APPENDIX B
Previous Site Investigation

August 2019: to be used for reporting on existing ground conditions only

Chelmer Consultancy Services
'Groundbreaking Services'

Geo-environmental Interpretative Report

Site	26 West Hill Park London N6 6ND
Client	Tatiana Konopleva
Date	May 2017
Our Ref	GENV/8522

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GEO-ENVIRONMENTAL INTERPRETATIVE REPORT

Chelmer Job No. 8522
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EXECUTIVE SUMMARY

26 West Hill Park, London N6 6ND	
Ground Conditions	The current work encountered Made Ground to a maximum depth of 0.9m below existing ground level (bgl). The Made Ground was found to be underlain by the Claygate Member which was not penetrated at the maximum borehole termination depth of 10.1m bgl.
Groundwater	A groundwater seepage was recorded in BH2 at a depth of 6.8m bgl. A groundwater strike was recorded in BH1 at a depth of 7.0m bgl. During the monitoring visits groundwater was recorded in BH1 at a depths of 3.40m and 3.44m bgl and in BH2 at depths of 1.74m, 1.72m and 1.80m bgl. Further assessment of controlled waters will be undertaken once lab results are available from the groundwater sampling undertaken.
Roots	Roots were observed at the site in BH1, BH2 & TP2. Roots up to 1mm in diameter were recorded in BH1 & BH2 to depths of 2.0m and 0.5m bgl respectively. Roots up to 10mm in diameter were recorded in TP2 to the maximum trial pit depth of 0.66m bgl.
Foundations	The proposed lower ground floor extensions are anticipated to be set at depths of between approximately 1.2m and 3.9m bgl, given the change in elevation across the site and allowing for the depth of the swimming pool in the rear. At these depths it is anticipated that the proposed extensions will be founded within the Claygate Member. In all cases foundations should be taken below any Made Ground and set within natural soils. Based on in-situ shear vane and laboratory testing in conjunction with empirical correlations (Bjerrum, 1972), an allowable bearing pressure of approximately 75 kPa is anticipated at a depth of 1.2m bgl, given the observed relatively high water levels at the site, at which settlements are expected to be within normal acceptable tolerances. Similarly at depths of 2.5m and 3.9m bgl allowable bearing pressures of approximately 100 kPa and 115 kPa respectively can be adopted for foundation design.
Shallow Excavations	Shallow excavations within the site will most likely be within Made Ground and Claygate Member. Within Made Ground short term support is likely to be required to maintain the excavations. The Claygate Member will by contrast be self-supporting to some degree and as such excavations below Made Ground may not require support in the short term. All excavations will be subject to normal health and safety considerations.
Swelling/ Shrinkage	The Claygate Member has been confirmed to possess 'medium' to 'high' volume change potential, in accordance with the National House Building Councils (NHBC) classification system given in Part 4 of their Standards (Ref. 5).
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 83 and 990 mg/l (measured as soluble SO_4) with a pH of 7.6 to 10.8. 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. This classification is subject to change on receipt of groundwater sampling results and will be updated in a revised report.
Ground Gas	During the return gas/groundwater monitoring visits, the maximum concentration of methane was recorded at 0.2%v/v and the maximum carbon dioxide concentration was recorded at 6.2%v/v. A maximum flow rate of 0.1/hr was recorded. The Gas Screening Values (GSVs) are low (due to the low flow rates encountered). However, given the high levels of carbon dioxide recorded in BH1 it is considered that further gas monitoring to confirm the level of risk is undertaken, or alternatively gas protection measures be installed, in line with the **Characteristic Situation 2** of CIRIA (2007) (Ref 7). **Characteristic Situation 2** is a 'Low risk' classification as per Modified Wilson and Card classification system, which requires gas protection measures to be incorporated within the proposed development, in accordance with CIRIA C665 and BS8485:2015, to help reduce the risk to future residents.
Soil Contamination	An elevated concentration of arsenic (32.3mg/kg) was identified within the Made Ground of BH1, which exceeds the ATRISK contaminated Land Screening Value (SSVs) of 32mg/kg for *Residential with Plant Uptake* criteria. 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. Based on the results of the chemical testing, the underlying soils are not considered to present a significant impact or constraint to the proposed development with regards to contamination. Despite the elevated concentration of arsenic identified within the upper levels of Made Ground in BH1, a low risk is considered present to future end

	users given the marginal exceedance of the CLEA Soil Guideline Values (SGVs). No further works are therefore required.
Soil Disposal	The results of the WAC tests indicate that the sample of Made Ground from BH1 would probably be classified as suitable for disposal at a site which accepts "Inert" material.

1.0 INTRODUCTION

1.1 This report has been prepared by Chelmer Site Investigation Laboratories Limited (CSI) to the instructions of the Engineer for the project, Croft Structural Engineers, on behalf of the client for the project, Tatiana Konopleva.

1.2 The address of the site is 26 West Hill Park, London N6 6ND and is located at approximate Ordnance Survey grid reference (OSNGR) 527905E, 186845N. The site comprises a three storey detached residential property, consisting of lower ground, ground and first floors. The property has front and rear gardens and a garage and driveway to the front. Mature trees and other vegetation are present across the site. A *Topographical Survey (LDC/1609006, dated October 2016)* is appended to this report.

1.3 It is to our understanding that the proposed development involves extension to the lower ground floor to front and rear, including relocation of the swimming pool and extensions to both ground and first floors to the side of the existing property. A terrace is also proposed to the front of the property at ground floor level, above the lower ground floor extension. *Existing and Proposed Plans (Drawing numbers 01 to 05 & 07, dated April 2017)* are 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 basement and 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 site investigation, 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 borehole and trial pit locations are indicated on the appended *Sketch Fieldwork Location Plan.*

2.3 The work at this site was undertaken on the 17th February and 2nd March 2017 and comprised the following elements:

Continuous Flight Auger (c.f.a.) Boreholes

2.4 Two c.f.a. boreholes (BH1 & BH2) were undertaken to depths of 10.1m below existing ground level (bgl). BH1 was undertaken in the west corner of the rear garden and BH2 was undertaken in the front driveway.

2.5 Discrete disturbed samples were taken at regular depth intervals as the boreholes were advanced.

2.6 Shear Vane tests were undertaken throughout the boreholes in order to provide additional information on the consistency of the material encountered.

2.7 Upon completion of boreholes BH1 & BH2 combined groundwater/ground gas monitoring standpipes were installed to a depth of 10.0m bgl.

2.8 Full details of the borehole findings are given on the appended *Borehole Record Sheets*.

Hand Excavated Trial Pits

2.9 The scope of works also included the excavation of two trial pits (TP1 & TP2) undertaken to expose and record existing foundations.

2.10 TP1 was excavated adjacent to the side of the single storey lower ground floor level and found the brick wall set directly onto the Claygate Member at a depth of 0.35m below the raised paving slab level (0.2m below ground level).

2.11 TP2 was excavated adjacent to a garden retaining wall in a raised flower bed in the area of the driveway. TP2 found the brick wall stepped out 0.05m below the level of the raised flower bed. The brick wall was found to be set onto Made Ground at a depth of 0.65m below the level of the raised flower bed.

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, three monitoring visits have been undertaken to measure groundwater and ground gas within the site using the installations fitted within boreholes BH1 & BH2 on 15th and 22nd March and 12th April 2017.

2.14 Groundwater testing is yet to be completed. When these results are obtained this report will be amended to include an assessment of risks to controlled waters.

2.15 The concentrations (%v/v) of methane (CH_4), carbon dioxide (CO_2), oxygen (O_2), hydrogen sulphide (H_2S) and carbon monoxide (CO) were recorded within the boreholes, along with the barometric pressure and gas flow (l/min) measurements.

2.16 Concentrations of Volatile Organic Compounds (VOC) were also recorded (in ppm) using a Photo-Ionisation Detector (PID).

2.17 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 Claygate Member with the London Clay Formation outcropping nearby. No superficial deposits were recorded.

3.2 Claygate Member

The Claygate Member is a sedimentary bedrock formed approximately 34 to 56 million years ago in the Palaeogene Period. It comprises dark grey clays with sand laminae, passing up into thin alternations of clays, silts and fine-grained sand, with beds of bioturbated silt. Ferruginous concretions and septarian nodules occur in places. These rocks were formed in shallow seas with mainly siliciclastic sediments (comprising of fragments or clasts of silicate minerals) deposited as mud, silt, sand and gravel.

3.3 London Clay

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 occurred. 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.

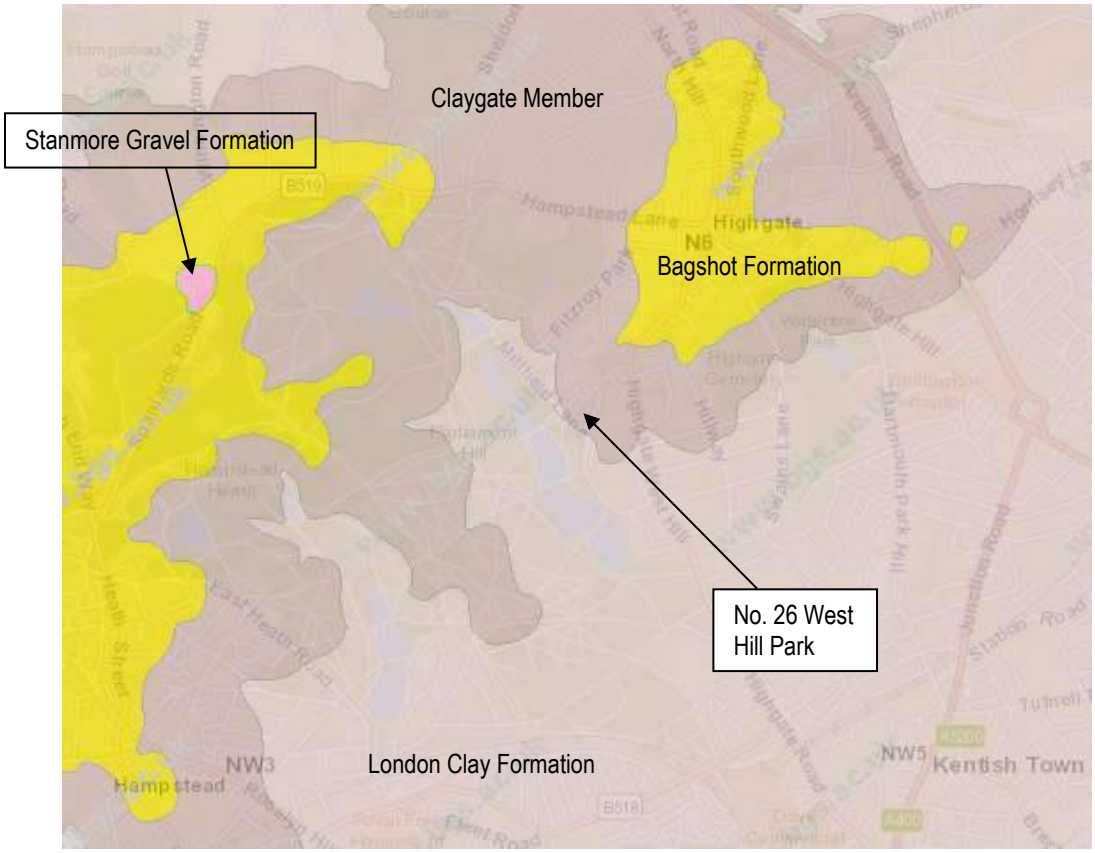

Figure 1. Site BGS Geological Plan (Contains British Geological Survey materials © NERC 2016. Base mapping is provided by ESRI)

4.0 SUMMARY OF GROUND CONDITIONS ENCOUNTERED

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

Depth to Top of Strata (m bgl)	Depth to Bottom of Strata (m bgl)	Stratum
0.00	0.04/0.40	Paving / Concrete
0.00/0.40	0.35/0.90	Made Ground
0.35	0.45	Concrete (TP1)
0.45	0.65+	Claygate Member: *firm thinly interlaminated grey silty CLAY and orange fine SAND (TP1)*
0.80/0.90	4.80/6.00	Claygate Member: *firm to stiff brown sandy silty CLAY*
4.80/6.00	10.10+	Claygate Member: *stiff/very stiff dark grey sandy silty CLAY*

4.2 It should be noted that the Made Ground depths recorded above are those encountered in the boreholes and trial pits 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 A groundwater seepage was recorded in BH2 at a depth of 6.8m bgl. A groundwater strike was recorded in BH1 at a depth of 7.0m bgl. During the monitoring visits groundwater was recorded in BH1 at a depths of 3.40m and 3.44m bgl and in BH2 at depths of 1.74m, 1.72m and 1.80m bgl.

4.4 Roots were observed at the site in BH1, BH2 & TP2. Roots up to 1mm in diameter were recorded in BH1 & BH2 to depths of 2.0m and 0.5m bgl respectively. Roots up to 10mm in diameter were recorded in TP2 to the maximum trial pit depth of 0.66m bgl.

5.0 LABORATORY TESTING

5.1 The following laboratory testing has been carried out on samples recovered from the boreholes and trial pits 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 a total of five samples of the Claygate Member.

For the samples tested the liquid limit was found to range between 51% and 65%, with a mean of 56%, the plastic limit between 16% and 20%, with a mean of 18%, the plasticity index between 35% and 45%, with a mean of 38%, and the modified plasticity index between 33% and 43%, with a mean of 36%. The moisture content of these samples was found to range between 19% and 34%.

These results indicate that the samples are classified as a Clay of 'high' (CH) plasticity in accordance with the Casagrande Geotechnical classification system.

5.5 *Particle Size Distributions*

The particle size distribution has been determined for four samples of the Claygate Member from the site.

The results are presented as grading curves appended to this report.

5.6 *BRE Special Digest 1 Tests*

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

The pH value was found range between 7.6 and 10.8 with the sulphate content, on a 2:1 water:soil extract found to vary between 83 and 990 mg/l.

5.7 *Chemical Analysis*

2 No. 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).

Groundwater testing is yet to be completed. When these results are obtained, this report will be amended to include an assessment of risks to controlled waters.

5.8 *Waste Classification Tests*

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

6.0 GEOTECHNICAL ASSESSMENT

SUMMARY OF PROPOSED DEVELOPMENT

6.1 It is to our understanding that the proposed development involves extension to the lower ground floor to front and rear, including relocation of the swimming pool and extensions to both ground and first floors to the side of the existing property. A terrace is also proposed to the front of the property at ground floor level, above the lower ground floor extension. *Existing and Proposed Plans (Drawing numbers 01 to 05 & 07, dated April 2017)* are 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 The proposed lower ground floor extensions are anticipated to be set at depths of between approximately 1.2m and 3.9m bgl, given the change in elevation across the site and allowing for the depth of the swimming pool in the rear. At these depths it is anticipated that the proposed extensions will be founded within the Claygate Member. In all cases foundations should be taken below any Made Ground and set within natural soils.

6.5 Based on in-situ shear vane and laboratory testing in conjunction with empirical correlations (Bjerrum, 1972), an allowable bearing pressure of approximately 75 kPa is anticipated at a depth of 1.2m bgl, given the observed relatively high water levels at the site, at which settlements are expected to be within normal acceptable tolerances.

6.6 Similarly at depths of 2.5m and 3.9m bgl allowable bearing pressures of approximately 100 kPa and 115 kPa respectively can be adopted for foundation design.

6.7 In the event that shallow foundations are not suitable for the proposed development piles will offer a suitable alternative. 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.

6.8 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
Claygate Member	
Bulk unit weight, γ_b	19 kN/m^3
Effective angle of internal friction, φ'	25˚
Undrained shear strength, Su	60-120 kN/m^2 (based on in-situ testing)

6.9 The following are estimated safe working loads (axial capacity) for a range of typical diameters for single bored piles extending to 6.0m, 8.0m and 10.0m below 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	150-200
Bored	6.00	0.60	200-250
Bored	8.00	0.30	100-150
Bored	8.00	0.45	200-250
Bored	8.00	0.60	300-350
Bored	10.00	0.30	150-200
Bored	10.00	0.45	300-350
Bored	10.00	0.60	400-450

6.10 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.

6.11 Made Ground has been identified within this site which should always be treated as a potential source of contamination. 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

6.12 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.

6.13 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
Effective cohesion, c'	0
Effective angle of internal friction, φ'	25°
Claygate Member	
Bulk unit weight, γ_b	19 kN/m^3
Earth pressure coefficient at rest, K_0	0.5-0.6
Undrained shear strength, Su	60-100 kN/m^2 (based on in-situ testing)
Effective angle of internal friction, φ'	25°

6.14 A groundwater seepage was recorded in BH2 at a depth of 6.8m bgl. A groundwater strike was recorded in BH1 at a depth of 7.0m bgl. During the monitoring visits groundwater was recorded in BH1 at a depths of 3.40m and 3.44m bgl and in BH2 at depths of 1.74m, 1.72m and 1.80m bgl. 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.

6.15 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.

6.16 Allowance should be made for appropriate groundwater control during construction cognisant of the prevailing site conditions and some form of dewatering may be needed.

6.17 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.

ANTICIPATED GROUND MOVEMENTS

6.18 Lateral stress release in the ground surrounding the excavation by both foundation construction 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).

6.19 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.

SHALLOW EXCAVATIONS

6.20 Shallow excavations within the site will most likely be within Made Ground and Claygate Member. Within Made Ground short term support is likely to be required to maintain the excavations. The Claygate Member will by contrast be self-supporting to some degree and as such excavations below Made Ground may not require support in the short term. All excavations will be subject to normal health and safety considerations.

SWELLING AND SHRINKAGE

6.21 The Claygate Member has been confirmed to possess 'medium' to 'high' volume change potential, in accordance with the National House Building Councils (NHBC) classification system given in Part 4 of their Standards (Ref. 5).

BURIED CONCRETE

6.22 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 83 and 990 mg/l (measured as soluble SO_4) with a pH of 7.6 to 10.8. 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. This classification is subject to change on receipt of groundwater sampling results and will be updated in a revised report.

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 0.90m 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. Given the Secondary 'A' aquifer classification of the underlying Claygate Member this is considered to be a low to moderate risk. Further assessment of controlled waters will be undertaken once lab results are available from the groundwater sampling undertaken.

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.

7.16 Ground gas may migrate on/offsite or 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 Section 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 ATRISK soil 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.

ASSESSMENT OF CONTAMINATION RESULTS

Soils

7.26 An elevated concentration of arsenic (32.3mg/kg) was identified within the Made Ground of BH1, which exceeds the ATRISK contaminated Land Screening Value (SSVs) of 32mg/kg for *Residential with Plant Uptake* criteria.

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, the underlying soils are not considered to present a significant impact or constraint to the proposed development with regards to contamination. Despite the marginally elevated concentration of arsenic identified within the upper levels of Made Ground in BH1, a low risk is considered present to future end users given the marginal exceedance of the CLEA Soil Guideline Values (SGVs). No further works are therefore considered necessary.

Ground Gas

7.29 During the return gas/groundwater monitoring visits, the maximum concentration of methane was recorded at 0.2%v/v and the maximum carbon dioxide concentration was recorded at 6.2%v/v. A maximum flow rate of 0.1/hr was recorded. The full land-borne gas assessment details are appended.

7.30 The Gas Screening Values (GSVs) are low (due to the low flow rates encountered). However, given the high levels of carbon dioxide recorded in BH1 it is considered that further gas monitoring to confirm the level of risk is undertaken, or alternatively gas

protection measures be installed, in line with the **Characteristic Situation 2** of CIRIA (2007) (Ref 7).

7.31 **Characteristic Situation 2** is a 'Low risk' classification as per Modified Wilson and Card classification system, which requires gas protection measures to be incorporated within the proposed development, in accordance with CIRIA C665 and BS8485:2015, to help reduce the risk to future residents.

SOIL DISPOSAL & WASTE ACCEPTANCE CRITERIA

7.32 An EN 14473/02 Waste Acceptance Criteria (WAC) test has been undertaken to classify waste disposal purposes, from a sample collected from BH1 at 0.50m bgl.

7.33 The results of the WAC tests indicate that the sample of Made Ground from BH1 would probably be classified as suitable for disposal at a site which accepts "Inert" material.

7.34 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

7.35 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	Low	An elevated concentration of arsenic was identified within the tested soil samples. However, given the only marginal exceedance of guideline values, a low risk to future end users is considered present. No further works will therefore be required to reduce the level of risk to future users.
		Construction /maintenance workers	Very Low	Appropriate Personal Protective Equipment (PPE) and other measures (e.g. good standards of hygiene, washing facilities) should be utilised during groundworks.
	Leaching	Surface water and groundwater	Low	A low risk of leaching is considered given the identified contamination was recorded to only marginally exceed guideline values. Further assessment of controlled waters will be undertaken once lab results are available from the groundwater sampling undertaken.
	Plant uptake	Vegetation (not for consumption)	Very Low	The soil at this site is not considered to present a phytotoxic risk to new vegetation (not for consumption).
	Direct contact	Construction materials	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	Further assessment of controlled waters will be undertaken once lab results are available from the groundwater sampling undertaken.
	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	Low / Moderate	Given the high recorded concentrations of carbon dioxide, it is recommended that further gas monitoring is undertaken to help develop a more detailed understanding of the underlying gas regime at the site. Alternatively, protective measures in accordance with **Characteristic Situation 2** are deemed necessary to safeguard the development.
	Inhalation of vapours	Site end users/ Construction and future maintenance workers	Low / Moderate	Given the high recorded concentrations of carbon dioxide, it is recommended that further gas monitoring is undertaken to help develop a more detailed understanding of the underlying gas regime at the site. Alternatively, protective measures in accordance with **Characteristic Situation 2** are deemed necessary to safeguard the development.

8.0 SUMMARY & RECOMMENDATIONS

Geotechnical

8.1 The proposed lower ground floor extensions are anticipated to be set at depths of between approximately 1.2m and 3.9m bgl, given the change in elevation across the site and allowing for the depth of the swimming pool in the rear. At these depths it is anticipated that the proposed extensions will be founded within the Claygate Member. In all cases foundations should be taken below any Made Ground and set within natural soils.

8.2 Based on in-situ shear vane and laboratory testing in conjunction with empirical correlations (Bjerrum, 1972), an allowable bearing pressure of approximately 75 kPa is anticipated at a depth of 1.2m bgl, given the observed relatively high water levels at the site, at which settlements are expected to be within normal acceptable tolerances. Similarly at depths of 2.5m and 3.9m bgl allowable bearing pressures of approximately 100 kPa and 115 kPa respectively can be adopted for foundation design.

8.3 In the event that shallow foundations are not suitable for the proposed development piles will offer a suitable alternative.

8.4 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.

8.5 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.

8.6 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.

Contaminated Land

Soils

8.7 A marginally elevated concentration of arsenic was recorded within the soil samples tested when compared to the CLEA Soil Guideline Values for *Residential with Plant Uptake* criteria.

8.8 Based on the results of the chemical testing, the underlying soils are not considered to present a significant impact or constraint to the proposed development with regards to contamination. Despite the elevated concentration of arsenic identified within the upper levels of Made Ground in BH1, a low risk is considered present to future end users given the marginal exceedance of the CLEA Soil Guideline Values (SGVs). No further works are therefore considered necessary.

8.9 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.

8.10 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.

Ground Gases/Vapour

8.11 Due to the elevated carbon dioxide concentrations recorded, it is recommended that further gas monitoring is undertaken to help develop a more detailed understanding of the underlying gas regime at the site.

8.12 Alternatively, appropriate gas protection measures should be selected for the proposed development, in accordance with CIRIA C665 and BS8485:2015, to help reduce the risk to future residents.

8.13 **Characteristic Situation 2** is a 'Low risk' classification as per Modified Wilson and Card classification system, which requires gas protection measures to be incorporated within the proposed development, in accordance with CIRIA C665 and BS8485:2015, to help reduce the risk to future residents.

8.14 A scoring system is referred to within BS 8485:2015, whereby each protection measure has an individual score. The proposed development is private residential and therefore

would be classified as a Type A building. The score for such a development must equal or exceed a gas protection score of **3.5** for **Characteristic Situation 2**.

8.15 The following solutions are provided to meet requirements for **Characteristic Situation 2** (taken from Tables 4, 5, 6 and 7 in BS 8485:2015) and are dependent on achieving the necessary points score as detailed above;

Floor and substructure design:
-Precast suspended segmental subfloor (i.e. beam and block) **Score 0**; or
-Cast in-situ ground bearing floor slab **Score 0.5**; or
-Cast in-situ monolithic reinforced ground bearing raft or reinforced cast in-situ suspected floor slab with minimal penetrations **Score 1 or 1.5** (depended on level of reinforcement)
Breaches in floor slabs such as joints have to be effectively sealed against gas ingress in order to maintain these performances.
Protection element / system (Score 1.5):
- Passive subfloor dispersal layer
(media used to provide dispersal layer are: clear void, polystyrene void former blanket, geocomposite void former blanket, no fines gravel layer with gas drains, no fines gravel layer);

Proprietary gas resistant membrane (Score 2):
- Gas resistant membrane
It is important that the membrane is durable so that damage is prevented during construction on-site and is installed correctly by a competent contractor. All joints and penetrations (e.g. services) should be appropriately sealed and bonded to the membrane. The use of pre-fabricated or site fabricated top hats should be used to minimise leaks;

8.16 The above options are considered to best compliment the anticipated foundation design, however, other options can be developed using BS8485 if required.

8.17 It is beneficial to design simple foundations to aid the easy incorporation of gas protection systems. For example, the reduction of service penetrations through a slab by relocation through the outer wall above ground level will reduce the detailing required if laying a membrane and therefore reduce the risk of failure.

8.18 As a precursor to site construction works the investigation boreholes and monitoring wells located beneath the proposed building structures should be grouted with a low permeability slurry.

8.19 Service runs should be sealed at the edge of the building by filling the annulus around pipes with an impermeable barrier to prevent ground gas migration. Where piped cable runs are present, the internal pipes should be sealed with a closed cell foam (or similar) at the edge of buildings. These measures are in addition to the specialist seals around the service entry points to the buildings envelopes discussed above.

8.20 If piling techniques are to be considered in the foundations of the proposed buildings, this can create or exacerbate migration pathways from the deeper underlying material to directly beneath the building structure. Therefore, should a piling solution be used, careful consideration of the methods employed should be given so to not create a preferential pathway for ground-gases to migrate to the buildings, with cast in-situ concrete piles preferred.

8.21 A Remediation Method Statement will likely be required by the Local Authority, to outline the necessary remedial works, for their review and approval, along with a Validation Report.

Additional Comments

8.22 As always, the above recommendations are based on a selected number of representative samples, with sampling locations based on the information available at the time of this investigation.

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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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Chelmer Site Investigations 'Groundbreaking Services'

Borehole Log

Site:	Client:	Borehole ID:
26 West Hill Park, Highgate, London, N6 6ND	Tatiana Konopleva	BH1

Contract Number:	Date:	Logged By:	Checked by:	Weather:	
8522	17/02/17	L.J.S.	J.H.	Dry	Sheet 1 of 1

Easting:	Northing:	Ground Level:	Plant Used:	Scale:
N.D.	N.D.	N.D.	100Ø CFA Secondman	N.T.S.

Samples & In Situ Testing			Strata Details				Roots and Groundwater		
Depth (m)	Sample	Test Result	Depth (m)	Thickness (m)	Legend	Strata Description	Roots Information	Gw (m)	Install
GL			GL				Roots of live and dead appearance of 1mmØ to 2.0m.		
0.25	D			0.90		MADE GROUND: Dark yellow-brown slightly sandy slightly gravelly silty clay with rare brick fragments. Sand is fine. Gravel is sub-rounded of fine chalk.			
0.50	D								
			0.90						
1.00	D	V 70 72				Firm orange brown sandy silty CLAY. Sand is fine.			
1.50	D								
2.00	D	V 94 94					No roots observed below 2.0m.		
2.50	D			3.60					
3.00	D	V 114 116				.....becoming stiff from 3.0m.			
3.50	D								
4.00	D	V 120+ 120+							
4.50	D		4.50			Stiff brown slightly sandy silty CLAY with occasional pockets of fine brown silt and orange sand.			
5.00	D	V 120+ 120+		1.50					
6.00	D	V 120+ 120+	6.00			Stiff moist dark grey slightly sandy silty CLAY with occasional pockets of brown silt and fine sand.			
7.00	D	V 120+ 120+						*7.0*	
8.00	D	V 120+ 120+		4.00		.....rare shell fragments at 8.0m.			
9.00	D	V 120+ 120+							
10.00	D	V 120+ 120+	10.10			Borehole terminated at 10.10m			

Remarks:

Groundwater 'strike' at 7.0m.
Borehole wet and open on completion.
Standpipe installed to 10.0m, slotted pipe: 9.0m, plain pipe: 1.0m, shingle and cover.

Key:

CFA	Continuous Flight Auger
D	Small Disturbed Sample
GL	Ground Level
V	Pilcon Vane (kPa)

Chelmer Site Investigations 'Groundbreaking Services'

Borehole Log

Site:	Client:	Borehole ID:
26 West Hill Park, Highgate, London N6 6ND	Tatiana Konopleva	BH2

Contract Number:	Date:	Logged By:	Checked by:	Weather:	
8522	02/03/17	L.J.S.	J.H.	Dry	Sheet 1 of 1

Easting:	Northing:	Ground Level:	Plant Used:	Scale:
N.D.	N.D.	N.D.	CFA Secondman	N.T.S.

Samples & In Situ Testing			Strata Details				Roots and Groundwater		
Depth (m)	Sample	Test Result	Depth (m)	Thickness (m)	Legend	Strata Description	Roots Information	Gw (m)	Install
GL			GL	0.10		Block paving	Roots of live and dead appearance of 1mmØ to 0.5m. No roots observed below 0.5m.		
			0.10	0.30		Concrete			
0.40	D		0.40	0.40		MADE GROUND: Brown slightly sandy gravelly silty clay with occasional brick and concrete fragments. Sand is fine to medium. Gravel is sub-angular of fine flint.			
0.50	D		0.80	1.20		Stiff orange-brown sandy silty CLAY with occasional grey veining. Sand is fine.			
1.00	D	V 78 80							
1.50	D								
2.00	D	V 92 90	2.00	2.80		Stiff brown sandy silty CLAY. Sand is fine.			
2.50	D								
3.00	D	V 120+ 120+							
3.50	D								
4.00	D	V 120+ 120+				.....becoming darker from 3.8m.			
4.50	D								
5.00	D	V 120+ 120+	4.80	5.20		Very stiff dark grey sandy silty CLAY with rare pockets of brown silt and fine sand.		6.8	
6.00	D	V 120+ 120+							
7.00	D	V 120+ 120+							
8.00	D	V 120+ 120+							
9.00	D	V 120+ 120+							
10.00	D	V 120+ 120+	10.10			Borehole terminated at 10.10m			

Remarks:

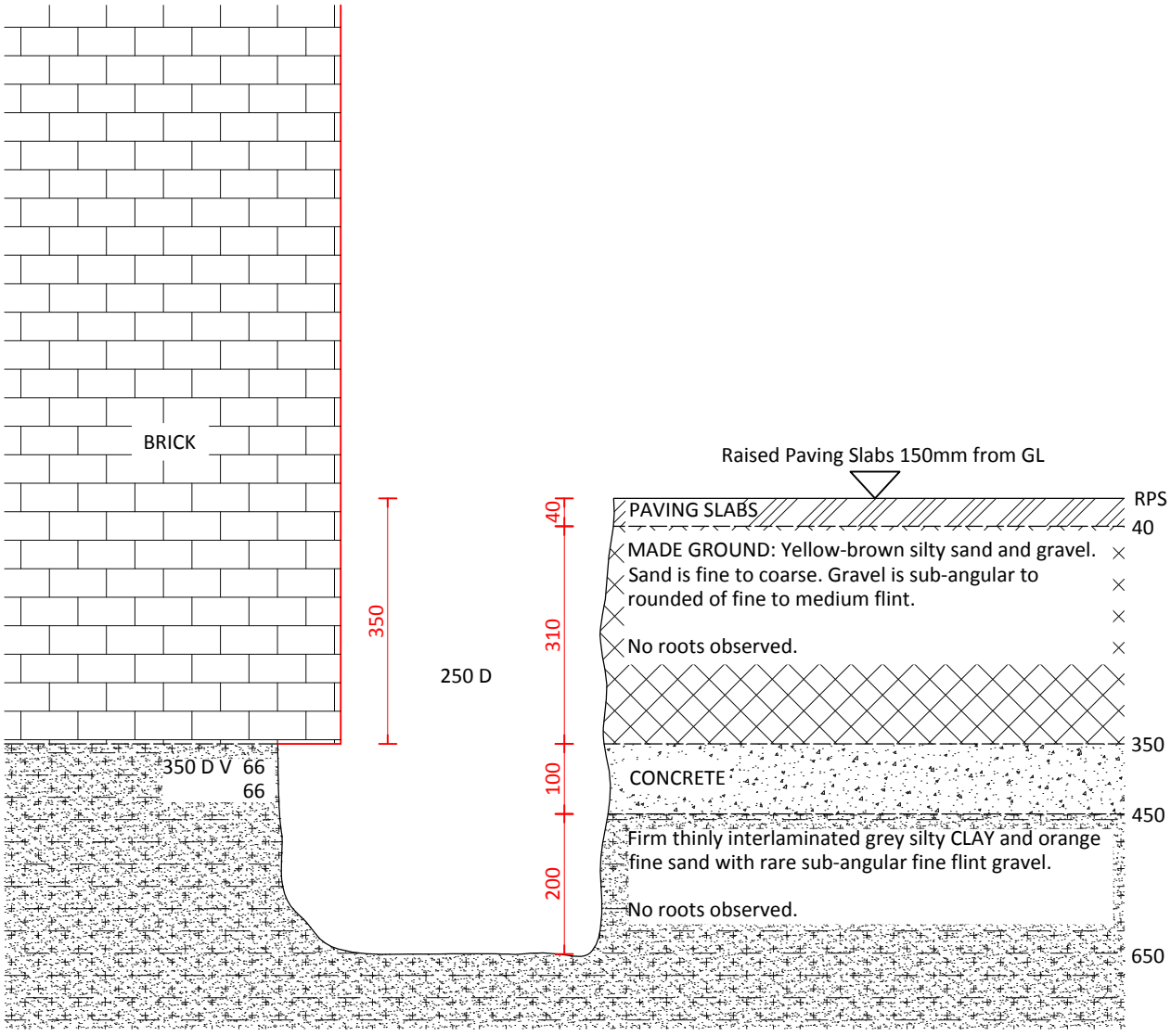
Groundwater 'seepage' at 6.8m.
Borehole moist and open on completion.
Plastic standpipe installed to 10.0m, slotted pipe: 9.0m, plain pipe: 1.0m, bentonite: 9.0m, shingle: 1.0m and gas value installed..

Key:

CFA Continuous Flight Auger
D Small Disturbed Sample
GL Ground Level
V Pilcon Vane (kPa)

Site:		Client:			Trial Pit ID:
26 West Hill Park, Highgate, London, N6 6ND		Tatiana Konopleva			TP1
Contract Number:	**Date:**	**Logged By:**	**Checked by:**	**Weather:**	
8522	17/02/17	L.J.S.	J.H.	Dry	Sheet 1 of 1
Easting:	**Northing:**	**Ground Level:**	**Excavation Method:**		**Scale:**
N.D.	N.D.	N.D.	HAND TOOLS		N.T.S.

Trial Pit Log



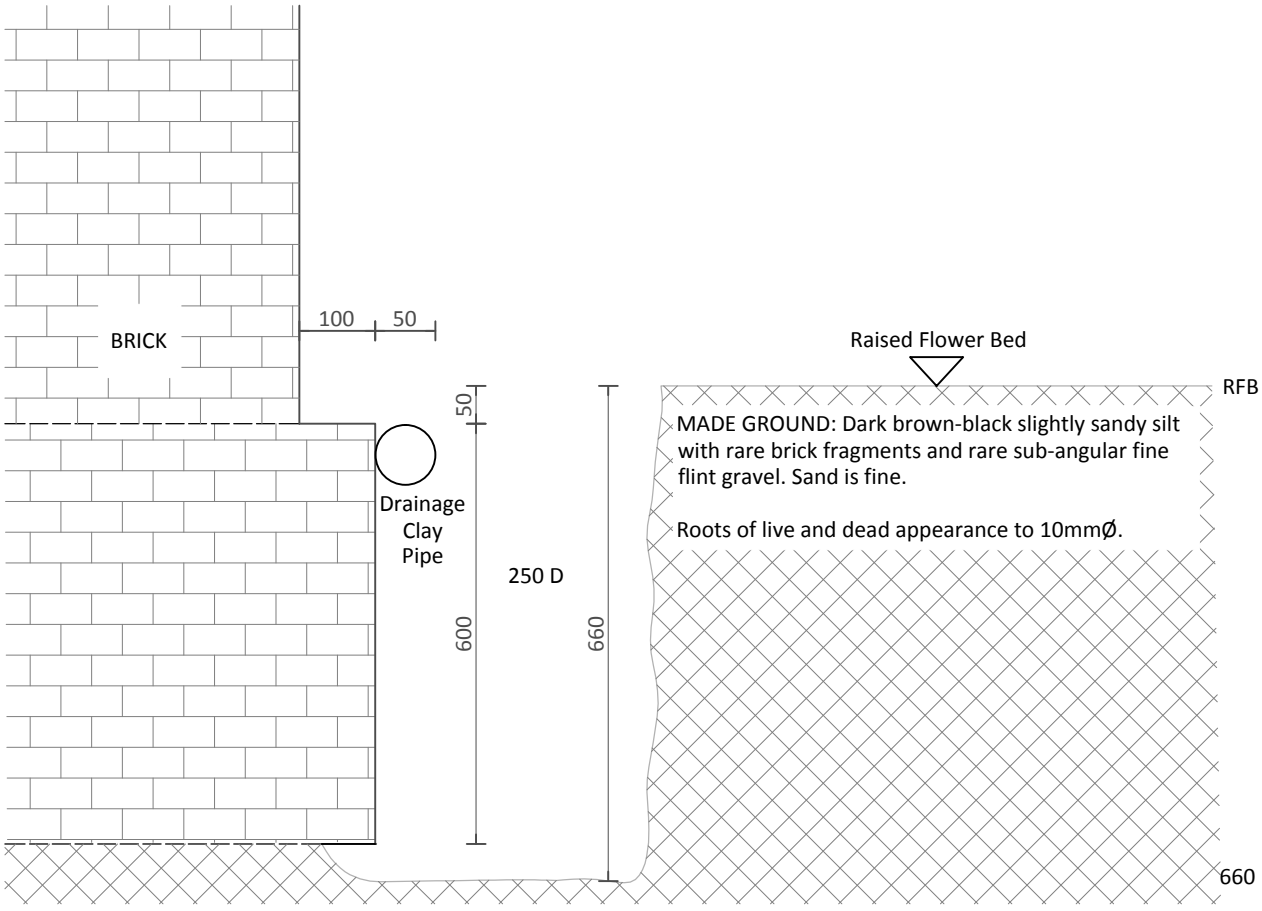
TRIAL PIT 1 TERMINATED AT 650mm

Remarks:	Key:
All dimensions in millimetres.	GL Ground Level RPS Raised Paving Slabs D Small Disturbed Sample V Pilcon Vane (kPa)

Chelmer Site Investigations
'Groundbreaking Services'

Trial Pit Log

Site:		Client:			Trial Pit ID:
26 West Hill Park, Highgate, London, N6 6ND		Tatiana Konopleva			TP2
Contract Number:	**Date:**	**Logged By:**	**Checked by:**	**Weather:**	
8522	17/02/17	L.J.S.	J.H.	Dry	Sheet 1 of 1
Easting:	**Northing:**	**Ground Level:**	**Excavation Method:**		**Scale:**
N.D.	N.D.	N.D.	HAND TOOLS		N.T.S.



TRIAL PIT 2 TERMINATED AT 660mm

Remarks:	Key:
All dimensions in millimetres.	RFB Raised Flower Bed D Small Disturbed Sample

UKAS TESTING
8284

Chelmer
Geotechnical Laboratories
'Groundbreaking Services'

Laboratory Report

Site	**26 West Hill Park, Camden**
Client	**Tatiana K**
Date	**22-Mar-17**
Our Ref	**CSI8522**
CGL Ref	**CGL8522**

Chelmer Site Investigation Laboratories Ltd
Unit 15 East Hanningfield Industrial Estate, Old Church Road, East Hanningfield, Essex CM3 8AB
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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 : CGL8522

Client Reference : CSI8522

For the attention of : Tatiana K

This report comprises of the following :

1	Cover Page
1	Inside Cover/Contents Page
3	Pages of Results
1	Moisture/Shear Strength Chart
1	Plasticity Chart
4	Particle Size Distribution - Sieve & Sedimentation Charts
5	Pages of BRE SD1 Results
1	Limitations of Report Page

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 : CGL8522
Client : Tatiana K
Client Reference : CSI8522
Site Name : 26 West Hill Park, Camden

Date Received : 07/03/2017
Date Testing Started : 07/03/2017
Date Testing Completed : 22/03/2017
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	1.5	86159	D	23	<5	59	18	41	0.12	39	CH								
BH1	3.0	86162	D	20	<5	54	18	36	0.06	34	CH								
BH1	3.5	86163	D	21	<5	54	17	37	0.11	35	CH								
BH1	4.5	86164	D	26	<5	52	17	35	0.27	33	CH								
BH1	8.0	86166	D	31	<5	56	19	37	0.32	35	CH								

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 :- JH

Checked & Authorised By:- Martyn Graham **Senior Laboratory Technician**
Chelmer Site Investigation Laboratories Ltd

Date Checked :- 27/03/2017

Laboratory Testing Results

BS 1377 : 1990

Job Number : CGL8522
Client : Tatiana K
Client Reference : CSI8522
Site Name : 26 West Hill Park, Camden

Date Received : 07/03/2017
Date Testing Started : 07/03/2017
Date Testing Completed : 22/03/2017
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	1.5	86169	D	19	<5	52	17	35	0.07	33	CH			91					
BH2	2.5	86170	D	27	<5	51	16	35	0.31	33	CH			120+					
BH2	3.5	86172	D	28	<5	53	17	36	0.31	34	CH			120+					
BH2	4.5	86174	D	27	<5	53	18	35	0.27	34	CH			120+					
BH2	5.5	86175	D	28	<5	55	17	38	0.29	36	CH			120+					
BH2	10.0	86178	D	30	<5	63	20	43	0.22	41	CH			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 :- JH

Checked & Authorised By:- Martyn Graham **Senior Laboratory Technician**
Chelmer Site Investigation Laboratories Ltd

Date Checked :- 27/03/2017

Laboratory Testing Results

BS 1377 : 1990

Chelmer Geotechnical Laboratories "Groundbreaking Services"

Job Number : CGL8522
Client : Tatiana K
Client Reference : CSI8522
Site Name : 26 West Hill Park, Camden

Date Received : 07/03/2017
Date Testing Started : 07/03/2017
Date Testing Completed : 22/03/2017
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]
TP1	0.4	86179	D	34	<5	65	20	45	0.31	43	CH			66					

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 :- JH

Checked & Authorised By:- Martyn Graham **Senior Laboratory Technician**
Chelmer Site Investigation Laboratories Ltd

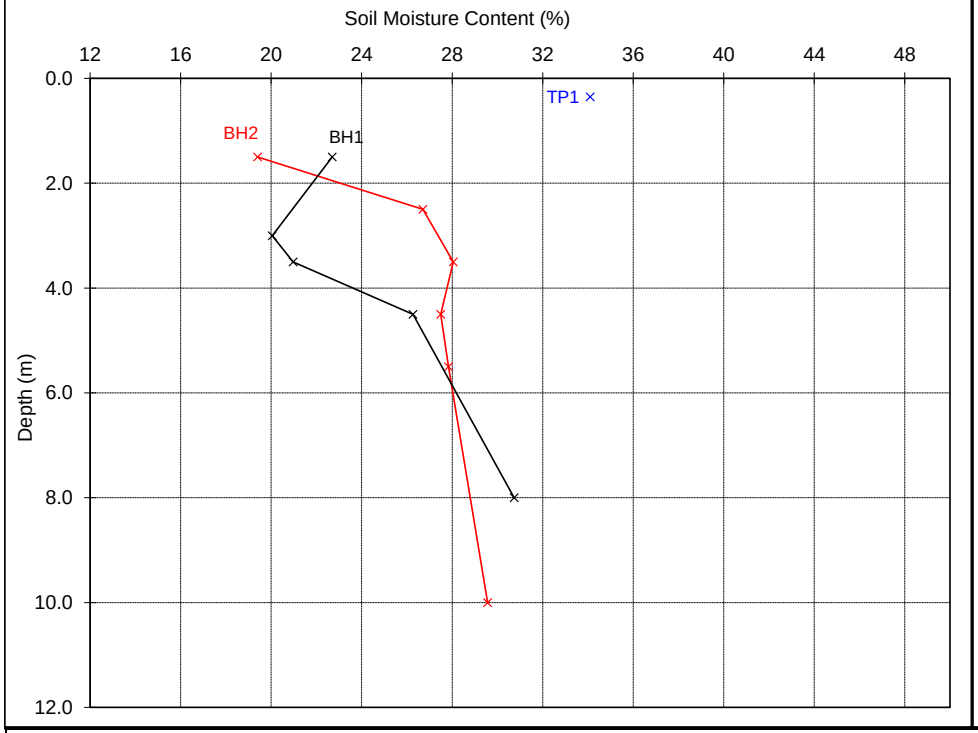
Date Checked :- 27/03/2017

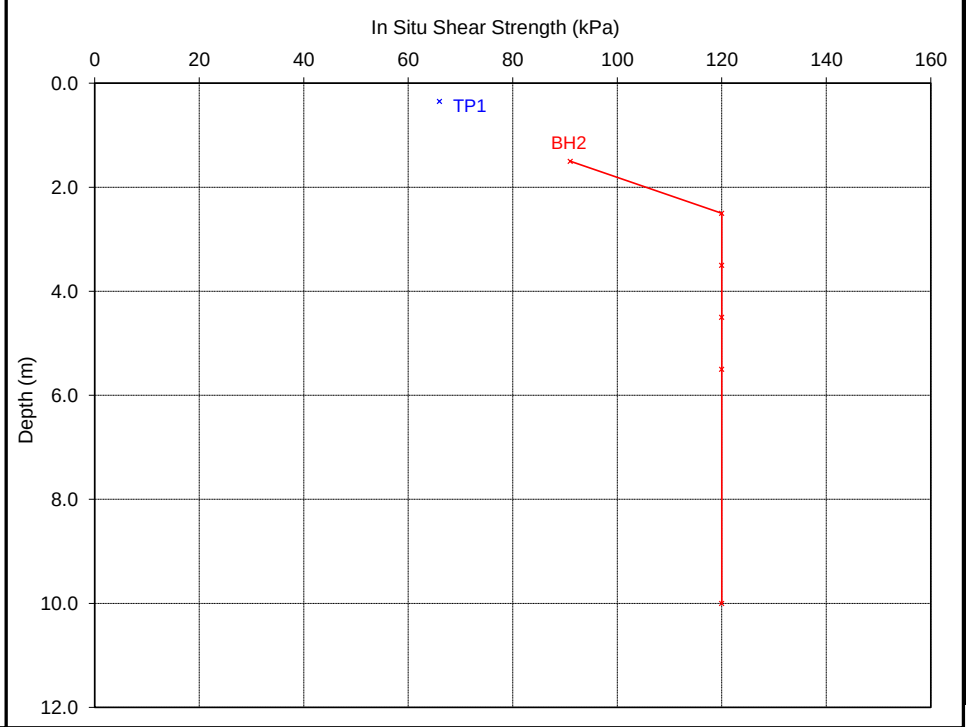
Laboratory Testing Results

Moisture Content/Shear Strength Profile

Chelmer Geotechnical Laboratories 'Groundbreaking Services'

Job Number :	CGL8522	Date Received :	07/03/2017
Client :	Tatiana K	Date Testing Started :	07/03/2017
Client Reference :	CSI8522	Date Testing Completed :	22/03/2017
Site Name :	26 West Hill Park, Camden	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 & Authorised By:- Martyn Graham **Senior Laboratory Technician**
Chelmer Site Investigation Laboratories Ltd

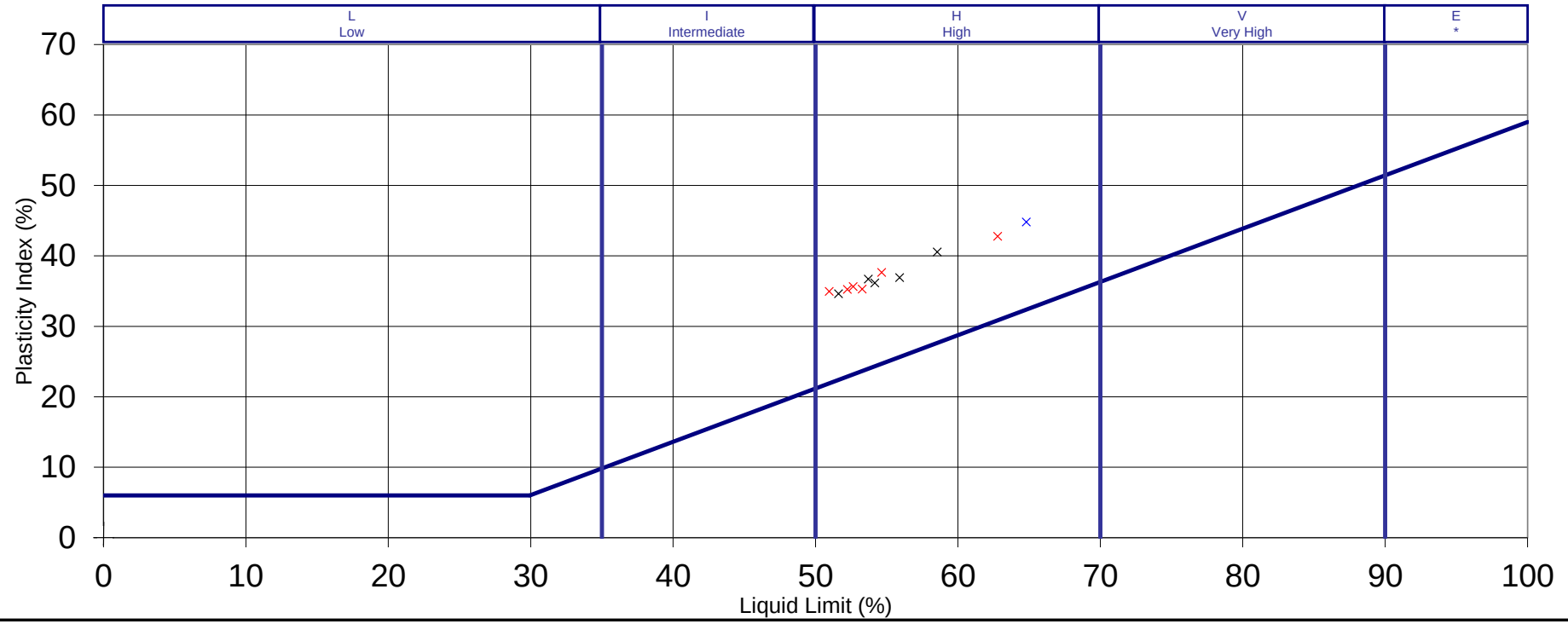
Date: 27/03/2017

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 :	CGL8522	Date Received :	07/03/2017
Client :	Tatiana K	Date Testing Started :	07/03/2017
Client Reference :	CSI8522	Date Testing Completed :	22/03/2017
Site Name :	26 West Hill Park, Camden	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 :- TP1
BH1
BH2

UKAS TESTING
8284

Comments :-

Checked & Authorised By:- Martyn Graham **Senior Laboratory Technician**
Chelmer Site Investigation Laboratories Ltd

Date: 27/03/2017

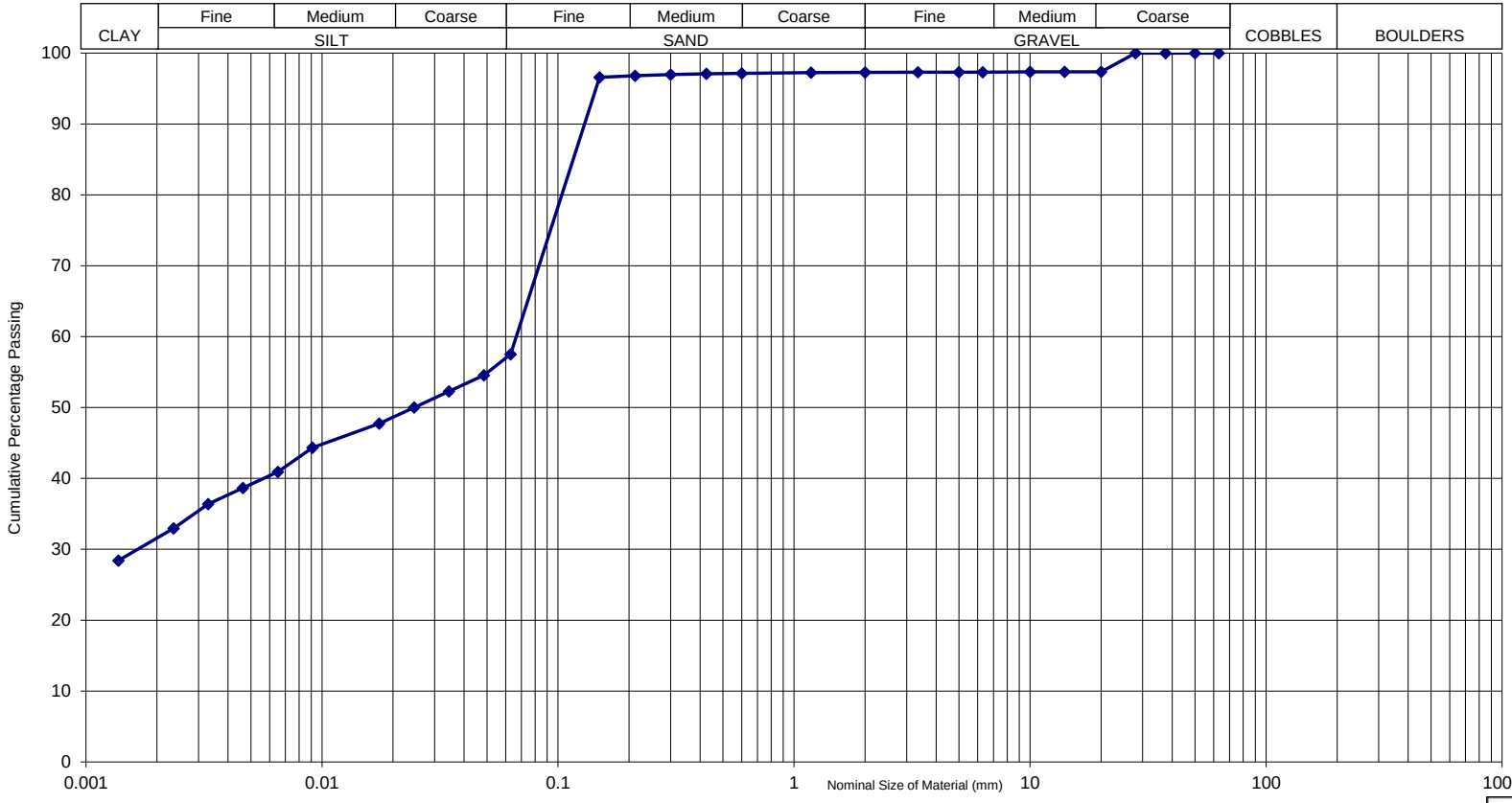
PARTICLE SIZE DISTRIBUTION

BS 1377-2:1990

Chelmer Geotechnical Laboratories 'Groundbreaking Services'

Job Number :	CGL8522	Site Name :	26 West Hill Park, Camden
Sample Number :	BH1	Soil Description :	Sandy silty CLAY with rare coarse gravel.
Depth (m) :	2.5		
Sample UID :	86161		

Type of Sieving :	Hydrometer
Date :	10-Mar-17
Tested By :	CE
Laboratory :	Chelmer Geotechnical CM3 8AB



Sieve Size (mm)	% Passing
90.0	100
75.0	100
63.0	100
50.0	100
37.5	100
28.0	100
20.0	97
14.0	97
10.0	97
6.3	97
5.0	97
3.35	97
2.00	97
1.18	97
0.600	97
0.425	97
0.300	97
0.212	97
0.150	97
0.063	58
0.048	55
0.035	52
0.025	50
0.017	48
0.009	44
0.007	41
0.005	39
0.003	36
0.002	33
0.001	28

Calculations :-

$$f = \frac{(M_1 - M_2) + P}{M_1} \times 100$$

$f = 100P/M_1$ (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 :-
Results Passing 63µm Sieve NOT UKAS accredited.

UKAS TESTING 8284

Checked By :- MG Date Checked :- 27-Mar-17

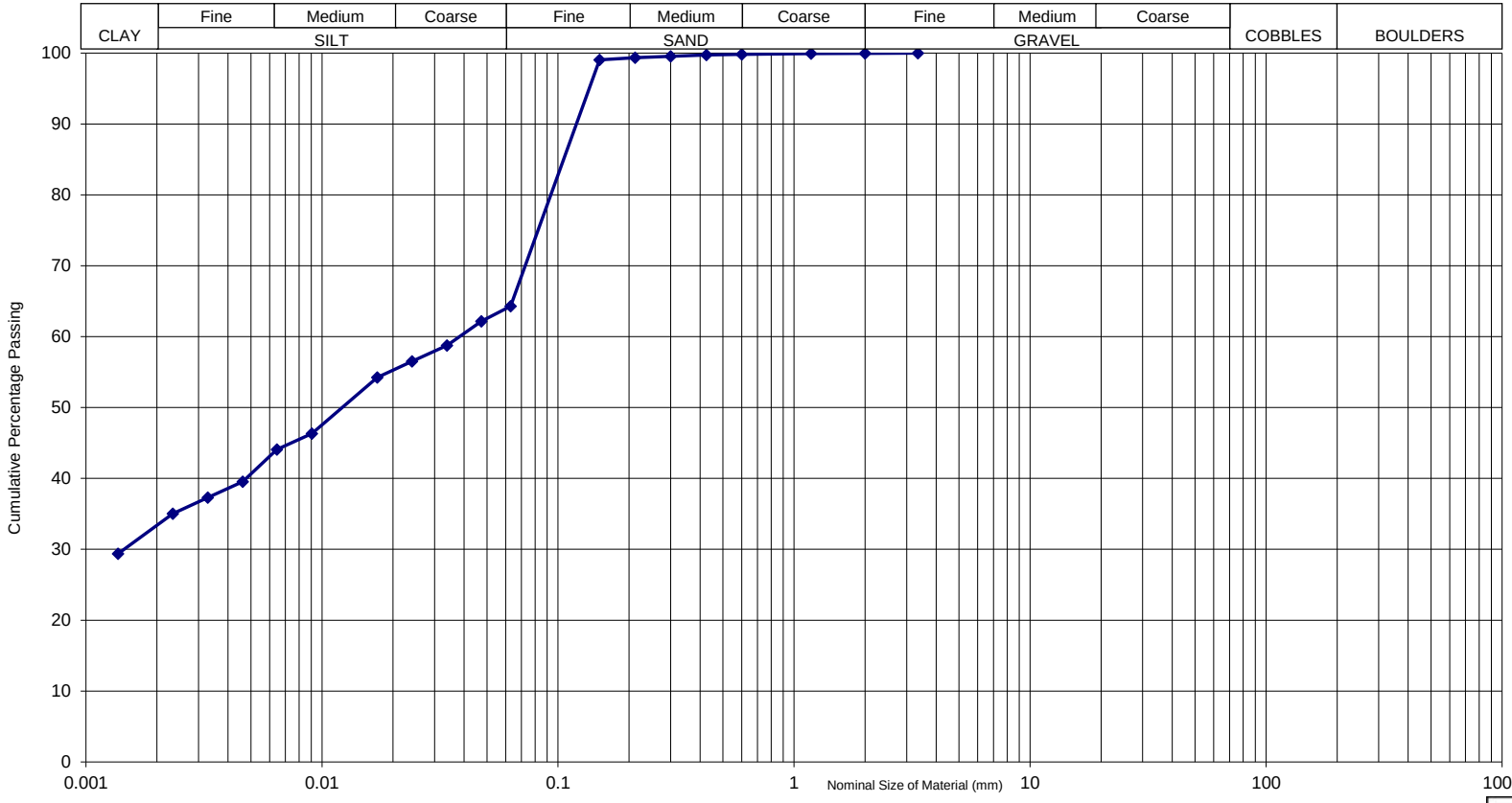
PARTICLE SIZE DISTRIBUTION

BS 1377-2:1990

Chelmer Geotechnical Laboratories 'Groundbreaking Services'

Job Number :	CGL8522	Site Name :	26 West Hill Park, Camden
Sample Number :	BH1	Soil Description :	Sandy silty CLAY.
Depth (m) :	5.0		
Sample UID :	86165		

Type of Sieving :	Hydrometer
Date :	10-Mar-17
Tested By :	CE
Laboratory :	Chelmer Geotechnical CM3 8AB



Sieve Size (mm)	% Passing
90.0	100
75.0	100
63.0	100
50.0	100
37.5	100
28.0	100
20.0	100
14.0	100
10.0	100
6.3	100
5.0	100
3.35	100
2.00	100
1.18	100
0.600	100
0.425	100
0.300	100
0.212	99
0.150	99
0.063	64
0.047	62
0.034	59
0.024	57
0.017	54
0.009	46
0.006	44
0.005	40
0.003	37
0.002	35
0.001	29

Calculations :-

$$f = \frac{(M_1 - M_2) + P}{M_1} \times 100$$

$f = 100P/M_1$ (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 :-
Results Passing 63µm Sieve NOT UKAS accredited.

UKAS TESTING 8284

Checked By :- MG Date Checked :- 27-Mar-17

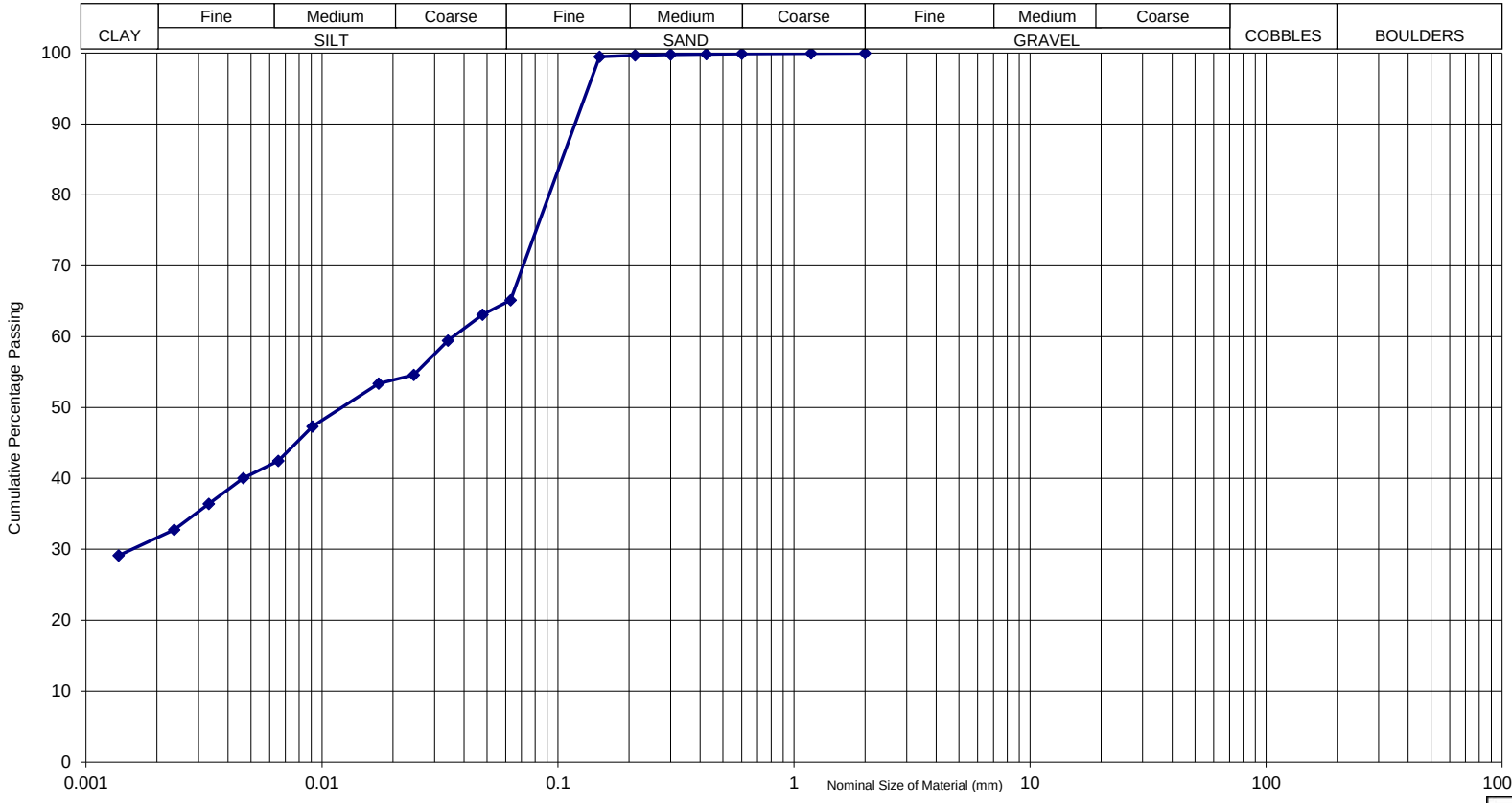
PARTICLE SIZE DISTRIBUTION

BS 1377-2:1990

Chelmer Geotechnical Laboratories 'Groundbreaking Services'

Job Number :	CGL8522	Site Name :	26 West Hill Park, Camden
Sample Number :	BH2	Soil Description :	Sandy silty CLAY.
Depth (m) :	4.0		
Sample UID :	86173		

Type of Sieving :	Hydrometer
Date :	10-Mar-17
Tested By :	CE
Laboratory :	Chelmer Geotechnical CM3 8AB



Sieve Size (mm)	% Passing
90.0	100
75.0	100
63.0	100
50.0	100
37.5	100
28.0	100
20.0	100
14.0	100
10.0	100
6.3	100
5.0	100
3.35	100
2.00	100
1.18	100
0.600	100
0.425	100
0.300	100
0.212	100
0.150	99
0.063	65
0.048	63
0.034	59
0.024	55
0.017	53
0.009	47
0.007	42
0.005	40
0.003	36
0.002	33
0.001	29

Calculations :-

$$f = \frac{(M_1 - M_2) + P}{M_1} \times 100$$

$f = 100P/M_1$ (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 :-
Results Passing 63µm Sieve NOT UKAS accredited.

UKAS TESTING 8284

Checked By :- MG Date Checked :- 27-Mar-17

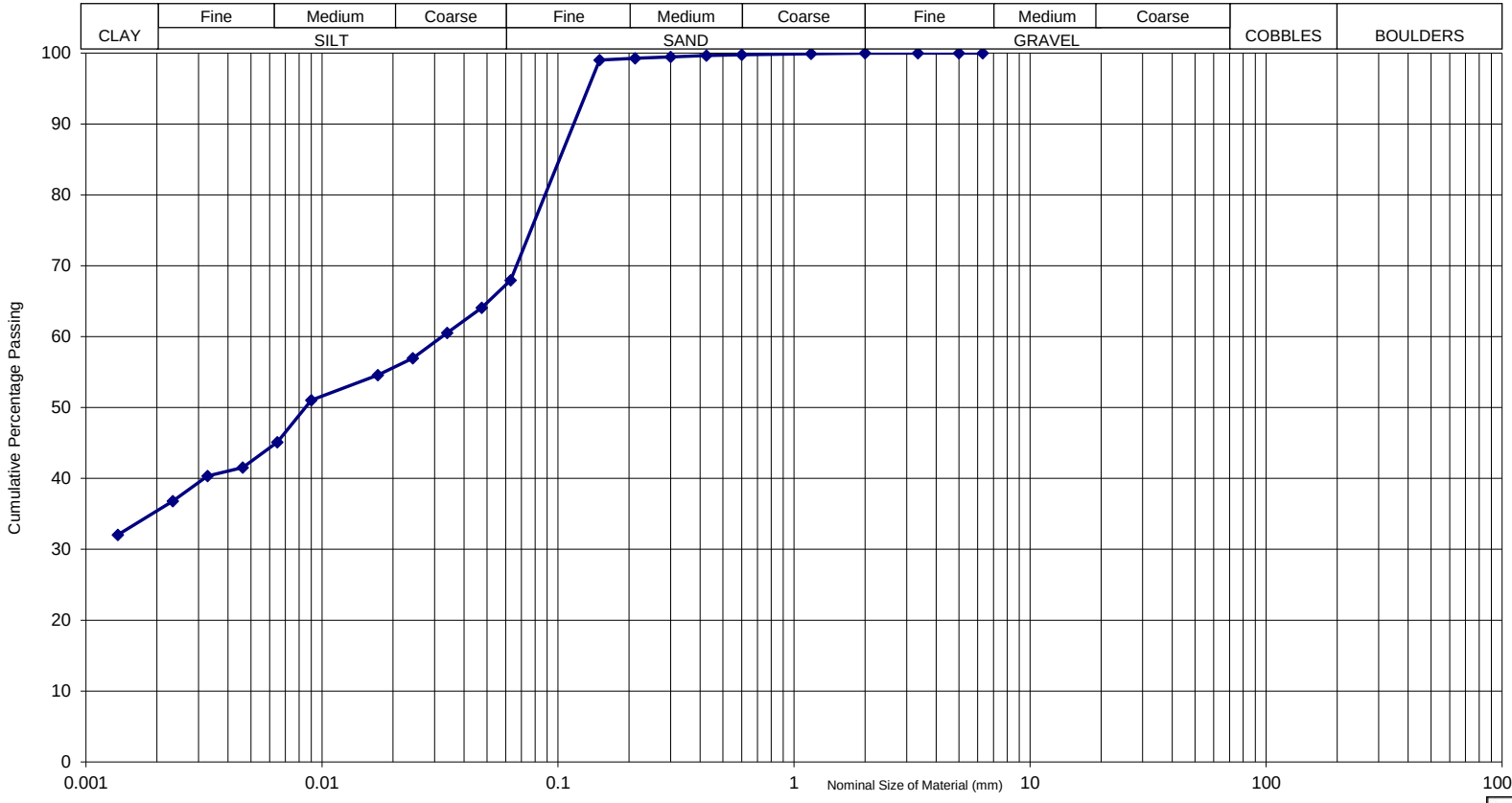
PARTICLE SIZE DISTRIBUTION

BS 1377-2:1990

Chelmer Geotechnical Laboratories 'Groundbreaking Services'

Job Number :	CGL8522	Site Name :	26 West Hill Park, Camden
Sample Number :	BH2	Soil Description :	Sandy silty CLAY.
Depth (m) :	6.0		
Sample UID :	86176		

Type of Sieving :	Hydrometer
Date :	10-Mar-17
Tested By :	CE
Laboratory :	Chelmer Geotechnical CM3 8AB



Sieve Size (mm)	% Passing
90.0	100
75.0	100
63.0	100
50.0	100
37.5	100
28.0	100
20.0	100
14.0	100
10.0	100
6.3	100
5.0	100
3.35	100
2.00	100
1.18	100
0.600	100
0.425	100
0.300	99
0.212	99
0.150	99
0.063	68
0.048	64
0.034	61
0.024	57
0.017	55
0.009	51
0.006	45
0.005	42
0.003	40
0.002	37
0.001	32

Calculations :-

$$f = \frac{(M_1 - M_2) + P}{M_1} \times 100$$

$f = 100P/M_1$ (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 :-
Results Passing 63µm Sieve NOT UKAS accredited.

UKAS TESTING 8284

Checked By :- MG Date Checked :- 27-Mar-17

Nicholls Colton Group
7 - 11 Harding Street
Leicester
LE1 4DH

Chelmer Site Investigations
Unit 15
East Hanningfield Industrial Estate
CM3 8AB

Analytical Test Report: L17/0622/CSI/001

Your Project Reference:	**CGL8522**	Samples Received on:	13.03.2017
Your Order Number:	7801	Testing Instruction Received:	13.03.2017
Report Issue Number:	1	Sample Tested:	13 to 17.03.2017
Samples Analysed:	7 Soils	Report issued:	17.03.2017

Signed

James Gane
Commercial Manager
Nicholls Colton Group

Notes:

General

Please refer to Methodologies tab for details pertaining to the analytical methods undertaken.

Samples will be retained for 14 days after issue of this report unless otherwise requested.

Samples were supplied by customer, results are representative of the material provided

Deviating Samples

Samples were received in suitable containers	**Yes**
A date and time of sampling was provided	**Yes**
Sample holding times were exceeded prior to analysis of determinants	**No**

Where samples do not meet one or more of the above criteria they will be classed as deviating, this means data may not be representative of the sample at the time of sampling and it is possible that results provided may be compromised.

Accreditation Key

UKAS = UKAS Accreditation, MCERTS = MCERTS Accreditation, u = Unaccredited

Date of Issue 24.01.2017
Owned by Emily Blissett - Customer Services Supervisor
Authorised by James Gane - Commercial Manager
G:\LE1 Production\Commercial\Current Reports\2017\L17\CSI - Chelmer\L17-0622-CSI\[L17-0622-CSI 001.xlsx]Sample Descriptions

Nicholls Colton Group
7 - 11 Harding Street
Leicester
LE1 4DH

L17/0622/CSI/001

Project Reference - CGL8522

Analytical Test Results - BRE Suite

NC Reference			17-8216	17-8217	17-8218	17-8219	17-8220	17-8221
Client Sample Reference			86158	86160	86164	86167	86168	86171
Client Sample Location			BH1	BH1	BH1	BH1	BH2	BH2
Depth (m)			0.50	2.00	4.50	10.0	0.50	3.00
Date of Sampling			06.03.2017	06.03.2017	06.03.2017	06.03.2017	06.03.2017	06.03.2017
Time of Sampling			AM	AM	AM	AM	AM	AM
Sample Matrix			Clay	Clay	Clay	Clay	Clay	Clay
Determinant	**Units**	**Accreditation**						
Water soluble sulphate	(mg/l)	u	93	150	160	990	190	83
Acid Soluble Sulphate	(%)	u	0.04	0.05	0.14	0.33	0.09	0.04
Total Sulphur	(%)	u	0.02	0.02	0.05	0.78	0.04	0.01
pH Value	pH Units	MCERTS	8.4	7.7	7.6	7.6	10.8	9.6

Nicholls Colton Group
7 - 11 Harding Street
Leicester
LE1 4DH

L17/0622/CSI/001

Project Reference - CGL8522

Analytical Test Results - BRE Suite

NC Reference			17-8222
Client Sample Reference			86177
Client Sample Location			BH2
Depth (m)			8.00
Date of Sampling			06.03.2017
Time of Sampling			AM
Sample Matrix			Clay
Determinant	**Units**	**Accreditation**	
Water soluble sulphate	(mg/l)	u	390
Acid Soluble Sulphate	(%)	u	0.18
Total Sulphur	(%)	u	0.42
pH Value	pH Units	MCERTS	8.6

Nicholls Colton Group
7 - 11 Harding Street
Leicester
LE1 4DH

L17/0622/CSI/001

Project Reference - CGL8522

Sample Descriptions

NC Reference	Client Sample Reference	Sample Location	Description	% Passing 2mm BS test sieve
17-8216	86158	BH1	Brown/orange silty sandy clay.	100
17-8217	86160	BH1	Brown/orange silty sandy clay.	100
17-8218	86164	BH1	Brown silty sandy clay.	100
17-8219	86167	BH1	Grey silty sandy clay.	100
17-8220	86168	BH2	Brown/orange silty sandy clay.	100
17-8221	86171	BH2	Brown/orange silty sandy gravelly clay.	100
17-8222	86177	BH2	Grey silty sandy clay.	100

Nicholls Colton Group
7 - 11 Harding Street
Leicester
LE1 4DH

L17/0622/CSI/001

Project Reference - CGL8522

Analysis Methodologies

Matrix	Determinant	Sample condition for analysis	Test Method used
Soil	pH	As Received	In house method statement - MS - CL - pH in soils (using a 1:3 soil to water extraction)
Soil	Sulphate (w/s)	Oven Dried	In house method statement - MS - CL - Anions by Aquakem
Soil	Acid Sulphate	Oven Dried	In house method statement - MS - CL - BRE Analysis
Soil	Total Sulphur	Oven Dried	In house method statement - MS - CL - BRE Analysis

UKAS TESTING
8284

Chelmer Geotechnical Laboratories
'Groundbreaking Services'

This report is personal to the client, confidential and non assignable. It is issued with no admission of liability to any third party.

This report shall not be reproduced, except in full, without the written approval of Chelmer Site Investigations Laboratories Ltd.

Where our involvement consists exclusively of testing samples, the results and comments (if provided) relate only to the samples tested.

Any samples that are deemed to be subject to deviation will be recorded as such within the test summary.

Nicholls Colton Group
7 - 11 Harding Street
Leicester
LE1 4DH

Chelmer Site Investigations
Unit 15
Hanningfield Industrial Estate
CM3 8AB

Analytical Test Report: L17/0620/CSI/001

Your Project Reference:	**CGL8522-C**	Samples Received on:	13.03.2017
Your Order Number:	7799	Testing Instruction Received:	13.03.2017
Report Issue Number:	1	Sample Tested:	13 to 21.03.2017
Samples Analysed:	3 Soils	Report issued:	21.03.2017

Signed

James Gane
Commercial Manager
Nicholls Colton Group

Notes:

General

Please refer to Methodologies tab for details pertaining to the analytical methods undertaken.

Samples will be retained for 14 days after issue of this report unless otherwise requested.

Moisture Content was determined in accordance with NC method statement MS - CL - Sample Prep, oven dried at <30˚C.

Moisture Content is reported as a percentage of the dry mass of soil, this calculation is in accordance with BS1377, Part 2, 1990, Clause 3.2

Stone Content was determined in accordance with NC method statement MS - CL - Sample Prep and refers to the percentage of stones retained on a 10mm BS test sieve.

With the exception of Sulphate, Sulphur and LoI which are crushed over the 2mm test sieve, concentrations are reported as a percentage mass of the dry soil passing the 10mm BS test sieve. As received samples have been corrected for moisture content but not stone content.

Samples were supplied by customer, results are representative of the material provided

Deviating Samples

Samples were received in suitable containers	**Yes**
A date and time of sampling was provided	**Yes**
Sample holding times were exceeded prior to analysis of determinants	**Yes**

Where samples do not meet one or more of the above criteria they will be classed as deviating, this means data may not be representative of the sample at the time of sampling and it is possible that results provided may be compromised.

WAC Testing

Samples were leached in accordance with BS EN 12457-2: 2002.

Eluate Results are reported as L/S 10. These results have been calculated in accordance with BS EN 12457-2:2002.

Comparative values are taken from the Environment Agency document “Guidance for waste destined for disposal in landfills”, Version 2, June 2006.

Accreditation Key

UKAS = UKAS Accreditation, MCERTS = MCERTS Accreditation, u = Unaccredited

Date of Issue 24.01.2017
Owned by Emily Blissett - Customer Services Supervisor
Authorised by James Gane - Commercial Manager
G:\LE1 Production\Commercial\Current Reports\2017\L17\CSI - Chelmer\L17-0620-CSI\[L17-0620-CSI 001.xlsx]Cover Sheet

Nicholls Colton Group
7 - 11 Harding Street
Leicester
LE1 4DH

L17/0620/CSI/001

Project Reference - CGL8522-C

Analytical Test Results - Env Suite 1

NC Reference			17-8198	17-8200
Client Sample Reference			86144	86146
Client Sample Location			BH1	BH2
Depth (m)			0.25	0.50
Date of Sampling			06.03.2017	06.03.2017
Time of Sampling			AM	AM
Sample Matrix			Clay	Clay
Determinant	**Units**	**Accreditation**		
Arsenic	(mg/kg)	MCERTS	32.3	< 10
Cadmium	(mg/kg)	MCERTS	1.2	0.7
Chromium (Total)	(mg/kg)	UKAS	30.8	28.6
Copper	(mg/kg)	MCERTS	22.5	11.2
Lead	(mg/kg)	MCERTS	66.9	29.4
Mercury	(mg/kg)	UKAS	< 2.5	< 2.5
Nickel	(mg/kg)	MCERTS	13.1	18.1
Selenium	(mg/kg)	u	< 8	< 8
Zinc	(mg/kg)	MCERTS	67.2	44.9
Total Phenols	(mg/kg)	MCERTS	< 1	< 1
Cyanide (Total)	(mg/kg)	MCERTS	< 1	< 1
pH	pH Units	MCERTS	8.5	10.3
Sulphate	(mg/l)	u	61	110
Sulphur	(%)	u	0.02	0.02
Sulphide	(mg/kg)	u	4.0	4.0
Acenaphthene	(mg/kg)	MCERTS	<0.02	0.05
Acenaphthylene	(mg/kg)	UKAS	0.03	<0.02
Anthracene	(mg/kg)	UKAS	0.07	0.10
Benzo (a) anthracene	(mg/kg)	MCERTS	0.25	0.27
Benzo (a) pyrene	(mg/kg)	MCERTS	0.24	0.22
Benzo (b) fluoranthene	(mg/kg)	MCERTS	0.29	0.26
Benzo (g, h, i) perylene	(mg/kg)	MCERTS	0.15	0.13
Benzo (k) fluoranthene	(mg/kg)	MCERTS	0.12	0.12
Chrysene	(mg/kg)	MCERTS	0.29	0.30
Dibenzo (a,h) anthracene	(mg/kg)	MCERTS	0.04	0.03
Fluoranthene	(mg/kg)	MCERTS	0.50	0.50
Fluorene	(mg/kg)	MCERTS	<0.02	0.04
Indeno (1, 2, 3,-cd) pyrene	(mg/kg)	MCERTS	0.16	0.14
Naphthalene	(mg/kg)	MCERTS	<0.02	0.03
Phenanthrene	(mg/kg)	MCERTS	0.15	0.31
Pyrene	(mg/kg)	MCERTS	0.43	0.43
Total PAH (Sum of USEPA 16)	(mg/kg)	UKAS	2.76	2.93

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L17/0620/CSI/001

Project Reference - CGL8522-C

Analytical Test Results - TPH CWG

NC Reference			17-8198	17-8200
Client Sample Reference			86144	86146
Client Sample Location			BH1	BH2
Depth (m)			0.25	0.50
Date of Sampling			06.03.2017	06.03.2017
Time of Sampling			AM	AM
Sample Matrix			Clay	Clay
Determinant	**Units**	**Accreditation**		
Aliphatics				
>C_5 to C_6	(mg/kg)	u	<0.03	<0.03
>C_6 to C_8	(mg/kg)	u	0.09	0.03
>C_8 to C_{10}	(mg/kg)	u	<0.03	<0.03
>C_{10} to C_{12}	(mg/kg)	u	<12	<12
>C_{12} to C_{16}	(mg/kg)	u	<12	<12
>C_{16} to C_{21}	(mg/kg)	u	<12	<12
>C_{21} to C_{35}	(mg/kg)	u	12	13
Aromatics				
>C_5 to C_7	(mg/kg)	u	<0.03	<0.03
>C_7 to C_8	(mg/kg)	u	<0.03	<0.03
>C_8 to C_{10}	(mg/kg)	u	<0.03	<0.03
>C_{10} to C_{12}	(mg/kg)	u	<12	<12
>C_{12} to C_{16}	(mg/kg)	u	<12	<12
>C_{16} to C_{21}	(mg/kg)	u	<12	<12
>C_{21} to C_{35}	(mg/kg)	u	12	<12

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Project Reference - CGL8522-C

Certificate Of Analysis - WAC Suite

NC Reference	17-8199
Client Sample Reference	86145, BH1
Sample Description	Brown/orange silty sandy clay with calcerous matter and root fragments.
Depth (m)	0.5
Date of Sampling	06.03.2017
Time of Sampling	AM
Sample Matrix	Clay
Moisture Content (%)	22
Stone content (%)	0

			Determined Result	Inert Waste Landfill	Stable non reactive hazardous waste in a non hazardous landfill	Hazardous Waste Landfill
Solid Analysis						
Total Organic Carbon	%	MCERTS	<1.0	3.0	5.0	6.0
Loss on Ignition	%	UKAS	4.4	-	-	10.0
BTEX	mg/kg	MCERTS	<0.4	6.00	-	-
PCB's (7 Congeners)	mg/kg	u	<0.03	1.00	-	-
Mineral Oil ($>C_{10}$ to C_{40})	mg/kg	u	39	500	-	-
PAH	mg/kg	u	1.3	100	-	-
pH	units	MCERTS	8.3	-	> 6	-
Eluate Analysis						
Arsenic	mg/kg	u	< 0.03	0.50	2	25
Barium	mg/kg	u	< 0.05	20	100	300
Cadmium	mg/kg	u	< 0.03	0.04	1	5
Chromium (total)	mg/kg	u	< 0.03	0.5	10	70
Copper	mg/kg	u	< 0.10	2.0	50	100
Mercury	mg/kg	u	< 0.01	0.01	0.2	2
Molybdenum	mg/kg	u	0.04	0.5	10.0	30
Nickel	mg/kg	u	< 0.03	0.4	10.0	40
Lead	mg/kg	u	< 0.10	0.5	10.0	50
Antimony	mg/kg	u	< 0.01	0.06	0.7	5
Selenium	mg/kg	u	0.01	0.1	0.5	7
Zinc	mg/kg	u	< 0.10	4	50	200
Chloride	mg/kg	u	12	800	15000	25000
Fluoride	mg/kg	u	6.4	10	150	500
Sulphate (as SO_4)	mg/kg	u	120	1000	20000	50000
Phenol Index	mg/kg	u	< 1.0	1	-	-
Dissolved Organic Carbon	mg/kg	u	210	500	800	1000

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L17/0620/CSI/001

Project Reference - CGL8522-C

Sample Descriptions

NC Reference	Client Sample Reference	Sample Location	Description	Moisture Content (%)	Stone Content (%)
17-8198	86144	BH1	Brown/orange silty sandy gravelly clay with calcerous matter.	22	0.9
17-8200	86146	BH2	Brown/orange silty sandy clay.	25	1.4

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L17/0620/CSI/001

Project Reference - CGL8522-C

Analysis Methodologies

Matrix	Determinant	Sample condition for analysis	Test Method used
Soil	Metals	Air Dried	In house method statement - MS - CL - ICP metals
Soil	PAH	As Received	In house method statement - MS - CL - PAH (As received)
Soil	Phenols	As Received	In house method statement - MS - CL - Phenols by Skalar
Soil	Cyanide	As Received	In house method statement - MS - CL - Cyanide by Skalar
Soil	pH	As Received	In house method statement - MS - CL - pH in soils (using a 1:3 soil to water extraction)
Soil	Sulphate (w/s)	Oven Dried	In house method statement - MS - CL - Anions by Aquakem
Soil	Total Sulphur	Oven Dried	In house method statement - MS - CL - BRE Analysis
Soil	Sulphide	Air Dried	In house method statement - MS - CL - Sulphide
Soil	CWG	As Received	In house method statements - MS - CL - EPH in soil and MS - CL - VPH

Chelmer Consultancy Services
'Groundbreaking Services'

Contamination Test Results on Soil Samples

Location: 26 West Hill Park, London, N6 6ND	Date : 06/03/2017	Job No. : 8522	Sheet 1 of 1

Borehole No.	Units	BH1	BH2	ATRISK Contaminated Land Screening Values (SSV) derived using CLEA v1.04 for 6% SOM			
Sample No.		86144	86146				
Depth (m)		0.25	0.50				
Material Type		Clay	Clay	Residential with plant uptake	Residential without plant uptake	Allotments	Commercial/ Industrial
Aromatic Hydrocarbons (mg/kg)	>C5-C7	<0.03	<0.03	0.33	0.988	0.07	95
	>C7-C8	<0.03	<0.03	610	2710	120	420000
	>C8-C10	<0.03	<0.03	177	233	64.5	64100
	>C10-C12	<12	<12	389	1080	86.4	68300
	>C12-C16	<12	<12	687	2040	160	65600
	>C16-C21	<12	<12	804	1330	288	28400
	>C21-C35	12	<12	1220	1330	1550	28400
Aliphatic Hydrocarbons (mg/kg)	>C5-C6	<0.03	<0.03	259	261	5120	>1000000
	>C6-C8	0.09	0.03	14700	49400	16600	>100000
	>C8-C10	<0.03	<0.03	144	144	2130	170000
	>C10-C12	<12	<12	4140	4340	8870	171000
	>C12-C16	<12	<12	5260	5310	15900	171000
	>C16-C21	<12	<12	88200	146000	462000	>1000000
	>C21-C35	12	13	88200	146000	462000	>1000000
Naphthalene	mg/kg	<0.02	0.03	8.71	9.22	23.4	22700
Acenaphthylene	mg/kg	0.03	<0.02	-	-	-	-
Acenaphthene	mg/kg	<0.02	0.05	2130	4770	612	106000
Fluorene	mg/kg	<0.02	0.04	1930	3100	725	72100
Phenanthrene	mg/kg	0.15	0.31	-	-	-	-
Anthracene	mg/kg	0.07	0.10	18300	24000	10400	545000
Fluoranthene	mg/kg	0.50	0.50	2160	3210	924	72700
Pyrene	mg/kg	0.43	0.43	1550	2400	620	54500
Benzo(a)anthracene	mg/kg	0.25	0.27	8.54	9.04	15.1	142
Chrysene	mg/kg	0.29	0.30	927	1010	1170	14300
Benzo(b)fluoranthene	mg/kg	0.29	0.26	9.86	10.3	18.6	144
Benzo(k)fluoranthene	mg/kg	0.12	0.12	100	104	227	1440
Benzo(a)pyrene	mg/kg	0.24	0.22	0.998	1.04	2.10	14.4
Indeno(1,2,3-cd)pyrene	mg/kg	0.16	0.14	9.75	10.3	16.6	144
Dibenz(a,h)anthracene	mg/kg	0.04	0.03	1.00	1.03	2.57	14.4
Benzo(ghi)perylene	mg/kg	0.15	0.13	103	104	342	1450
TOTAL PAH	mg/kg	2.76	2.93				
Cyanide (Free)	mg/kg	<1	<1	34	34	34	34
pH	unit	8.5	10.3	-	-	-	-
Copper (Total)	mg/kg	22.5	11.2	4020	8370	1110	109000
Lead (Total)	mg/kg	66.9	29.4	200	310	80	2330
Zinc (Total)	mg/kg	67.2	44.9	17200	46800	3990	>1000000
				LQM/CIEH Generic Assessment Criteria			
Chromium (Total)	mg/kg	30.8	28.6	3000	3000	34600	30400
				CLEA Soil Guideline Values (SGV)			
Arsenic (Total)	mg/kg	32.3	<10	32	35	43	640
Cadmium (Total)	mg/kg	1.2	0.7	10	83.6	1.8	230
Mercury (Total)	mg/kg	<2.5	<2.5	170	238	80	3600
Nickel (Total)	mg/kg	13.1	18.1	130	130	230	1800
Phenols (Total)	mg/kg	<1	<1	420	519	280	3200
Selenium (Total)	mg/kg	<8	<8	350	595	120	13000
Total Sulphate as SO4	mg/l	61	110	-	-	-	-
W/S Sulphate as SO4 (2:1)	g/l						
Elemental Sulphur	%	0.02	0.02	-	-	-	-
Sulphide	mg/kg	4.0	4.0	-	-	-	-

Key

PAH - Polyaromatic Hydrocarbons
TPH - Total Petroleum Hydrocarbons
- Not determined

Result exceeds ATRISK screening value
Result exceeds EQS/CIEH generic assessment criteria
Result exceeds CLEA Soil Guideline Value (SGV)

Groundwater/Ground Gas Monitoring Record Sheet

Site Ref: 8522
Site Name: 26 West Hill Park, Highgate, London N6 6ND

Well	Date	Methane Peak	Methane Steady	Methane GSV	Carbon Dioxide Peak	Carbon Dioxide Steady	Carbon Dioxide GSV	Oxygen	Atmos.	Flow	Response Zone	Depth to Water	CO	H2S	VOC
		%v/v	%v/v	l/hr	%v/v	%v/v	l/hr	%v/v	mbar	l/hr	m bgl	m bgl	ppm	ppm	ppm
BH1	15.03.17	0.2	0.2	0.0000	4.5	4.5	0.0000	16.6	1024	0.0		3.40	0	0	0.0
	22.03.17	0.2	0.2	0.0002	6.2	6.1	0.0062	15.3	994	0.1		3.40	0	0	0.1
	12.04.17	0.2	0.2	0.0000	5.6	5.6	0.0000	14.7	1009	0.0		3.44	0	0	0.1
BH2	15.03.17	0.2	0.1	0.0000	0.5	0.4	0.0000	20.0	1024	0.0		1.74	1	0	0.2
	22.03.17	0.2	0.2	0.0000	1.0	0.8	0.0000	19.9	994	0.0		1.72	0	0	0.1
	12.04.17	0.2	0.2	0.0002	1.8	1.8	0.0018	17.9	1009	0.1		1.80	0	0	0.2

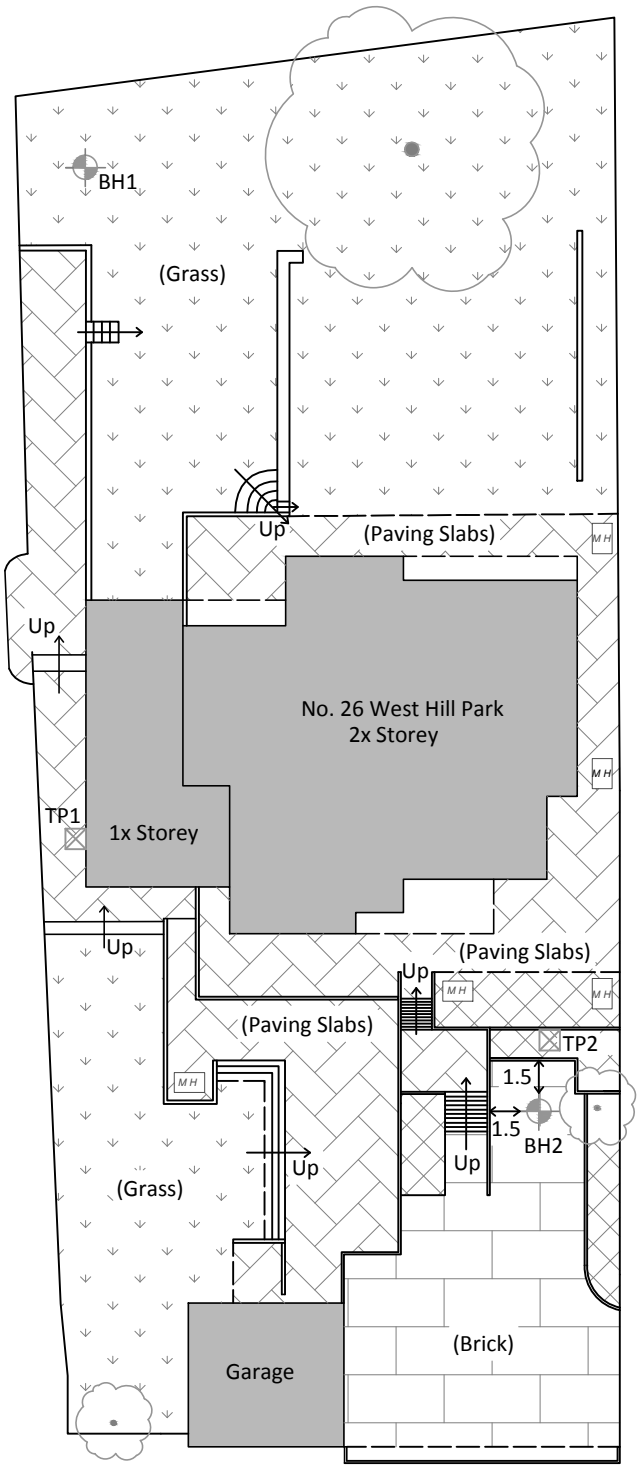
Notes

NR = Not recorded
Values in Red exceed CIRIA 665 criteria (CO_2 >5.0% and CH_4 >1.0%)

Chelmer Site Investigations
'Groundbreaking Services'

Site Plan

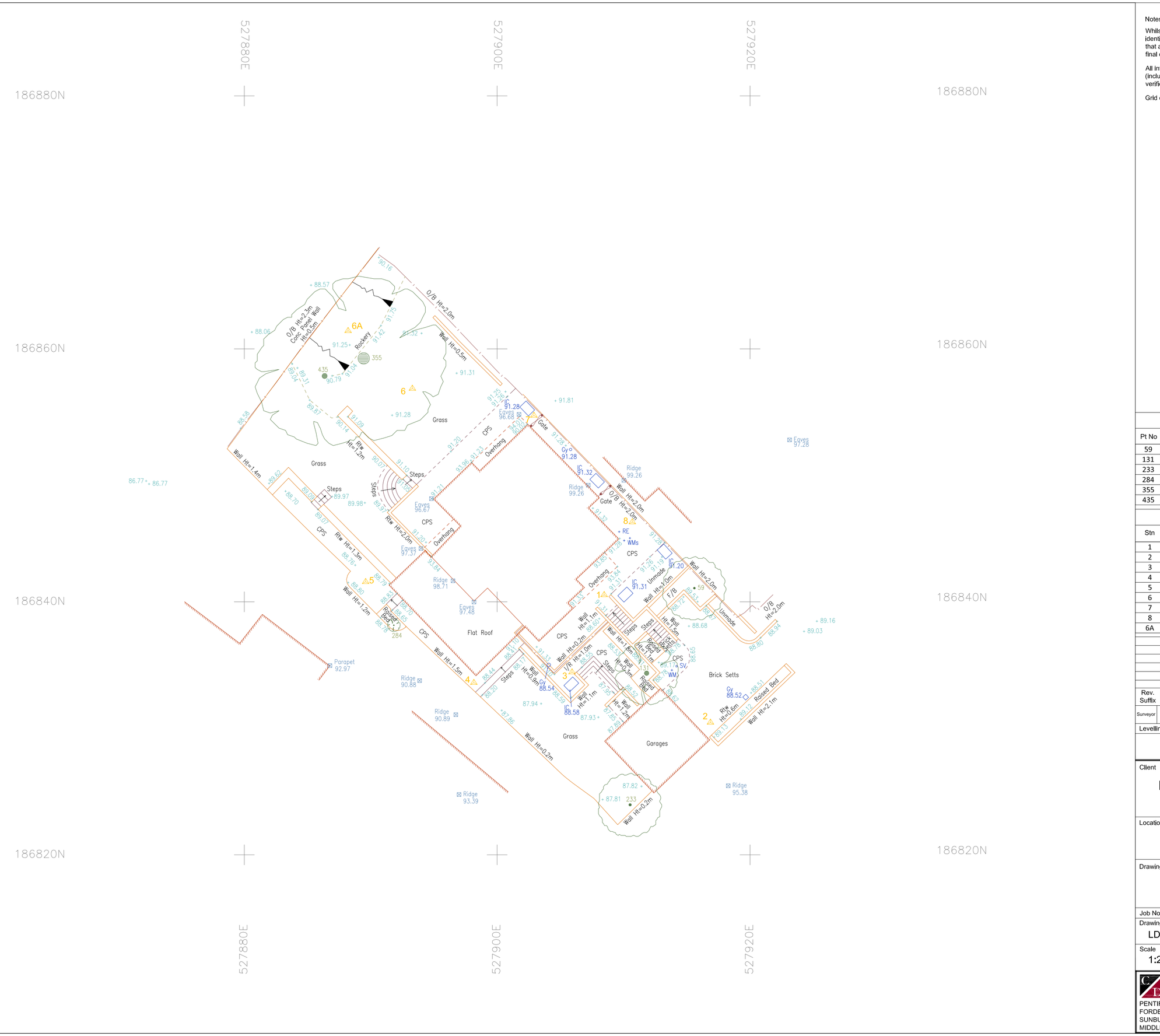
Site:		Client:			Site Plan ID:
26 West Hill Park, Highgate, London, N6 6ND		Tatiana Konopleva			SP
Contract Number:	**Date:**	**Logged By:**	**Checked by:**	**Weather:**	
8522	17/02/17	D.B.	J.H.	Dry	Sheet 1 of 1
Easting:	**Northing:**	**Ground Level:**	**Plan:**		**Scale:**
N.D.	N.D.	N.D.	N.D.		N.T.S.



Remarks: All dimensions in metres.

Key:

Tree/shrub | Borehole | Trial pit | Manhole



Notes:

Whilst every effort has been made to correctly identify species of trees on the site, we advise that an arborologist be consulted before any final decisions are made.

All information contained in this drawing (including digital data) should be checked and verified prior to any fabrication or construction.

Grid coordinates are based on an OS GNSS system.

INDICATIVE

Tree Schedule

Pt No	Spread	Bole	Height	Species
59	5.0	0.15	6.0	YEW
131	5.0	0.35	6.0	CHERRY
233	5.0	0.20	6.0	CYPRESS
284	1.0	0.75	1.0	SAPLING
355	13.0	0.90	15.0	OAK
435	11.0	0.40	15.0	SILVER BIRCH

Coordinate Table

Stn	Easting	Northing	Level
1	527908.461	186840.549	91.315
2	527916.867	186830.460	88.588
3	527905.921	186834.440	88.557
4	527898.156	186833.606	88.441
5	527889.600	186841.582	88.729
6	527893.296	186856.860	91.286
7	527902.906	186854.729	91.284
8	527910.689	186846.307	91.268
6A	527888.210	186861.425	90.989

Rev. Suffix	Date	Initial	Revision Details

Surveyor	MB	Verified By	MB	CAD Operator	TJH	Approved By	ARL	Date	12,10,16

Levelling GNSS Datum OSGB36

To an OS GNSS Datum

Client

Luxury Development Construction

Location

26 Westhill Park
Highgate

Drawing Title

Topographical Survey

Job No. 1609006	Old Job No.
Drawing Number LDC/1609006	Revision Suffix
Scale 1:200m (A2)	Date October 2016

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