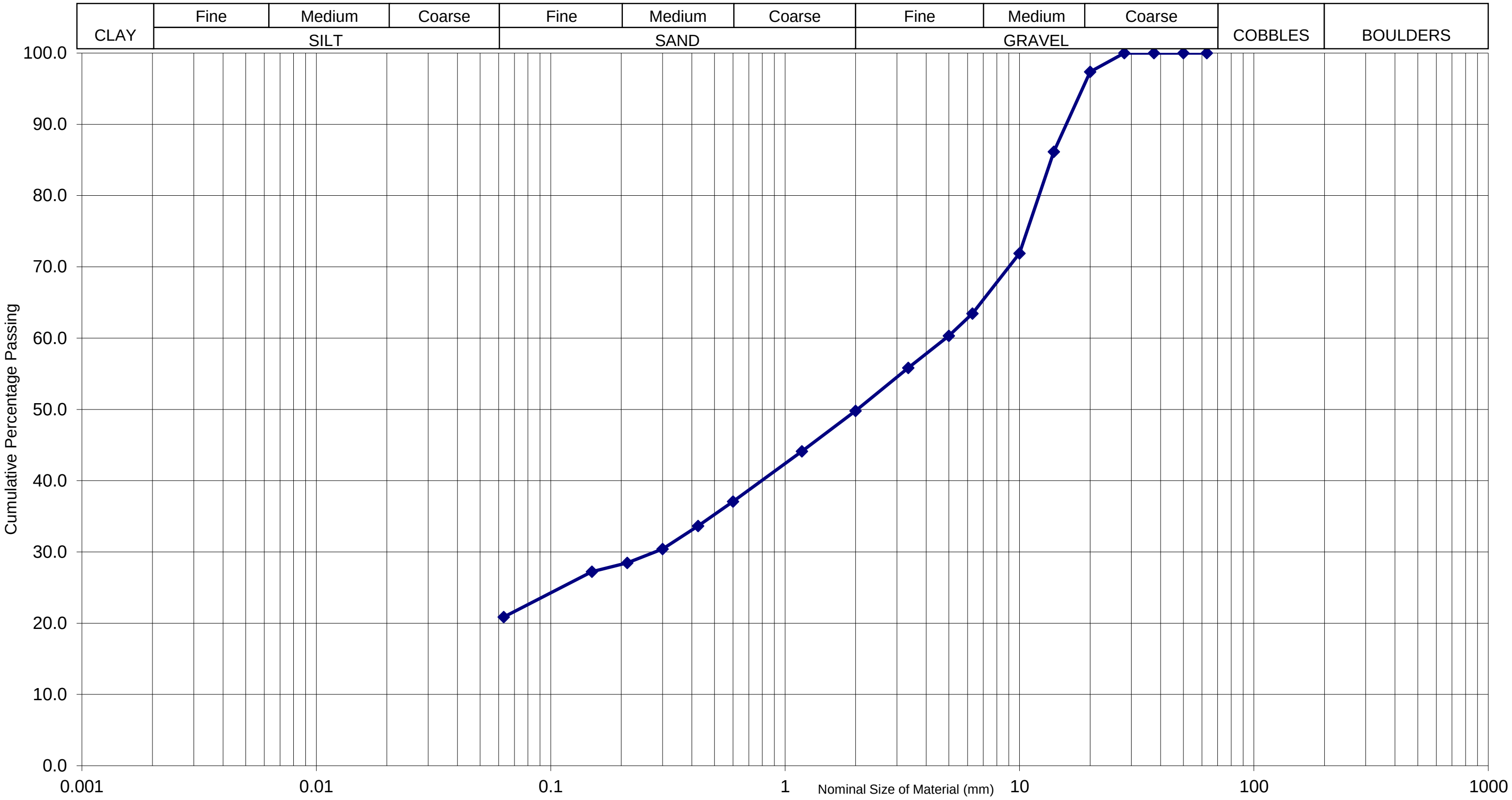
PARTICLE SIZE DISTRIBUTION

BS 1377-2:1990

Chelmer Geotechnical Laboratories 'Groundbreaking Services'

Job Number :	CGL5839	Site Name :	76 Fleet Road, London, NW3
Sample Number :	BH1	Soil Description :	Brown/grey silty very sandy fine to medium GRAVEL.
Depth (m) :	2.00		
Sample UID :	66595		

Type of Sieving : Washed
Date : 24-Sep-15
Tested By : HS
Laboratory : Chelmer Geotechnical CM3 8AB



Sieve Size (mm)	% Passing
90.0	100.0
75.0	100.0
63.0	100.0
50.0	100.0
37.5	100.0
28.0	100.0
20.0	97.4
14.0	86.2
10.0	71.9
6.3	63.4
5.0	60.3
3.35	55.8
2.00	49.8
1.18	44.1
0.600	37.1
0.425	33.7
0.300	30.4
0.212	28.5
0.150	27.2
0.063	20.9

Calculations :-

$$f = \frac{(M_1 - M_2) + P}{M_1} x100$$

$f =$ 100P/M_1 (dry sieving)

f = Percentage of fines passing 0.063mm
M_1 = Mass of dried test sample before washing (kg)
M_2 = Mass of dried residue retained on the 0.063m (kg)
P = Mass of screened material remaining in the pan (kg)

Comments :-

Checked By :- MC   Date Checked :- 29-Sep-15