DESK STUDY & GEOTECHNICAL GEO-ENVIRONMENTAL INTERPRETATIVE REPORT

48 Elsworthy Road
London
NW3 3BU

CONCEPT

ISSUE 02

DESK STUDY & GEOTECHNICAL/GEO-ENVIRONMENTAL INTERPRETATIVE REPORT

48 Elsworthy Road
London
NW3 3BU

Prepared for: Mr & Mrs Swycher

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1.0 INTRODUCTION

Concept Site Investigations have been instructed by Milk Structures on behalf of Mr & Mrs Swycher to carry out a Desk Study and Geotechnical/Geoenvironmental Interpretative report in respect of the proposed development to the rear of the site known as 48 Elsworthy Road, London NW3 3BU (Figure 1).

The results of the desk study information searches, provided by Envirocheck, are presented in the attached appendices and are summarised herein.

This report presents the ground conditions and geotechnical properties of the soils encountered at the site, provides recommendations on the geotechnical parameters to be adopted in foundation and retaining wall design and provides a brief appraisal of the levels of contamination present and the environmental factors related to the site. Detailed design is outside the scope of this report.

This report refers to and takes into account the findings of the following reports, which should be read in conjunction with this report:

- Concept Site Investigations Factual Site Investigation Report (Ref. 112405/FR 02, dated October 2011).

The recommendations within this report are based on information obtained from three cable percussion boreholes and five trial pits. Ground conditions may vary across the site and no responsibility is undertaken with regards to possible ground variations at locations that have not been investigated.

Discussion of archaeological and unexploded ordnance issues is outside the scope of this report.

This report has been prepared for Mr & Mrs Swycher and Milk Structures based on their specific requirements. Reasonable skill and care has been exercised in the preparation of this report in accordance with the technical requirements of the brief. Notwithstanding the efforts made by the professional team in undertaking this investigation, it is possible that conditions other than those indicated in this report may exist at the site.

2.0 THE SITE

The site is located on the Elsworthy Road, London NW3 3BU. The approximate centre of the site is located at National Grid Reference 527230 184010 in the London Borough of Camden. The site is bounded to the north and west by Wadham Gardens, to the east by Lower Merton Rise and to the south by detached residential properties adjacent to Primrose Hill grounds at the back.

The site is located within a residential area and covers about 600m$^{2.}$ The site is roughly rectangular in shape with the sides running approximately north-west to the south-east, with a detached villa occupying the majority of the plot.

In general the site appears to be relatively flat and level. Spot levels surrounding the site indicate levels of between +47.3m on the intersection of Elsworthy Road and Lower Merton Rise (50m east) to +47.8m on Wadham Gardens (30m north).

A plan showing the location of the site is presented in Figure 1.

3.0 PROPOSED DEVELOPMENT

The proposed development comprises the construction of a new basement, which will be excavated below the rear half of the existing building to approximately 3mbgl and extended out from the footprint of the property below the rear garden. A sunken courtyard will be created and the ground floor of the property to the rear will be modified as part of the scheduled works. The new development will expand over a 150m^2 area.

The proposed foundation works for the new basement will involve traditional underpinning below the footprint of the existing building and the use of a ground bearing basement slab.

Due to limited space available a mini-piled wall acting in conjunction with the internal reinforced concrete liner wall is proposed to form a lateral support to the basement excavation below the garden.

The characteristic dead and live foundation loads are estimated to be the following magnitudes:

- Internal underpinning approximately 100kN/m SLS
- External retaining wall approximately 50kN/m SLS
- Pier point loads approximately 150kN/m SLS
- General basement slab 20 kN/m^2 SLS

4.0 SITE HISTORY

Historical maps and data have been reviewed in order to determine the site history and changes in land-use with time. When using historical maps, it is important to recognise that there may be a delay of several years between mapping fieldwork and the publication of the map. Caution should be applied when using maps to date development. All distances and directions are in relation to the site unless otherwise stated. A summary of the principal changes shown in the historical maps contained in the Envirocheck Report is given in Table 4.1 below. The historical maps from the Envirocheck Report are included in Appendix A.

Date	Map Scale/Source	Remarks
1871	1:2,500	Extensive properties and gardens along Avenue Road to the east of the site. The northern half of Harley Road and western side of King Henry's Rd were developed, while the area of interest belonged to the Eton and Middlesex Cricket Ground. 3No pond features noted 200m to the SW and 300m to the E of the site.
1873-1882	1:10,560	A rectangular feature appears within 500m to the SE of the site, situated in the Primrose Hill grounds, later referred to as Barrow Hill Reservoir (constructed in 1825).
1896	1:2,500	Air Shafts to the north of the site (associated with tunnel ventilation for London & North Western Railway). Eton and Middlesex Cricket Ground no longer present, development of the eastern end of the Elsworthy Road and Elsworthy Terrace. St Mary's Church first appear on the map (built in 1873) Pond features no longer present.
1915	1:2,500	Further development of the northern area: Wadham Gardens and Elsworthy Road (west side) residential properties. The property at No 48 Elsworthy Road first appear on the map
1946 1951	1:1,250 1:10,000	Minor bomb damage during WWII, loss of Willet House at No 43 Elsworthy Road
1953-1954	1:1,250	Redevelopment of No 43 Elsworthy Road – Willet House replaced by a 3 storey block of flats

1967-1972	1:1,250	Subdivision of larger property at No 27 Elsworthy Road into smaller units/flats
1974-1976	1:10,000	Originally exposed Barrow Hill Reservoir appears covered on the map from 1974. It is still in use nowadays.
1984-Present	1:1,250	Minor redevelopments within larger properties (extensions, conversions and sub-divisions only). No 48 remains unchanged.
2000	See Reference 1.	Street map with rivers superimposed presents the river Tyburn arising from Shepherd's well flowing southwards through Swiss Cottage down to Regent's Park, carried by an aqueduct over Regent's Canal.

Table 4.1. Summary of Site History and Land Use

In summary, the historical maps show that prior the middle of the eighteenth century the land currently occupied by Elsworthy Road and neighbourhood, was entirely agricultural. The street map of early London Rivers revealed the presence of Tyburn Stream, within the site's closest neighbourhood, which nowadays is channelled underground through the city. The increased housing development took place in mid 1800's starting from extensive properties and gardens along the Avenue Road while the Elsworthy Road was occupied by Eton and Middlesex Cricket Ground. The area of interest has been partially developed by the end of the 1800's and by early 1900's the Elsworthy Road and Wadham Gardens to the north were occupied by residential properties and gardens. The house at No 48 for the first time appears on the map from 1915. The area experienced minor damage throughout World War II leading to the loss of the residence at No 43 which was replaced in 1950's by the block of flats. By 1957 several underground tunnels have been constructed within 250m to the North of the study area. Since then area has undergone some additional infill development including sub-division of larger houses into smaller units and building of extensions. The property at No 48 remains unchanged.

5.0 CONCEPTUAL GROUND MODEL

A conceptual ground model (CGM) presents a range of possible subsurface conditions that can be forecast, knowing the geological processes that formed the ground beneath the site, highlighting the groundwater and surface water flow paths, reviewing the site history and current land use, to create initial assessment of the ground conditions and to design a suitable site investigation.

5.1 Geology

The British Geological Survey, 1:50,000 scale Solid and Drift Geological Map for North London, Sheet 256 (1994), shows the site is underlain by London Clay. No superficial deposits recorded.

Publically available records published by the British Geological Survey indicate that several boreholes were constructed approximately 200m east of the site at approximate National Grid Reference 527426 184078. At that location the borehole records indicate that a varying thickness of Made Ground 0.50 – 3.00m overlies weathered London Clay Formation comprising firm brown fissured clay with localised orange staining and frequent Selenite deposits. This in turn overlies unweathered London Clay to depths exceeding 20mbgl where the borehole records terminate. Deeper pumping wells were constructed approximately 500m northwest of the site. These records indicate that the London Clay Formation extends to 84.20mbgl. The Lambeth group and Thanet Sand Formations underlie this to 100.40mbgl, The upper chalk was proved at this depth and extends below the base of the borehole at 159mbgl.

5.2 Hydrology

The site is **not situated** within the catchment of the pond chains of Hampstead Heath as defined in figure 14 in the LB Camden Guidance for Subterranean Development.

The nearest surface water feature to the site is Regents Canal located about 1km south east of the site.

There are 3 groundwater abstraction points located within 1km to the South East and 1 within 500m to the North West of the study area. No pollution incidents to controlled waters or discharge consents are noted within 500m of the site.

The construction of the proposed basement **will not affect** the quality of surface water being received by adjacent properties as no sources of contaminated ground water are expected nearby.

The construction of the basement is unlikely to interfere to a great extend with the surface water flow routes as long as the site drainage is designed in an appropriate manner, to accept the additional surface run-off created by the increased hard standing area which will restrict infiltration.

The increased hardstanding area may have an impact to the surface water flows being received by adjacent properties and this needs to be taken into account in the design of the basement perimeter walls and drainage layout.

5.3 Hydrogeology

The site lies within an area underlain by London Clay and classified by the Environment Agency as a non aquifer (negligibly permeable). The site is designated as **unproductive strata** (see Appendix A). The Lower Aquifer within the Chalk (estimated to be at depth exceeding 60mbgl) is located below the level of any existing or potential basements. The area is located in a source protection zone II.

The ground water flow within the London Clay layer and any superficial man made deposits is likely to follow the topography of the site which is generally flat, hence no significant flow towards any direction is anticipated.

The London Clay layer underlying the site is likely to act as aquiclude thus preventing the immediate drainage of any surface water precipitation into the overlying Made Ground layer and hence there is a likelihood of perched water levels forming.

The proposed basement will extend below the rear garden and will create an additional hard surfaced area below the ground surface of approximately 45m2. This is unlikely to significantly affect the subterranean groundwater flow as this is likely to be nearly non- existent within the London Clay layer and the flat topography of the site.

The proposed basement may extend beneath the water table surface. Monitoring of stnadpipes installed during the site investigation will establish the groundwater regime under the site.

There are no wells or any potential spring lines within 100m of the site. The eastern branch of Tyburn Stream leading into the Regents Park Pond is reported to be running approximately 300mm to the west of the site in a culvert (The History of Lost Rivers in Camden, March 2010). The hydrogeological survey provided by GroundSure also mentions the existence of an extended culvert, St Agnes Well, within 48m to the west of the site boundary. The potential spring where the river Tyburn emanates from is near the Royal Free Hospital in Belsize Park more than 1.5km away from the site.

Taking into account the absence of the shallow aquifer the groundwater flooding susceptibility in the Ground Sure report has been assessed as being **negligible.**

Elsworthy Road is **not susceptible** to flooding caused by overflow of the existing sewer system in accordance with Camden's map of susceptible streets included in their Planning guidance document for subterranean development.

5.4 Walkover Survey

In order to record any visual observations in relation to environmental contamination and geotechnical issues present on site a walkover survey has been carried out prior the works commencing.

The residential building occupying the site is a large period detached villa which occupies the majority of the plot. There is a garage attached to the building to the south-western side. The building shows no visual external signs of significant cracking or structural deformation.

The house sits close to the boundary with the adjoining properties. The property to the left hand side (No 46 Elsworthy Road)) is positioned within 4m from the left hand side flank wall and the flank wall of No 50 Elsworthy Road is within 2m from the left hand side flank wall.

There is a small rear garden and a drive way to the front. The majority of surface cover surrounding the house comprises slate pavement slabs of various shapes and timber decking covering the majority of the garden area to the rear of the property. No olfactory or visual evidence of contamination was noted during the reconnaissance.

Mature and semi mature trees including **maple** (*Acer spp.*), common flowering **garden climbers** (*Clematis spp.*) and **shrubs** (*Hydrangea spp.*) were predominately located along the north-western boundary within the site as well as directly outside the property boundary and at the front of the residence. No evidence of invasive species such as Japanese Knotweed plants was observed.

5.5 Railway features

Network Rail railway lines, underground tunnels/cuttings, are present within the surrounding neighbourhood. These include tunnels of the "cut and cover" type connecting Harrow Wealdstone and Euston and also South Hampstead and Euston (London Midland Trains and London

Overground) located within approximately 100m of the study area. The above railway lines are running underground, parallel to King Henry's Road and Adelaide Road. These are sufficiently distant not to affect/be affected by the proposed basement development.

5.6 Mining

The area is exclusive of any mining related cavities within 150m of the study area. The site lies outside any defined coalfield area as reported by GroundSure hence the likelihood of risks associated with mining instability in the vicinity of the site is **negligible.**

5.7 Buried infrastructure

Buried infrastructure can influence the existing path of groundwater flow. The existing buried communication and drains services may already affect the flow of groundwater if the linear structure extends into the shallow aquifer. In the case of the Elsworthy Road area the risk is **negligible** due to the absence of a shallow aquifer.

5.8 Slope Stability

The topography of the site is relatively flat with no natural or man-made slopes greater than 7˚ present in the vicinity. The site is not part of a wider hillside setting and there are no railway cuttings/embankments that could be affected by the proposed basement development.

The site is underlain by London Clay and it is hence susceptible to subsidence related movements associated with moisture retention from nearby trees and seasonal variations. There is a history of subsidence in the local area. This is discussed further in the following sections and recommendations are given.

The site is not located near any water courses or spring lines and it is not within 50m of the Hampstead Ponds.

Made Ground is likely to be present across the site. Elsworthy Road is within 5m of the front of the property but the proposed basement will not extend under the full depth of the property and hence it will be outside the 5m zone.

The proposed basement will increase the differential depth of foundations relative to the neighbouring properties. The building however is detached and therefore differential settlements are not considered to be an issue. Ground movements related to the deflection of the basement retaining walls may affect surrounding properties. This is discussed further in the recommendations section.

The site is not within the exclusion zone of any tunnels or other known underground features.

6.0 SITE INVESTIGATION

Concept Site Investigations carried out a ground investigation between the 22th and 30nd September 2011 (Concept Site Investigations Factual Site Investigation Report, 11/2405/FR02).

The ground investigation comprised three cable percussion boreholes to a maximum depth of 15.00m below ground level and five trial pits (to expose existing foundations) were excavated to a maximum depth of 1.70mbgl. The locations of the borehole and trial pits are shown in Figure 2 of this report.

Concept Site Investigations carried out a suite of geotechnical laboratory tests, on samples retrieved from the boreholes. These tests comprised classification tests including moisture content and Atterberg Limit determinations, undrained triaxial compression tests, pH/sulphate content and oedometer testing. The results of the insitu and laboratory tests are presented in the factual site investigation report and are discussed in Section 6 of this report.

Environmental Scientifics Group carried out a suite of chemical tests on samples retrieved from all boreholes. The results of these tests are summarised in Concept's Factual Site Investigation Report and a brief assessment based on these results is made in Section 7 of this report.

7.0 GROUND CONDITIONS

7.1 Stratigraphy

The ground conditions encountered in the exploratory holes generally confirmed the expected geology. The stratigraphy, based on the results from the current ground investigation comprised Made Ground to a maximum depth of approximately 2.50m from ground level underlain by London Clay proven to a depth of 15.00m from ground level.

7.2 Made Ground

Made Ground was encountered in all the trial pits and boreholes. It was present to a depth of 0.80m in TP01; 1.30m in TP02 and TP04; to 1.50m depth in TP05 and a maximum of 1.70mbgl in TP03. The Made Ground layer increased in thickness towards the rear of the garden with the greatest thickness of 2.65m recorded in BH02 close to the rear boundary of the site. The Made Ground was variable, comprising slightly gravelly and gravelly clay locally with slight organic odour with brick, concrete, rare chalk fragments and clayey gravelly sand.

7.3 London Clay

The London Clay was proven to a depth of 15.00m from ground level. It comprised a firm to stiff brown (occasionally mottled grey/bluish grey) Clay with pockets of orangish brown sand. Selenite crystals were present between 4.00m and 7.00m in borehole BH01, between 1.50m and 5.50m in BH02 and below 5.00m in BH03.

Claystone fragments were encountered in borehole BH01 at a depth of 7.00m with a band of claystone recorded at 7.40m (20cm thick).

7.3.1 Classification Tests

Atterberg Limit tests performed on samples from the London Clay showed it to be of high to very high plasticity in all of the boreholes, with a plasticity index ranging between 49% and 55% (Figure 2). The natural moisture contents for BH01-03 are plotted in Figures 3a-3c and range between 28% and 38%, generally reducing with depth.

Bulk densities were measured as part of the undrained triaxial compression tests. A bulk density of $20kN/m^3$ can be adopted in the design.

7.3.2 Assessment of Desiccation

The London Clay at this location is of high to very high plasticity i.e. it has a very high potential to experience volumetric changes (shrinkage/expansion) due to variations in moisture content.

The presence of vegetation comprising mature maple trees, common flowering trees and garden shrubs was recorded along the northeast and northwest boundaries of the site and to the front of the property. It is possible that the effect of moisture extraction from these trees could result in desiccation of the London Clay.

Roots of live appearance were encountered in all trial pits and boreholes to a maximum depth of 3.50m in BH03. Root samples form the trial pits were sent for analysis and were identified to belong to various species. In particular, roots recovered from TP01 and TP02 at the right hand side of the property were found to belong to the species of Acer and Clematis. Roots recovered from TP03 by the right hand side rear bay were found to belong to the species of Acer and roots from TP04 and TP05 by the rear left hand side elevation were identified to belong to the species of Hydrangea.

Comparison of the natural moisture content with Driscoll's onset of desiccation limits of PI+ 2% and 0.4 x LL (Figure 4b - 4c) shows moisture content values within the first 4m depth to be set above the plastic and liquid desiccation limits. Although desiccation was not proven with the above comparison, the presence of tree roots and mature trees suggests that the London Clay layer is likely to be susceptible to it up to a depth of at least 4mbgl. The exact depth and lateral extent of the desiccation/heave zone cannot be definitively determined from the available data.

7.3.3 Strength and Stiffness Parameters

The results of undrained triaxial shear strength compression tests carried out on undisturbed 102mm diameter samples recovered during the ground investigation correlate well with the SPT (N) results, yielding the following approximate correlation which corresponds with that proposed by Stroud and Butler (1975) for London Clay:

$$\mathbf{C_u = 5\ N.}$$

It is recommended that the following characteristic design lines are adopted:

$$\mathbf{N_{char} = 9 + 1.4z \text{ blows /300mm}}$$

and

$$\mathbf{C_{uchar} = 45 + 7z \text{ kN/m}^2}$$

Where:

N_{char} is the characteristic SPT blow count

C_{uchar} is the characteristic undrained shear strength

z is the depth below the surface of the London Clay

Stroud (1998) suggests a stiffness correlation of **E’ = 400cu** is considered for London Clay at this site. This gives a corresponding drained stiffness of:

$$\mathbf{E'_{char} = 18{,}000 + 2{,}800z\ kN/m^2}$$

Similarly the undrained stiffness can be obtained utilising the correlation:

$$\mathbf{E' = 0.75\ E_u}$$

to give:

$$\mathbf{E_{u\ char} = 24{,}000 + 3{,}700z\ kN/m^2}$$

2 No Oedometer tests carried out in the laboratory suggests that a coefficient of compressibility of $\mathbf{m_v = 0.20m^2/MN}$ is reasonable for the above site. A higher coefficient of $\mathbf{m_v = 0.40m^2/MN}$ should be considered for the purposes of heave calculations. These are in agreement with Tomlinson’s (1994) recommendations for coefficients of compressibility for the weathered brown and upper blue London Clay.

7.4 Groundwater

No water seepages were encountered in the boreholes during drilling. All boreholes were dry. Standing water was encountered in TP03 at 1.70m depth. This could be related to leaking drains, or ponding of surface water runoff at this location.

Gas/groundwater monitoring instrumentation was installed as part of the ground investigation in all of the boreholes with a slotted response zone from 1.00m to 8.00m below ground level in BH01 and from 1.00m to 6.00m in BH02 and BH03. Groundwater was encountered in these instruments 2 to 8 days subsequent to the completion of the works at 5.86m bgl in BH01, at 6.91m bgl in BH02 and at 5.71m bgl in BH03. Further monitoring carried out in October 2011 showed the ground water level to have risen to 5.31m bgl in BH01, 4.69m bgl in BH02 and 4.75m bgl in BH03 respectively.

The groundwater phreatic surface appears to be generally level across the site at a level of approximately 5mbgl. The duration of the monitoring is not sufficiently long to enable the recording of seasonal variations and it is likely that the water level will rise further at times of heavy rainfall.

The Made Ground Layer above the relatively impermeable London Clay is also clayey and unlikely to be very permeable. Nevertheless, perched water tables should be anticipated.

Based on the above and depending on the timing of construction it is unlikely that the groundwater will pause a problem for the construction of the basement and short term groundwater levels of 4mbgl can be adopted.

For permanent wall design it is recommended that a ground water level as high as 0.5m -1mbgl is adopted with hydrostatic pressure distribution below this depth in accordance with the recommendations laid out in CIRIA report C580 (Embedded Retaining Walls, Guidance for Economic Design).

8.0 ENVIRONMENTAL ASSESSMENT

8.1 CONCEPTUAL SITE MODEL

8.1.1 General

The assessment of the potential impacts arising from contaminated land is based upon considerations of pollution linkages between contamination sources and sensitive receptors. The UK framework for the assessment of contaminated land endorses the principle of risk assessment and a suitable for use approach to contaminated land. Remedial action is only required if there are unacceptable risks to human health or the environment, taking into account the use of the land and its environmental setting. The methodology of risk assessment is normally set out in terms of significant pollutant linkages within a source-pathway-receptor model of the site. All three of these elements must be present for a site, or area of a site, to be determined to be contaminated.

A conceptual site model (CSM) describes the scenario in which the risks to human health and the environment (posed by contaminated land) are assessed. It describes the ground and surface conditions, and the activities performed on the site in terms of the ground works and final form of development. In particular the CSM identifies and describes the sources of potential contamination, the behaviour of the contamination in environmental media such as soils, groundwater, surface water and air. It also identifies and characterises potential human and ecological receptors, and plausible pathways. The CSM is normally used to focus investigations and inform upon any remediation strategy that may be required.

8.1.2 Sources

<u>On-Site</u>

No potentially significant contaminant sources have been identified on the proposed development site.

Prior to the nineteenth century the site was farmland owned by the Eton College Estate. Following this, various structures were constructed on or adjacent to the site, which appear to be residential, with some minor alteration of the structure on the site in the early to mid-20th Century up until the present time.
Based on the information reviewed, the risk of significant contamination at the site from on-site sources is considered **negligible.**

<u>Off-Site</u>

There are **no current** commercial/industrial or recorded pollution incidents surrounding the site that are considered to have **significantly** affected the soil or groundwater at the site. No petrol filling stations are located close to the site.

An electricity substation is present some 58m to the west from the site area. These facilities can comprise low volumes of oil in enclosed systems, that can lead to contamination of the surrounding soil should they malfunction/leak or be removed. However, due to the relative distance from the site it is considered unlikely that any *potential* contamination arising from this location would have any impact on the site. Therefore at present the risk from off-site sources is considered **very low**.

8.1.3 Receptors

Receptors potentially at risk from significant contamination are considered to include the following:

- Site users
- Site workers during development
- Residents and neighbours during development
- Maintenance workers (after development)
- General Public
- Shallow Aquifer

- Deep Aquifer
- Surface Water
- Flora and Fauna
- Building materials and underground services

8.1.4 Pathways

The potential exposure pathways linking the identified receptors to the potential contamination sources are considered to be as follows:

Human

- Direct ingestion of soil
- Dermal contact with soil
- Inhalation of fibres and particulates
- Inhalation of vapours and gases
- Ingestion of fruit and vegetables

Building Materials

- Contact with contaminated soil and surface water

Surface Water

- Soil leaching to groundwater then migrating to surface water
- Disturbance and migration along pathways created during construction then migration to surface water

Flora and Fauna

- Direct ingestion of soil
- Contact with soil
- Root uptake of contaminants

8.1.5 Assessment of Linkages

The proposed development comprise a new basement within the property located at 48 Elsworthy Road, which will be excavated below the rear half of the existing building and extended out from the footprint of the property into and below the rear garden. Any soil remaining at the surface may provide an exposure pathway for future users of the site.

A potential pollutant linkage exists for construction workers (direct contact/ingestion and inhalation) and neighbours (from dust emissions) during the excavation of potentially contaminated soils at the site. New hard standing areas will effectively sever many of pollutant linkages between future users of the site/building, maintenance workers and the potential site contaminants. There is a possibility for workers to be occasionally exposed to potential contaminants should any significant excavation works be undertaken. There is also possible linkage between vapours and soil gases and the building occupants, although it is noted that the excavation of the basement will likely removed significant quantities of made ground where present, thereby removing much of any *potential* source of gas/vapour generating material. This is assessed in Sections 9.3.2 and discussed further in Section 10.1.2 of this report.

The site is underlain by London Clay, classified as a non-aquifer. No Groundwater was encountered during the site investigation (September 2011), although water was encountered within the uppermost layer, during subsequent gas/groundwater monitoring visits.

The site is underlain by a major aquifer. However, the depth of the major chalk aquifer, although not precisely known, is estimated to be in excess of 60-80m meters below ground level based on the information in the geological map of the area. The proposed development does not include deep bored piles and the site is separated from the aquifer by a considerable thickness of impermeable clay. Therefore the risk to the major aquifer is considered **negligible.**

The significance of off-site sources of contamination is considered **very low**.

Building materials normally identified as being at risk on contaminated sites are concrete, plastic and metals. The risk can be controlled by the specification of suitably resistant materials or adequate protective measures.

9.0 HAZARD ASSESSMENT

9.1 Soil Screening Values

To simplify the assessment of ground contamination risks, the statutory guidance (circular 01/2006) advises that generic soil quality guideline values may be used for initial screening of contamination testing results, provided that such guideline values are available and are appropriate to the site circumstances and the potential pollutant linkages in question. If the results from an adequate site investigation are below the scientific and appropriate guidelines then the site can be regarded as uncontaminated. If the results exceed the screening guidelines then more detailed risk assessment is required to determine whether or not there is a need for remediation.

Soil Guideline Values (SGVs) have been published by the Environment Agency for a number of determinands based on the contaminant behaviour, human activity patterns and contaminant toxicology. The SGV's are currently in the process of being updated and as new values are published, former SGV's will be withdraw. Updated SGV's are currently available for arsenic, nickel, mercury, selenium, benzene, toluene, ethlybenzene and xylene. In the absence of updates, former CLEA SGV's for cadmium, hexavalent chromium, lead, and phenol are used in this report.

The CLEA model estimates human exposure (children and adults) to soil contaminants for those potentially living, working and/or playing on contaminated sites over long time periods (chronic exposure). The CLEA model does not assess risks to groundwater. The CLEA model does not include short term (acute) risks to construction workers.

Land Quality Management ltd (LQM) and the Chartered Institute of Environmental Health (CIEH) have produced and published Generic Assessment Criteria (GAC) using risk assessment software (CLEA) in accordance with the CLEA assessment framework for the four standard CLEA end uses (residential with plant uptake, residential without plant uptake, allotments, and commercial/industrial). These GACs are referred to where appropriate.

9.2 Hazardous Ground Gas

The results of the investigation have been assessed in accordance with the recommendations provided by the following references:

1. The Building Regulations 2000, Approved Document C (2004 edition);[1]
2. Assessing risks posed by hazardous ground gases to buildings, CIRIA Report C659;
3. Protection development from methane, CIRIA Report 149;
4. Passive Venting of Soil gases beneath buildings, DETR, Arup Environmental 1997;[2] .

No soil guideline values for hazardous soil gases have been published by Defra. The buildings regulations state that the hazards posed by ground gases must be assessed in a risk-based framework.

CIRIA Report C659 described a process of deriving gas-screening values (GSV) for hazardous ground gases. The method uses both gas concentrations and borehole flow rate to define a range of characteristic situations based on limiting borehole gas volume flow for methane and carbon dioxide. The GSV (in litres per hour) is calculated by multiplying the borehole flow rate (litres per hour) by the gas concentration (%).

The CIRIA report 149 and the DETR/Arup reports describe a number of ground gas regimes and suggest suitable mitigation for residential and commercial properties.

9.3 Application at 48 Elsworthy Road

9.3.1 Hazard assessment (Soils)

A total of 3 samples were selected from three locations at various depths, within the Made Ground and analysed for a range of potential contaminants. One of the samples was tested for Leachability WAC tests. The results are presented in Appendix C – Chemical Test Results.

Metals

The individual concentrations of nearly all metals analysed was generally low and below published SGVs/GAC's for residential end use, with the exception of one elevated lead concentration, which exceed the former Environment Agency SGV (450 mg/kg), with concentrations of **1232 mg/kg.**

[1] Building Regulations 2000 Approved Document C (2004) Site Preparation and Resistance to Contaminants and Moisture.
[2] DETR/Arup Environmental (1997) PIT Research Report: Passive venting of soil gases beneath buildings.

No current published guidance was available for barium, although Kelly's Indices, former GLC guidance for gasworks sites in London classifies site, with levels of barium between 0-500mg/kg as uncontaminated. The maximum reported barium concentration in the samples was analysed was 154 mg/kg.

Inorganic

The concentration of total cyanide was below Method Detection Limits (MDL = <0.5 mg/kg). The concentration of sulphide and total sulphur were very low or below the MDL. No asbestos fibres were identified in the samples tested.

Hydrocarbons

Two samples were analysed for phenols, speciated polyaromatic hydrocarbons (PAH), speciated total petroleum hydrocarbons (aliphatic/aromatic split) including BTEX. The concentrations for all total petroleum hydrocarbons compounds/fractions were very low and below screening criteria for residential land use. Total phenols was below the MDL (0.5mg/kg)

Comparison of polyaromatic compounds, with LQM/CIEH GAC's, taking into account respective Soil Organic Matter (SOM) Content (%SOM = TOC (%)/0.58) concentrations were very low and below screening criteria for residential use.

Leachate

The results of the two stage WAC tests reported concentrations of all dissolved solids that are below criteria for inert waste classification. (See Section 11.0).

9.3.2 Ground Gas

Four rounds of ground gas monitoring have been undertaken in three standpipes installed all of the boreholes, with response zones installed in the Made Ground and London Clay. For ease of reference, a summary of the maximum concentrations reported for methane, carbon dioxide and the gas flow rate during each visit is presented in Tables 9.1 to 9.4 below, although these will indicate a "worst case" scenario as the concentrations often dropped or varied during the monitoring period.

Table 9.1 Summary of Maximum Ground Gas Concentrations (07/10/11)

Borehole	Methane (%)	Carbon Dioxide (%)	Gas Flow (l/hr)
BH01	0.0	4.0	<0.1

Borehole	Methane (%)	Carbon Dioxide (%)	Gas Flow (l/hr)
BH02	0.0	0.7	<0.1
BH03	0.0	0.2	<0.1

Table 9.2 Summary of Maximum Ground Gas Concentrations (21/10/11)

Borehole	Methane (%)	Carbon Dioxide (%)	Gas Flow (l/hr)
BH01	0.0	5.4	<0.1
BH02	0.0	1.8	<0.1
BH03	0.0	0.1	<0.1

Table 9.3 Summary of Maximum Ground Gas Concentrations (28/10/11)

Borehole	Methane (%)	Carbon Dioxide (%)	Gas Flow (l/hr)
BH01	0.0	6.7	<0.1
BH02	0.0	2.1	<0.1
BH03	0.0	0.3	<0.1

Table 9.4 Summary of Maximum Ground Gas Concentrations (04/11/11)

Borehole	Methane (%)	Carbon Dioxide (%)	Gas Flow (l/hr)
BH01	0.0	7.1	<0.1
BH02	0.0	2.7	<0.1
BH03	0.0	0.2	0.3

Gas monitoring was carried out at various atmospheric pressures from 1017mb to 989mb. No methane was detected during any of the monitoring visits. Concentrations of carbon dioxide peaked at 7.1% during the last monitoring visit, most likely due to the low atmospheric pressure

(991mb) Gas flow rates were very low to negligible (0.3 l/h to <0.1l/h). The results have been assessed in accordance with the recommendations in the guidance (CIRIA C659) taking account of the maximum gas concentrations, the borehole volume flow rates and the typical source characteristics. The approach is to calculate the "total hazardous gas emission" based on the measured gas concentrations and the measured gas flow rates.

The maximum calculated borehole gas volume flow rates were all very low (below 0.1 l/h) for which no special precautions are normally required (CS 1). CIRIA report C659 suggests that the assessor should consider methane concentrations (independent of gas flow) above 1% by volume and carbon dioxide concentrations above 5% by volume in a risk based manner. The gas screening value is calculated by multiply the gas concentration (%) by flow rate (l/h). Even If the worst case flow rate is used (detected in the borehole with the lowest CO_2 concentration), the gas screening value = <u>0.07 x 0.3 = **0.021 l/h**</u>. This is classified in Table 8.5 in the CIRIA Report as **very low risk**. The proposed development will also remove over 3.0m thickness of soil from the site during construction of the basement and much of the *potentially* gas generating material (Made Ground) will be removed prior to development. Levels of organic material were also very low in the samples tests. Based on results of this investigation, it is proposed that no specific gas prevention measures are necessary.

10.0 RISK ASSESSMENT

10.1 Introduction

A preliminary risk assessment based on the proposed development has been undertaken based on the information currently available on the site. The risk characterisations provided below have been qualitatively assessed in a range from **Very High**/**High**/**Moderate**/**Low to Very Low.**

10.1.1 Risk to Human Health during Development

A potential pollutant linkage exists for construction workers (direct contact/ingestion) and inhalation and neighbours (from dust emissions) during the excavation of potentially contaminated Made Ground soils during the development of the site. The associated issues can be mitigated by appropriate construction practices and design measures based on the results of this site investigation. The concentrations of all contaminants were below levels that might be regarded as an **acute** risk to construction works, although one lead concentration above former SGV's was found to be present in one sample analysed. It is therefore recommended that specific precautions are taken to limit direct exposure to soils and dust during the development.

This should include the use of appropriate PPE and dust suppression during earthworks. Dust suppression will also mitigate the risks of fugitive dust emissions impacting on neighbouring sites.

10.1.2 Risks to Human Health following Development

The hazard assessment has identified one contaminant of concern with regards to lead in one of the samples tested. Due to the presence of a garden on the site, which will remain following development, dermal/inhalation pathways and risk to human receptors cannot be discounted. However soils at the location of the sample tested will likely be removed during construction of the basement. Notwithstanding this it is therefore recommended that any soils remaining at the surface following development, be screened to confirm that lead levels are below the relevant screening criteria prior to reuse for landscaping purposes. Should the above steps be carried out the risk to human health with regard to potential dermal/inhalation exposure is considered **low**.

The potential risk from migration and accumulation of ground gases such as methane, carbon dioxide following development has been assessed. No methane was detected, and although carbon dioxide was detected in concentrations in one borehole up to 7.1% gas flow rates were very low (0.3l/h to 0.1 l/h). In accordance with the gas screening procedures described in CIRIA Report 569, combined with the findings of the site investigation and the nature of proposed development the risk from ground gases was consequently assessed to be **very low**

10.1.3 Risks to Groundwater

Although water was detected during subsequent monitoring of the boreholes, it is unlikely that this water is in hydrological continuity with any sensitive receptors. Also, the site investigation has identified no elevated concentrations of non metallic, inorganic compounds and hydrocarbons, with only one slightly elevated metal (lead) in the upper soils in one location. The concentrations of leachable compounds were also very low. No controlled waters are located in proximity to the site and the site lies within an area classified (by the Environment Agency) as a non aquifer (negligibly permeable), and as an unproductive, major aquifer. The depth of the major chalk aquifer is not precisely known, but is estimated to be in excess of 60-80m meters below ground level. No pathway will be created to the deep aquifer (Chalk) during the development. Therefore the risk to groundwater is considered very low to negligible.

11.0 WASTE DISPOSAL

The proposed development will produce a large quantity of spoil material from the excavation of the basement structure. Spoil generated from the site will require disposal in accordance with the Environmental Protection Act 1990, the Landfill (England and Wales) Regulations 2002 (as amended), the Waste Management Licensing Regulations 1994 (as amended) and any other relevant statutory instrument and guidance. All material removed from site must be adequately described by reference to the appropriate codes in the European Waste Catalogue. Appropriate documentation should be retained, and be available for inspection, that demonstrates the nature of the material to be disposed of including chemical analysis where appropriate.

Basic waste characterisation (as defined by the guidance) must be carried out by, or on behalf of, the waste holder before landfilling. The general principle is that the composition, long-term behaviour and general properties of a waste to be landfilled must be known as precisely as possible. Waste received by a landfill operator will be subject to compliance checking and verification prior to landfilling**,** which will include periodic detailed analysis. The existing information from the site investigations will be useful in this respect.

Soils arising from the groundwork, requiring disposal, will require classification before disposal to a suitably licensed waste disposal facility. There are now three types of landfill (inert, non-hazardous and hazardous) and four principal types of waste, as outlined below as follows:

- **Inert** - generally uncontaminated natural soils. If this is the case the material may be disposed of to an inert landfill if it satisfies the inert leachability Waste Acceptance Criteria (WAC). Inert may also be used as a construction material in other sites.

- **Hazardous** - defined by the European Waste Catalogue and the analysis of ‘total’ chemical determinands to assess the hazard properties. It must be treated in accordance with the principles (BPEO) set out by the Directive. Treatment may change the classification to non-hazardous (as defined by the EWC and the ‘total’ chemical content). Subsequent to treatment, and the classification following treatment, the waste may only be disposed of it satisfies the leachability WAC for the relevant classification of landfill.

- **Stable non reactive hazardous waste** – defined in a similar manner to hazardous waste but satisfying stricter WAC. Subsequent to treatment, it may be disposed of in specifically designed separate cells in non-hazardous landfills (if the operator has obtained a permit to operate these cells). If the waste is not inert and not hazardous then by default the waste is non hazardous. Non hazardous waste may be sub classified based on the bio-degradable content.

Soil analysis revealed no concentrations of determinands classified as hazardous in accordance with the EWC. One sample of Made Ground was submitted for leachability analysis in accordance with BS12457 Part 3. The results were below criteria for inert wastes. From the available information of the other areas screened the test results suggests that the materials that could arise as spoil could will likely be classified as inert (or non-hazardous), particularly in natural soils. Additional characterisation may be required during the development contract, should any soils note encountered during this investigation arise.

12.0 IMPACT ASSESSMENT AND DESIGN RECOMMENDATIONS

In the following paragraphs the issues identified in the conceptual ground model are discussed and recommendations are made for their mitigation.

12.1 Existing Foundations

The foundations of the rear elevation were found to be as follows:

- On the right hand corner, TP01 adjacent to No 50 exposed brick corbelled footings bearing directly on top of a sandy silty clay layer at 0.75mbgl.
- To the right hand side of the bay wall (TP02) the footings comprised a single masonry corbel on a 0.60m thick concrete base bearing on the Made Ground layer at a depth of 1.10mbgl.
- To the left of the bay wall (TP03) a similar type of foundation was encountered with the masonry wall bearing on 0.6m mass concrete base. The footing at this location appears to have been underpinned in the past with a weak concrete underpin proven to a depth of 1.7mbgl. The base of the underpin was not proven.
- TP04 exposed masonry footings on a 0.80m thick concrete base which rests on the sandy silty clay layer at a depth of 1.30mbgl. A drain pipe encased in concrete was encountered within the top 0.50m.
- The observation pit TP05, located to the left of the rear elevation wall, exposed a plastic 100mm diameter pipe directly underneath the masonry wall embedded in a <0.10m ballast layer. The uncovered foundation is underlain by 0.80m thick concrete bearing onto the Made Ground layer at a depth of 1.3mbgl.

As discussed in section 7.3.2 all the above foundations are likely to be influenced by the shrinkage /swelling of the underlying London Clay layer caused by the moisture extraction of the surrounding vegetation.

12.2 Allowable Bearing Pressures

It is proposed to underpin the existing foundations of the property to a depth of approximately 3m below ground level (bgl) in order to construct the basement structure under the rear part of the building. The anticipated basement slab level is approximately 3mbgl.

At this level the recommended allowable bearing pressures for the London Clay are of the order of 120 kPa for strip footings and 150 kPa for individual pad footings.

12.3 Underpinning

The proposed level of underpinning is towards the end of the anticipated desiccation zone. As discussed in section 7.3.2 it is not possible to exactly determine the extend of this zone based on the available data. The base of the proposed underpins is unlikely to be affected by tree roots emanating from the large mature trees at the rear as the proposed retaining walls will form a cut-off for the ingress of roots. They can still however be affected by the presence of roots emanating from the front of the property. It is recommended that the vegetation and trees at the front of the property are managed at all times and kept at a reasonable height to prevent root migration to such depths.

If tree roots are found during the excavation of the underpins then these will need to extend to at least 0.75m to 1m or beyond the depth of the deepest tree root found in the excavations.

The underpinning of the existing foundations should be carried out in bays no longer than 1m.

The underpinning sequence should be such that no adjacent bays are constructed until the concrete has set for at least 24hous.

Reinforcement bars should be placed between adjacent bays to form a shear connection between the underpins.

During excavation of the bays the adjacent property should be monitored for signs of movement.

Consideration should be given to the transition between the underpinned rear part of the house and the non–underpinned front part. The difference in foundation levels is likely to cause differential settlements as the shallower front part is likely to move more than the rear with seasonal variations and tree influence. It is recommended that transitional underpins are constructed under the flank walls to enable a more even distribution of such movements. Transitional underpins should be sufficient to negate the need of a movement joint between the basement and non-basement part of the house.

12.4 Basement Slab

A reinforced concrete raft at basement level should be designed to withstand differential settlements caused by any potential desiccation/heave of the subsoil in addition to the heave caused by the removal of the overburden.

Removal of the overburden is likely to cause upward pressures of up to 60 kN/m2. This is likely to cause upward movements of the order of 35mm in the middle of the excavation reducing to 15mm towards its edges.

Assuming that construction of the remaining building will follow the construction of the ground bearing slab with no time delay the ground bearing slab will only experience a proportion of the heave due to the basement excavation as the load of the building is gradually transferred to the soil. The proportion of immediate heave likely to be experienced by the slab after its construction will be of the order of 50% of the above values i.e. around 17.5mm at the centre and 7.5mm at the edges. The remaining 50% of the heave will be acting in the long term and will be counteracted by the load applied. If the net applied load is greater than the total unload the remaining heave is unlikely to be a problem.

Adoption of a long term design water level of 0.5mbgl is recommended if a 25 year design life is sought for the structure. Based on this, the basement slab should be designed for water pressures of up to 25kN/m2 acting on its underside.

Although as discussed previously heave related pressures due to possible desiccation from any tree roots migrating from the vegetation at the front of the property cannot be discounted at this stage, these are unlikely to be high.

An alternative option is to suspend the basement slab. Care should be taken to allow sufficient void former to the underside of the slab to cater for the heave pressures discussed above.

Underslab drainage is recommended to reduce the effect of water pressures acting on the underside of the slab.

The benefit of adopting a suspended slab option over a ground bearing slab is that it will minimise the requirements for more detailed analysis and subject to a sufficient void being present will not be subjected to any heave pressures. Subject to structural design considerations it may be proven to be a cost effective and appropriate option for this development.

12.5 Retaining Wall Design

It is recommended that effective stress parameters are adopted for the design of the permanent retaining structures;

For the purposes of retaining wall design the following effective stress parameters can be adopted in the London Clay:

$c' = 0$

$\Phi_{crit}' = 25^\circ$ (BS 8002, 1994) These values represent a moderately conservative or "characteristic" estimate.

For the Made Ground Layer it is recommended that slightly lower effective stress parameters are adopted to account for the variability of the layer:

$c' = 0$

$\Phi_{crit}' = 18^\circ$

For stiff overconsolidated clays it is reasonable to adopt an earth pressure coefficient at rest $K_0 = 1$ (CIRIA C580 , 2003). Active (K_a) and Passive (K_p) coefficients can be derived from the equations and charts in Appendix A6 of the CIRIA C580 report.

An ultimate limit state design with factored strengths should be adopted to determine the toe level of the retaining walls. A serviceability state analysis where the various stages of construction are modelled should then be carried out in order to determine the anticipated ground movements and the prop forces and bending moments acting on the walls. This will enable the calculation of appropriate props and reinforcement for the walls.

The following are recommended to the adopted for the design:

1. Allowance for 0.5m to 1.0m over-excavation at the front of the wall.
2. Long term ground water level at 0.5m - 1m below ground level with hydrostatic distribution below this level
3. Surcharge pressure of 10kN/m2 at the retained side
4. Additional surcharge pressures from the foundations of the adjacent structures
5. Stiffness parameters for the walls in accordance with the recommendations of Ciria Report C580 of 0.7 x EI for undrained design and 0.5 x EI for drained design.

For temporary works design it is recommended that a mixed approach is used with drained conditions applied at the retained side and undrained with softening of the first 1m at the excavation side.

An Undrained approach may be possible to be adopted for the design of the temporary walls although it would be higher risk and would require controlled site conditions. The following need to be adhered to if such a design is to be adopted:

1. Permanent walls are constructed within a maximum of 6 months of the installation of the temporary structures.
2. There is strict control of the site operations
3. The stability of the temporary walls is inspected at all times and design checks are carried out if there is a change in circumstances.
4. There is allowance for softening of the clay for the first 1m of the excavation.
5. The formation of tension cracks filled with water is taken into account at the retained site with hydrostatic water pressures applied at the zone of the tension cracks.

12.6 Basement Construction

A piled wall system would be the most appropriate to be adopted for the construction of the basement. This will allow the ingress of the ground water within the excavation and hence will prevent the formation of a dam that could potentially divert the ground water to the adjoining properties. A reinforced concrete wall skin can then be constructed to form a watertight basement structure with a drainage channel formed between the piled wall and the internal water tight skin.

The above type of construction will maintain the hydrogeology of the area as the clay layer is sufficiently impermeable to prevent any surface water runoff towards the excavation.

Based on the current site investigation data it is not considered that the groundwater is likely to be a problem during the excavation of the basement. Although there were no seepages encountered in the London Clay during drilling we recommend that pumps are available during the excavation in order to cater for potential water seepages that may be encountered in the London Clay.

Any surcharges from potential piling work platforms and heavy plant traffic need to be considered during the detailed analysis of the walls.

Anti-heave measures should be adopted behind the walls to prevent heave/settlement related movements associated with desiccation from affecting the structures.

12.7 Movements of Adjacent Structures

The excavation of the basement will cause heave of the soil due to the net relief of vertical pressure on the soil beneath the basement. As the load applied by the structure is likely to be greater than the net unloading, long term heave is unlikely to be a problem. During the construction phase the unrestrained heave of the soil may result in uplift pressures exerted on the foundations of existing structures within influencing distance of the basement excavation. The movement will continue until a net load is re-applied equal to or greater than that associated with the remaining heave.

The heave potential to the ground surrounding the excavation will be counteracted by the settlement of the ground caused by the lateral movement of the faces of the excavation and the surface movements resulting from the installation of the piled walls.

Settlement /heave of the ground surface will not occur to any appreciable extent beyond a line drawn at a slope of 1 (horizontal) to 2 (vertical) from the base of the excavation (Tomlinson, 1989). Any shallow foundations within this line are likely to be affected. Although the property to the left hand side of No 48 is unlikely to be affected, the property to the right hand side lies within the zone of influence of the excavation.

The anticipated ground movements will need to be calculated for the various stages of construction. As discussed previously these are likely to be as follows:

1. Settlement of the ground surface behind the piled walls resulting from the installation of the walls. This is likely to be of the order of 0.04% of the pile depth reducing gradually over a distance of twice the pile depth (CIRIA C580).
2. Heave related movement associated with the excavation in front of the walls.
3. Short and long term settlement related movements associated with the deflection of the walls which is dependant of their stiffness and the propping systems proposed to be adopted.

Once an estimate of the above movements and related strains is determined by the calculations the potential cracking likely to be caused to the adjoining structure should be evaluated on the basis of the Boscardin and Cording (1989) and Burland damage classifications.

Monitoring of the adjoining structures within influencing distance of the proposed development should be carried out at regular intervals during and after the construction of the basement. The installation of inclinometers in boreholes set behind the walls is considered to be the most accurate and sensitive method of determining ground movements. The data from the inclinometers will be monitored continually using computer programs and the designer/contractor will be alerted if they exceed predetermined levels. Another alternative is total station monitoring of stations installed at the top of the piled walls at regular intervals combined with regular visual inspections of the adjoining property for signs of cracking.

12.8 Sub-surface Concrete

Concrete to be placed in contact with the soil or groundwater must be designed in accordance with the recommendations of Building Research establishment Special Digest 1 “Concrete in Aggressive Ground” taking into account the pH of the soils.

2:1 water/soil extract sulphate concentrations were measured on samples retrieved from the boreholes from a range of depths. The values recorded ranged between 0.35g/l SO_4 (BH01) and 2.82g/l SO_4 (BH02). The sample collected from BH02 represents the highest value and was assigned to class DS-3 of BRE Special Digest 1, “Concrete in Aggressive Ground”. The pH values recorded were between 7.73 and 8.70. Assuming static ground water, Table C1 of the Digest indicates an ACEC (Aggressive Chemical Environment for Concrete) site classification of AC-2s for natural soils. Due to a small number of soil samples tested, the highest measured sulphate concentration (mg/l SO_4) was taken as the characteristic value.

12.9 Drainage

The construction of the basement will increase the hard-standing area at the rear of the property by approximately 45m2. Surface water infiltration will therefore be limited over this area and there is a possibility that this is going to run off to either side of the basement towards the adjoining properties. The flat topography and the clayey (hence relatively impermeable) nature of the Made Ground will act as a deterrent to any significant surface water run off. The design of a permeable piled wall with a drainage channel between the wall and the impermeable inner basement skin will eliminate the risk of the basement acting as a barrier and diverting any existing water flow.

The increased surface water run off will need to be collected through a sump system by the existing drains. The anticipated additional water to be collected by the existing sewage system will need to be assessed as part of the drainage design.

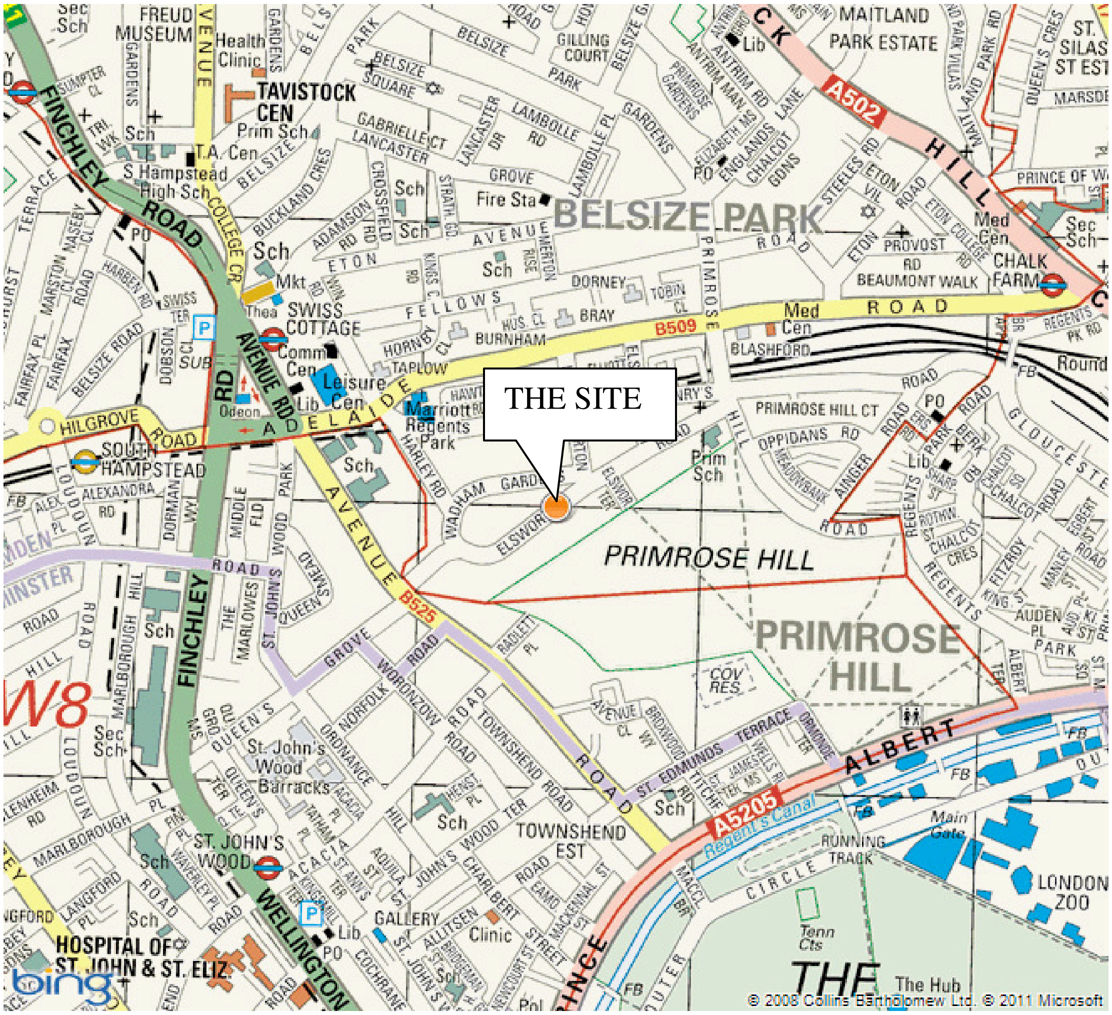
Based on the conceptual ground model presented in the previous paragraphs which suggests that the site is low risk in relation to any surface or subterranean flooding it is not considered necessary to carry out a more detailed hydrogeological /hydrological assessment and /or a flood risk assessment.

REFERENCES

1. Barton N. (2000). The Lost Rivers of London. Historical Publications Ltd. Revised Edition.
2. British Geological Survey (1996). *London and the Thames Valley.* London HMSO. 4TH Edition.
3. Boscardin M.D. Cording E.J. (1989). Building response to excavation – induced settlement. Journal of Geotechnical Engineering, ASCE, Vol. 115, No.1, pp.1-21.
4. Burland J.B., and Worth C.P. (1975). Settlement of Buildings and Associated Damage. Proceeding of a Conference on Settlement of Structures. Cambridge.
5. Camden River Restoration (2010). The History of Lost Rivers in Camden. The Historical Study of the Kilburn and Tyburn. Camden & University Collage London.
6. Concept Site Investigations, *Site Investigation Report*, (Ref. FR11/2405)
7. Carter, M. and Bentley, S. P. (1991). *Correlations of Soil Properties.* Pentech Press, London.
8. Stroud, M. A. (1988). The Standard Penetration Test- Its application and interpretation. *Penetration Testing in the UK.*
9. Tomlinson, M. J. (1969). *Foundation Design and Construction.* Longman Publishing. 5th Edition.
10. London Borough of Camden (2010). Camden Planning Guidance. Basement and lightwells. CPG 4.
11. BRE Digest 363. (1996). *Sulphate and acid resistance of concrete in the ground.*
12. BS 5930 (1999) + A2:2010. *Code of Practice For Site Investigations.*
13. BRE Special Digest 1. (2005). *Concrete in Aggressive Ground.*
14. CIRIA C580 (2003) *“Embedded Retaining Walls – Guidance for Economic Design”.*

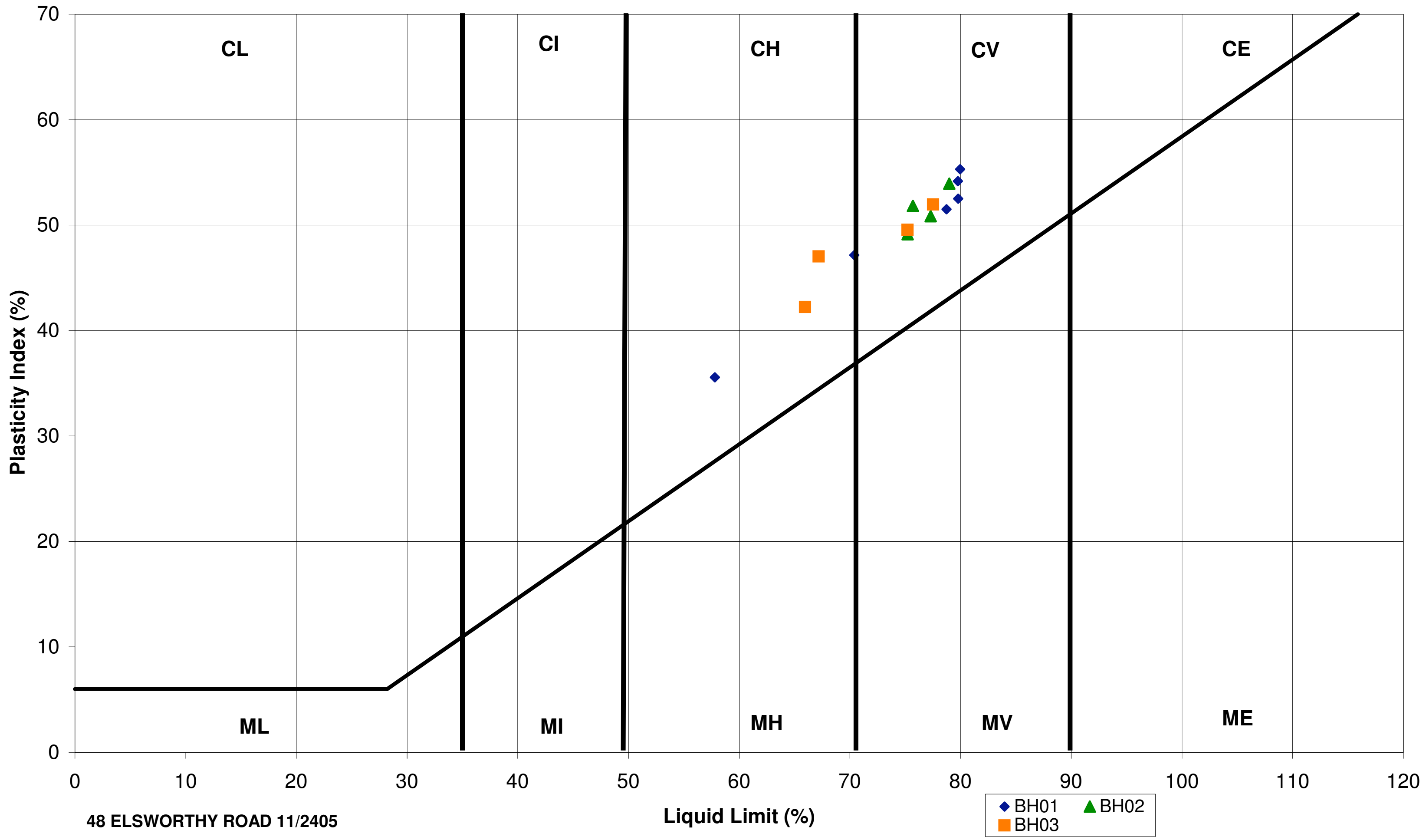
FIGURES

Figure 1 – Site location

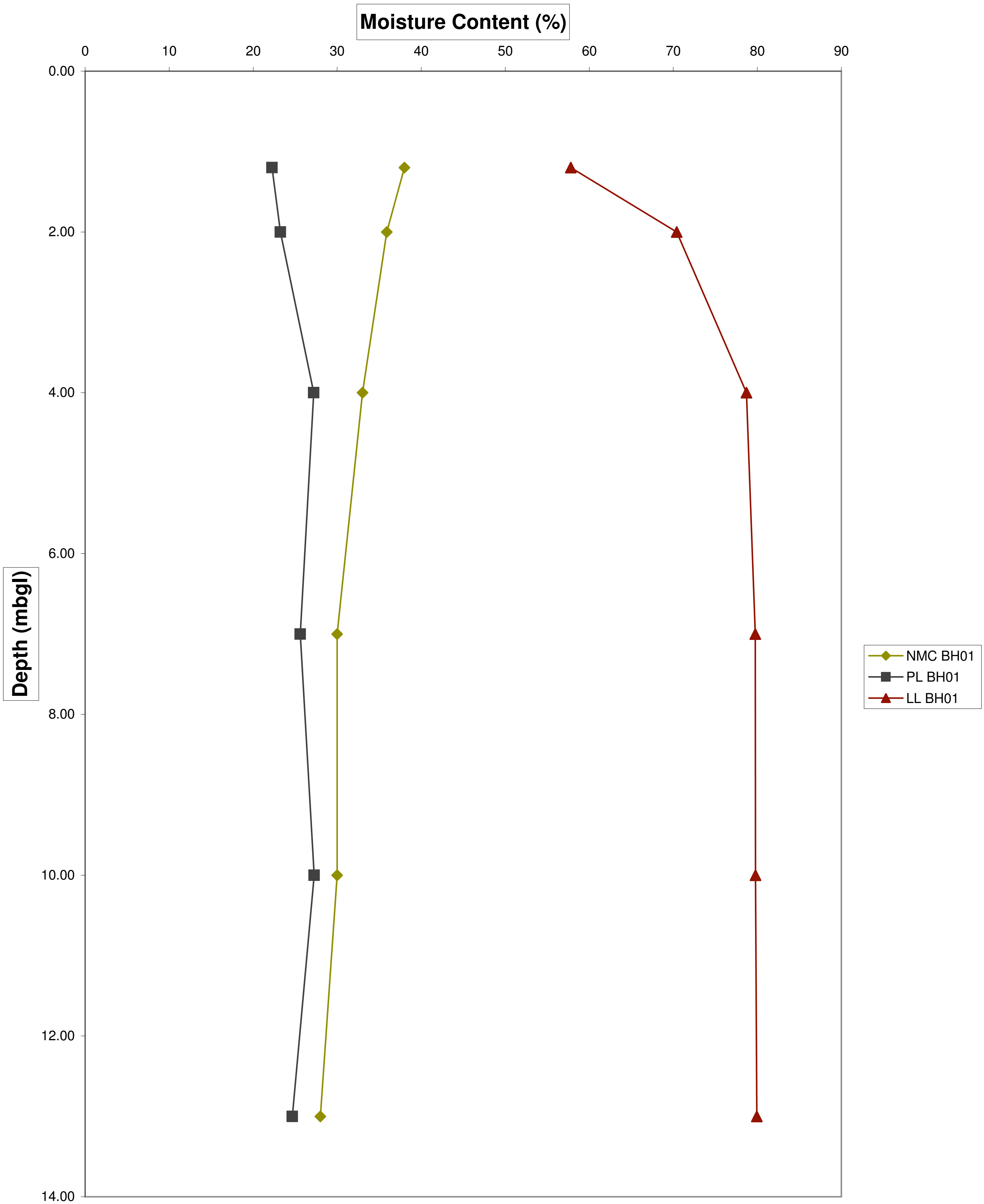


Not to scale

FIGURE 2: PLASTICITY CHART BH01-03

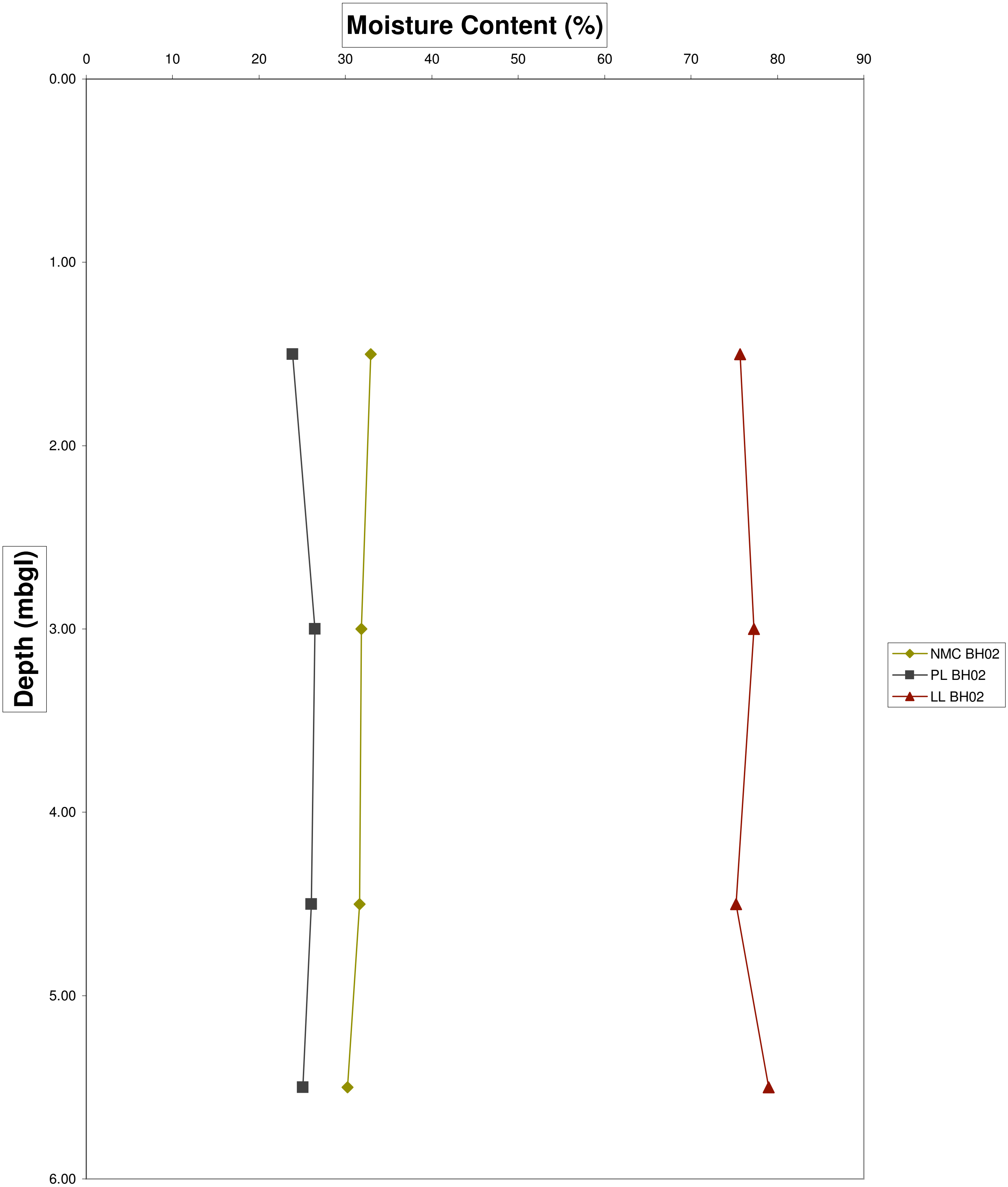


48 ELSWORTHY ROAD 11/2405



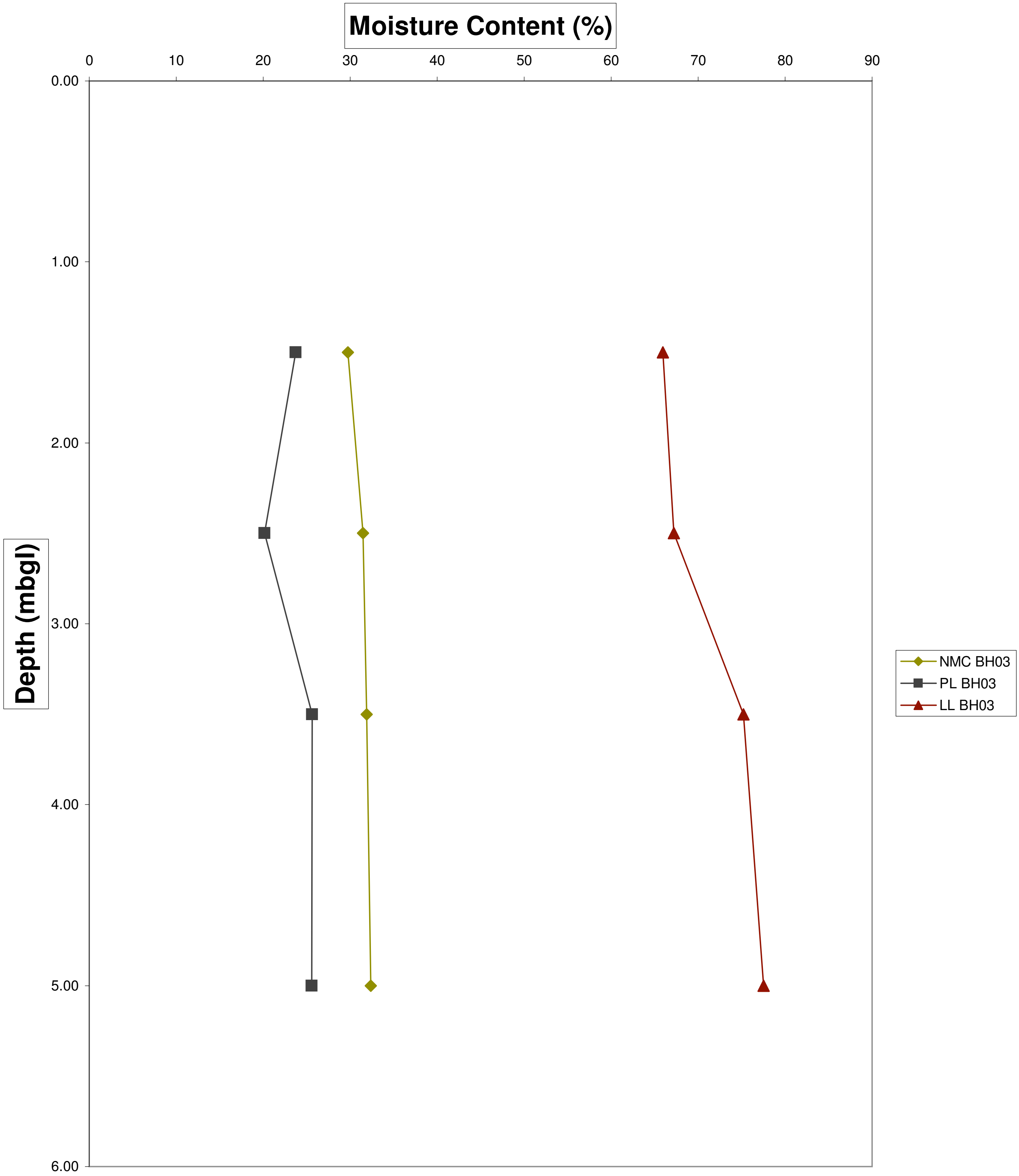
CONCEPT SITE INVESTIGATION
11/2405

FIGURE 3a: MOISTURE CONTENT AND ATTERBERG LIMITS
48 ELSWORTHY ROAD



CONCEPT SITE INVESTIGATION
11/2405

FIGURE 3b: MOISTURE CONTENT AND ATTERBERG LIMITS
48 ELSWORTHY ROAD



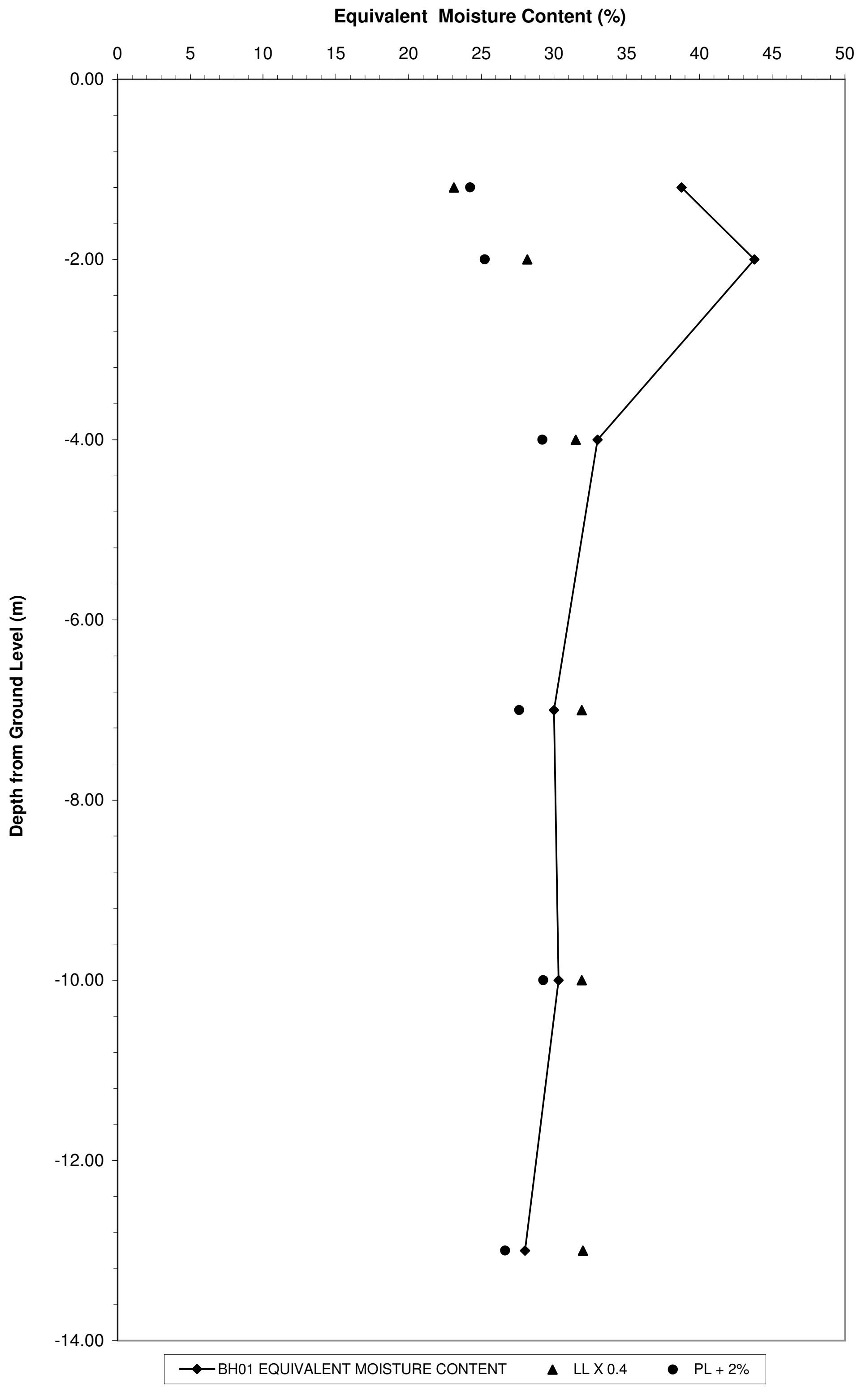
CONCEPT SITE INVESTIGATIONS
11/2405

FIGURE 3c: MOISTURE CONTENT AND ATTERBERG LIMITS
48 ELSWORTHY ROAD

CONCEPT SITE INVESTIGATIONS

Site Name:	48 Elsworthy Road, London NW3 3BU	**Job No.**	11/2405
Carried out for:	Mr & Mrs Swycher	**Date:**	25/10/11

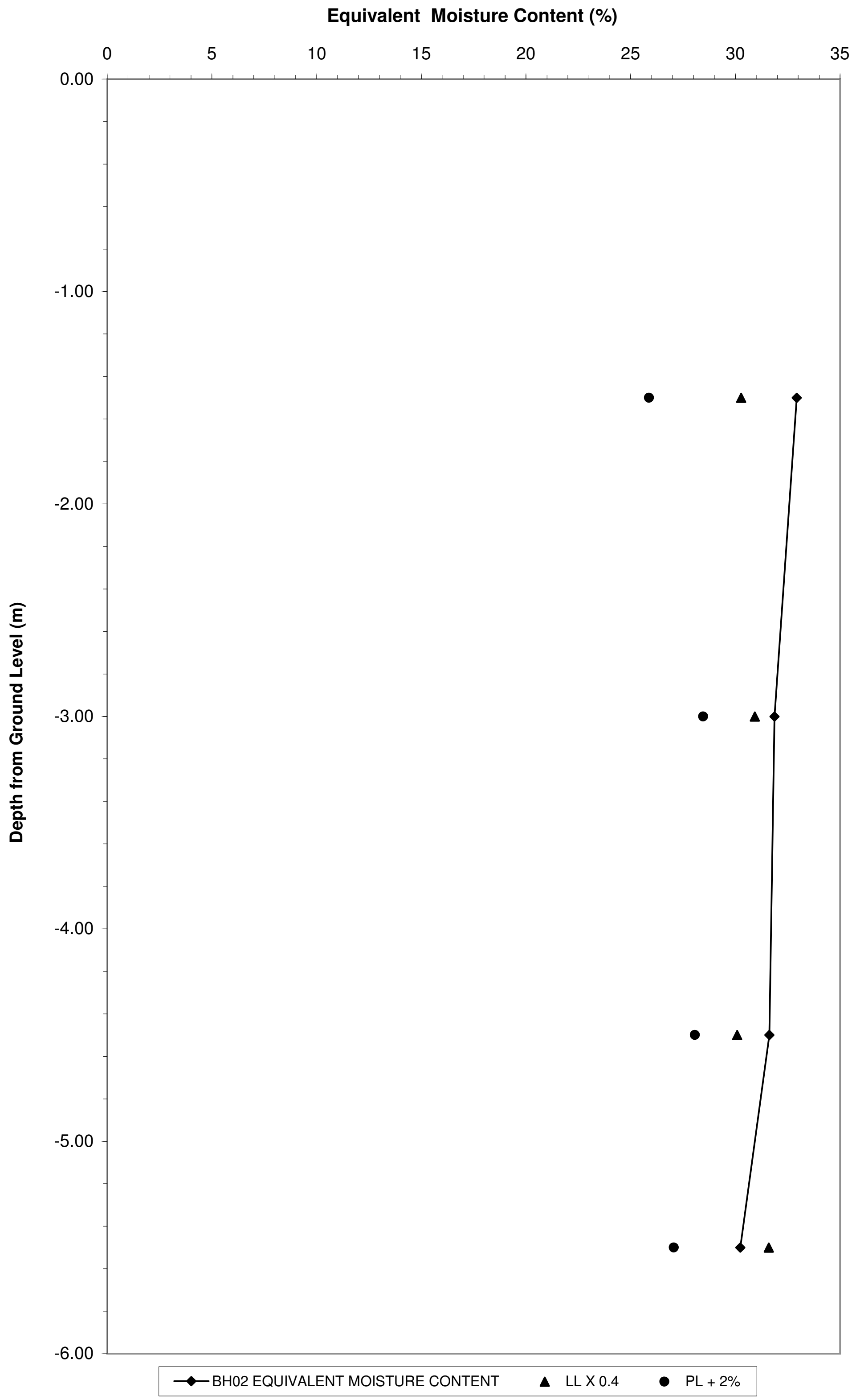
FIGURE 4a: COMPARISON OF EQUIVALENT MOISTURE CONTENT WITH DRISCOLL'S DESICCATION LIMITS - BH01



CONCEPT SITE INVESTIGATIONS

Site Name:	48 Elsworthy Road, London NW3 3BU	**Job No.**	11/2405
Carried out for:	Mr & Mrs Swycher	**Date:**	24/10/11

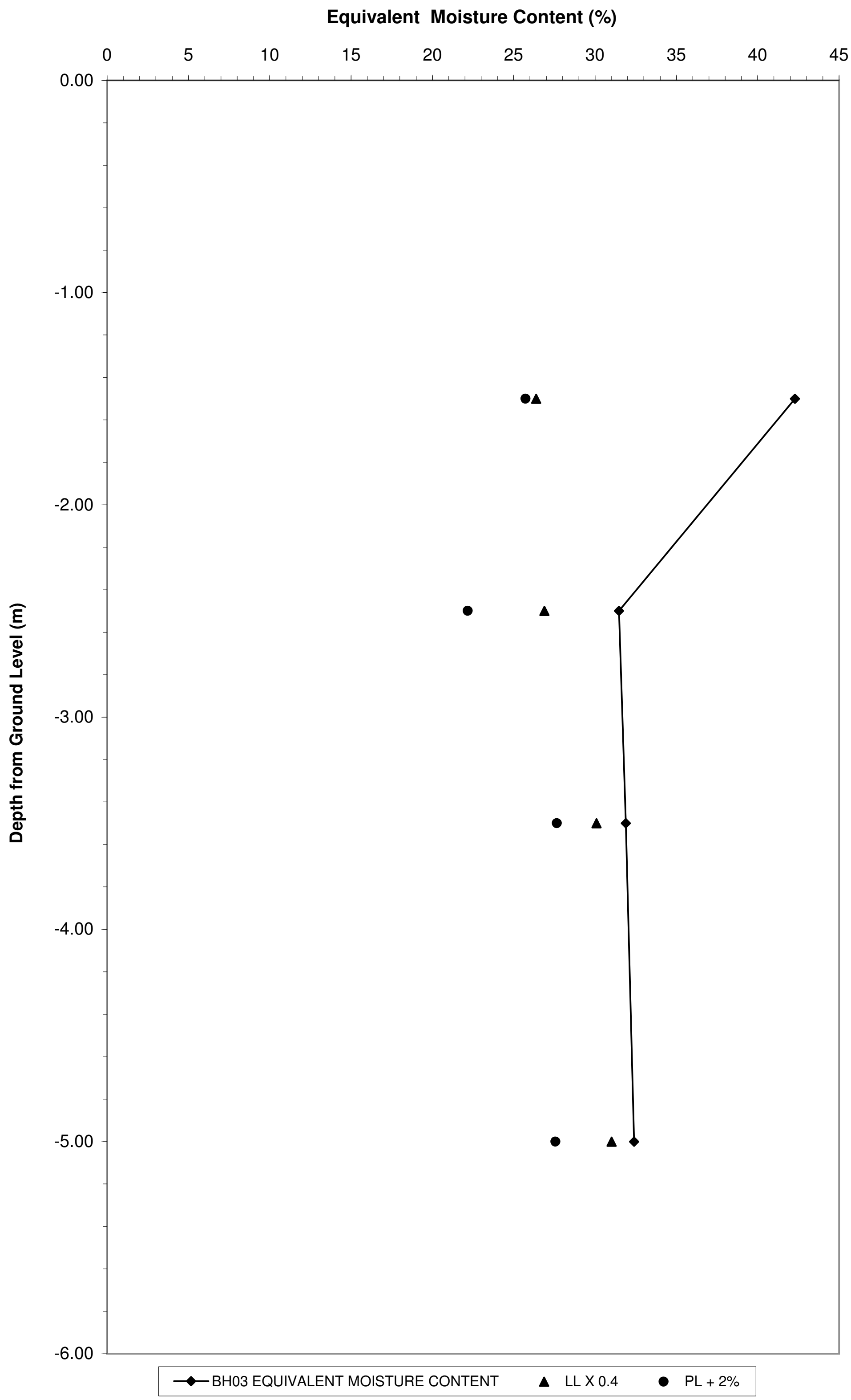
FIGURE 4b: COMPARISON OF EQUIVALENT MOISTURE CONTENT WITH DRISCOLL'S DESICCATION LIMITS - BH02



CONCEPT SITE INVESTIGATIONS

Site Name:	48 Elsworthy Road, London NW3 3BU	**Job No.**	11/2405
Carried out for:	Mr & Mrs Swycher	**Date:**	24/10/11

FIGURE 4c: COMPARISON OF EQUIVALENT MOISTURE CONTENT WITH DRISCOLL'S DESICCATION LIMITS - BH03



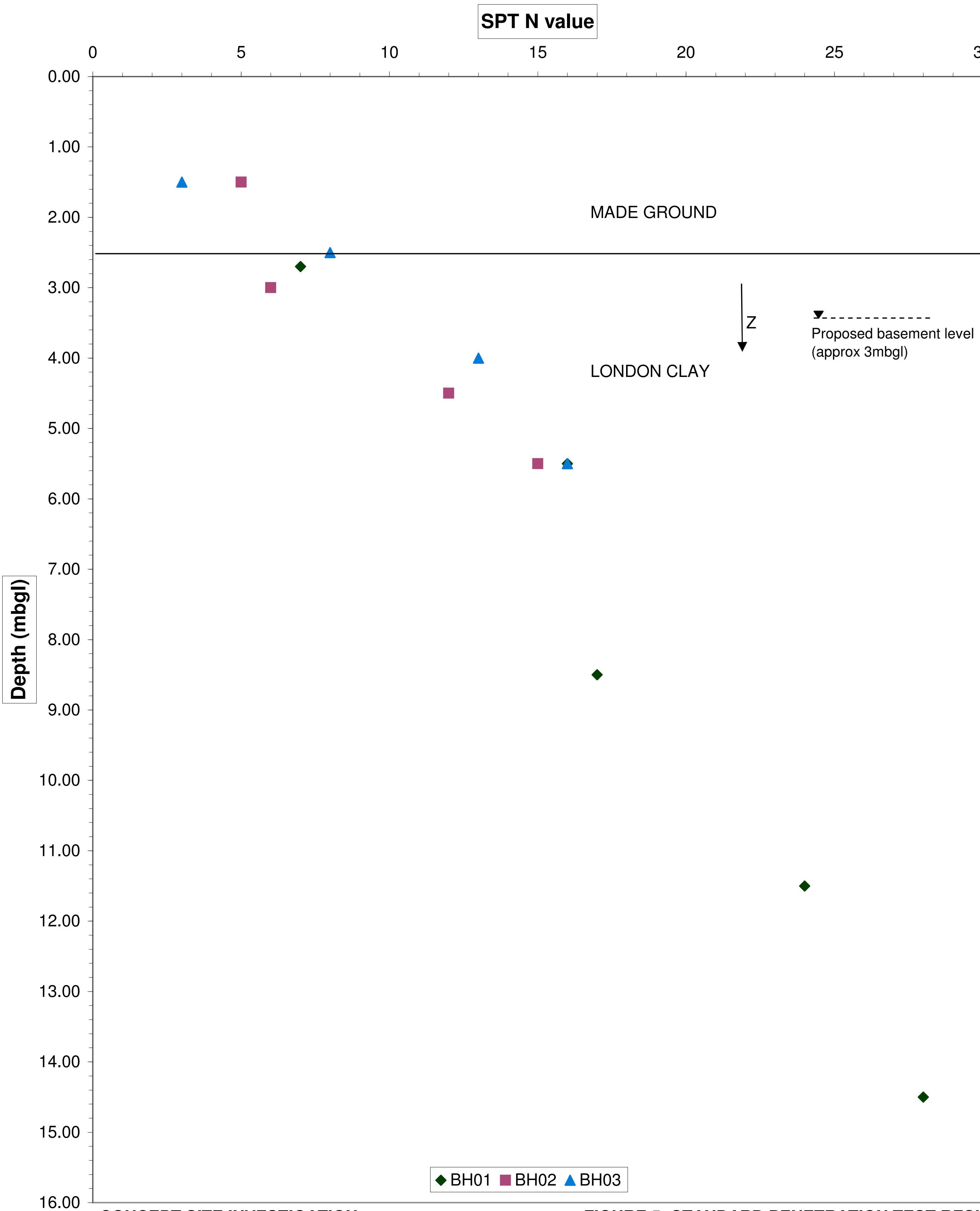


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FIGURE 5: STANDARD PENETRATION TEST RESULTS
48 ELSWORTHY ROAD
MADE GROUND/LONDON CLAY

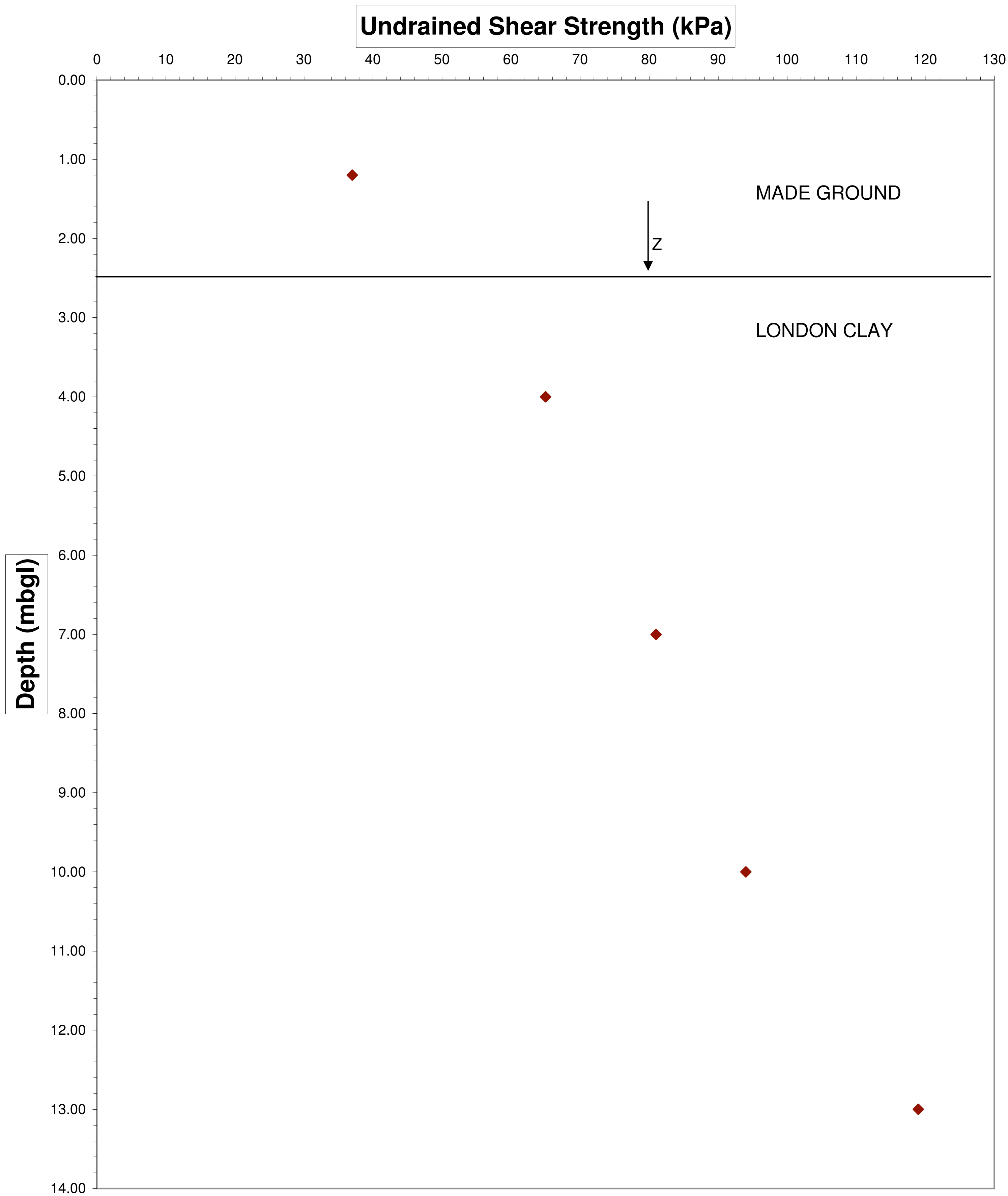

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FIGURE 6: UNDRAINED SHEAR STRENGTH RESULTS BH01
48 ELSWORTHY ROAD
MADE GROUND/LONDON CLAY

APPENDICES