SITE INVESTIGATION AND BASEMENT IMPACT ASSESSMENT REPORT

115 Frognal
London NW3

Client: Mr Paul Crocker

Engineer: Fluid Structures

J16245

May 2017




GEA Geotechnical & Environmental Associates

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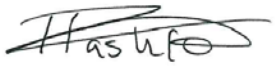
Report prepared by			
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	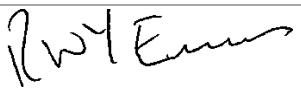		
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1	Final	Final	23 December 2016	
2	Final	Updated BIA and revised GMA	17 May 2017	
3	Final	Updated GMA with revised scheme	22 May 2017	

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This report is intended as a Ground Investigation Report (GIR) as defined in BS EN1997-2, unless specifically noted otherwise. The report is not a Geotechnical Design Report (GDR) as defined in EN1997-2 and recommendations made within this report are for guidance only.

CONTENTS

Part 3: GROUND MOVEMENT ANALYSIS

EXECUTIVE SUMMARY

This executive summary contains an overview of the key findings and conclusions. No reliance should be placed on any part of the executive summary until the whole of the report has been read. Other sections of the report may contain information that puts into context the findings that are summarised in the executive summary.

BRIEF

This report describes the findings of a site investigation carried out by by Geotechnical and Environmental Associates Limited (GEA) on the instructions of Fluid Structures, on behalf of Mr Paul Crocker, with respect to the construction of a new two-storey house with a partial single level basement. The purpose of the investigation has been to research the history of the site with respect to possible contaminative uses, to determine the ground conditions and hydrogeology, to assess the extent of any contamination and to provide information to assist with the design of the basement structure and suitable foundations for the proposed development. The report also includes information required to comply with London Borough of Camden (LBC) Planning Guidance CPG4, relating to the requirement for a Basement Impact Assessment (BIA). A ground movement assessment has also been carried out to provide an indication of the likely impact of the proposed development on adjoining structures. The proposed scheme has been slightly revised since the issue of the original report and the report has therefore been reviewed and updated to reflect the new proposals.

SITE HISTORY

The earliest map studied, dated 1871, indicates that the site was already developed with what appears to be five buildings. By the time of the 1896 map, these buildings had been demolished and replaced by two adjoining buildings, labelled as a lodge. Between 1954 and 1966, the lodge was demolished and replaced by the existing house and garage along the eastern elevation. By 1974, two extensions had been constructed along the western and eastern elevations and the site has remained essentially unchanged to the present day.

GROUND CONDITIONS

The investigation has confirmed the expected ground conditions, in that, beneath a moderate thickness of topsoil and / or made ground, extending to a maximum depth of about 1.20 m, soils of the Bagshot Formation were encountered, overlying the Claygate Member. The Bagshot Formation was found to extend to a depth of 11.70 m (40.25 m TBM) and initially comprised an upper horizon of firm or stiff light brown mottled orange-brown and light grey silty sandy clay, overlying medium dense clayey silty fine sand, interbedded with firm or stiff silty sandy clay, overlying medium dense silty fine sand with occasional pockets of clay. The Claygate Member comprised an upper weathered horizon of firm becoming stiff brown silty sandy clay, extending to a depth of 12.20 m (39.75 m TBM), overlying stiff, locally firm from water softening grey silty sandy clay, proved to the maximum depth investigated of 20.00 m (31.95 m TBM). Desiccated clay soils were encountered within the vicinity of existing trees to depths of between 2.00 m to 3.00 m. Monitoring has measured groundwater at a depth of 8.15 m (43.80 m TBM). Slightly elevated concentrations of lead have been measured in two samples of made ground.

RECOMMENDATIONS

The proposed 2.50 m to 3.00 m deep basement below the eastern part of the site will have a formation level at roughly 49 m TBM, above the measured water table by about 5 m within the loose silty sand or firm silty sandy clay of the Bagshot Formation. Significant groundwater inflows are not anticipated. It is understood that the proposed new house will be supported on piles and the basement excavation will be supported by a contiguous bored piled wall, which should provide suitable .

Additional contamination testing is recommended once levels have been finalised to ensure the absence of any significant contamination within the new garden areas.

BASEMENT IMPACT ASSESSMENT

The BIA has not indicated any concerns with regard to the effects of the proposed basement on the site and surrounding area. It has been concluded that the impacts identified can be mitigated by appropriate design and standard construction practice. The Ground Movement Analysis has predicted that damage to the neighbouring properties will be ‘negligible’ which falls within acceptable limits.

Part 1: INVESTIGATION REPORT

This section of the report details the objectives of the investigation, the work that has been carried out to meet these objectives and the results of the investigation. Interpretation of the findings is presented in Part 2 and an assessment of ground movements arising as a result of the proposed development is presented in Part 3.

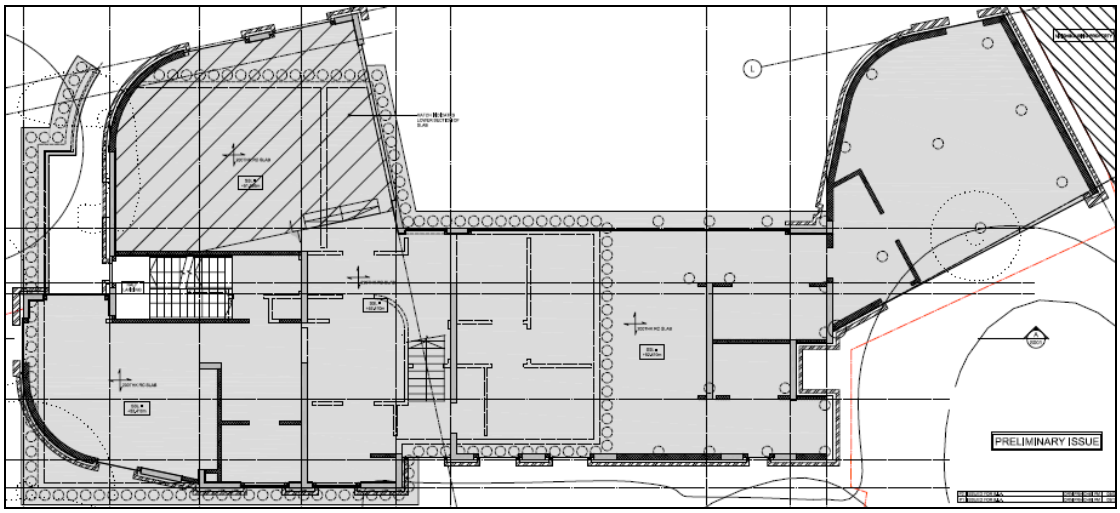
1.0 INTRODUCTION

Geotechnical and Environmental Associates (GEA) has been commissioned by Fluid Structures, on behalf of Mr Paul Crocker, to carry out a desk study and ground investigation at 115 Frognal, London, NW3 6XR. This report also forms part of a Basement Impact Assessment (BIA), which has been carried out in accordance with guidelines from the London Borough of Camden in support of a planning application. In addition, a ground movement analysis and building damage assessment has been completed.

1.1 Proposed Development

Since completion of the original GEA ground investigation in 2016, the proposed extent of the basement excavation has increased. The rest of the proposal remains the same in that the existing building is to be demolished and replaced by a new two-storey house with a single level basement beneath the eastern half of the house. The basement will extend to a depth of 3.00 m, roughly 49 m TBM.

This report is specific to the proposed development and the advice herein should be reviewed if the proposals are amended.



1.2 Purpose of Work

The principal technical objectives of the work carried out were as follows:

- to check the history of the site and surrounding areas with respect to previous contaminative uses;
- to determine the ground conditions and their engineering properties;
- to determine the configuration of existing foundations;
- to assess the impact of the proposed basement on the local hydrogeology, hydrology and stability of the surrounding natural and built environment;
- to provide advice with respect to the design of suitable foundations and retaining walls;
- to assess the ground movements caused by excavation of the proposed basement and the level of damage to the surrounding structures;
- to provide an indication of the degree of soil contamination present; and
- to assess the risk that any such contamination may pose to the proposed development, its users or the wider environment.

1.3 Scope of Work

In order to meet the above objectives, a desk study was carried out, followed by a ground investigation. The desk study comprised:

- a review of readily available geological maps;
- a review of historical Ordnance Survey (OS) maps; and
- a walkover survey of the site carried out prior to the fieldwork.

In the light of the desk study, an intrusive ground investigation was carried out which comprised, in summary, the following activities:

- a cable percussion borehole advanced to a depth of 20.00 m on the front driveway;
- two open-drive sampler boreholes advanced to depths of 6.45 m in the rear garden;
- installation of three groundwater monitoring standpipes, and four subsequent groundwater monitoring visits, carried out over a period of five weeks;
- two hand dug trial pits excavated to determine the configuration of the foundations of the existing house and garage;
- laboratory testing of selected soil samples for geotechnical purposes and for the presence of contamination;
- a ground movement analysis and building damage assessment; and
- provision of a report presenting and interpreting the above data, together with our advice and recommendations with respect to the proposed development.

The report includes a contaminated land assessment which has been undertaken in accordance with the methodology presented in Contaminated Land Report (CLR) 11[1] and involves identifying, making decisions on, and taking appropriate action to deal with, land contamination in a way that is consistent with government policies and legislation within the United Kingdom. The risk assessment is thus divided into three stages comprising Preliminary Risk Assessment, Generic Quantitative Risk Assessment, and Site-Specific Risk Assessment.

The exploratory methods adopted in this investigation have been selected on the basis of the constraints of the site including but not limited to access and space limitations, together with any budgetary or timing constraints. Where it has not been possible to reasonably use an EC7 compliant investigation technique a practical alternative has been adopted to obtain indicative soil parameters and any interpretation is based upon engineering experience, local precedent where applicable and relevant published information.

1.3.1 Basement Impact Assessment

The work carried out also includes a Hydrological and Hydrogeological Assessment and Land Stability Assessment (also referred to as Slope Stability Assessment), all of which form part of the BIA procedure specified in the London Borough of Camden (LBC) Planning Guidance CPG4[2] and their Guidance for Subterranean Development[3] prepared by Arup ('the Arup Report'). The aim of the work is to provide information on surface water, groundwater and land stability and in particular to assess whether the development will affect neighbouring properties or groundwater movements and whether any identified impacts can be appropriately mitigated by the design of the development.

1.3.2 Qualifications

The land stability element of the Basement Impact Assessment (BIA) has been carried out by Martin Cooper, a BEng in Civil Engineering, a chartered engineer (CEng), member of the Institution of Civil Engineers (MICE), and Fellow of the Geological Society (FGS) who has over 25 years' specialist experience in ground engineering. The subterranean (groundwater) flow assessment has been carried out by John Evans, MSc in Hydrogeology, Chartered Geologist (CGeol) and Fellow of the Geological Society of London (FGS). The surface water and flooding assessment has been carried out by Rupert Evans, a hydrologist with more than ten years' consultancy experience in flood risk assessment, surface water drainage schemes and hydrology / hydraulic modelling. Rupert Evans is a Chartered Environmentalist, Chartered Water and Environmental Manager and a Member of CIWEM.

The assessments have been made in conjunction with Steve Branch, a BSc in Engineering Geology and Geotechnics, MSc in Geotechnical Engineering, a Chartered Geologist (CGeol) and Fellow of the Geological Society (FGS) with over 30 years' experience in geotechnical engineering and engineering geology.

All assessors meet the qualification requirements of the Council guidance.

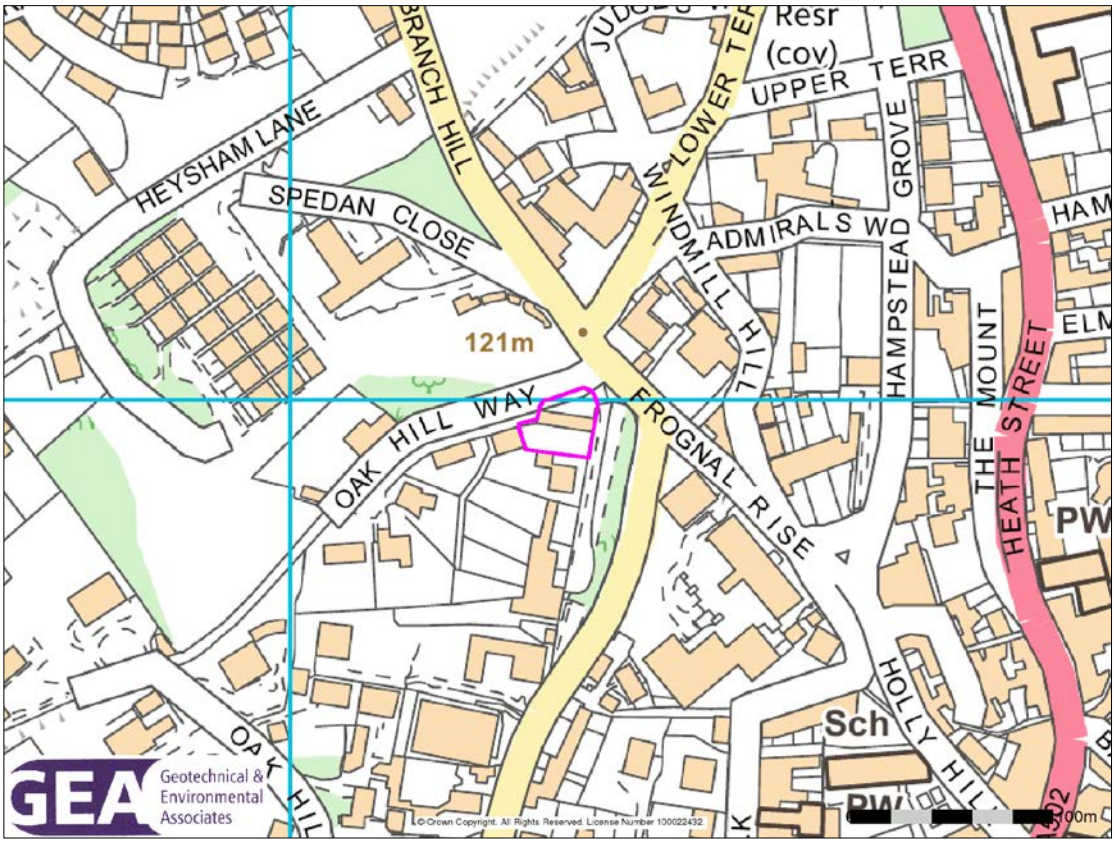
1 *Model Procedures for the Management of Land Contamination* issued jointly by the Environment Agency and the Department for Environment, Food and Rural Affairs (DEFRA) Sept 2004
2 London Borough of Camden Planning Guidance CPG4 *Basements and lightwells*
3 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

1.4 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted, the number of locations where the ground was sampled and the number of soil, gas or groundwater samples tested; no liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by GEA.

2.0 THE SITE

2.1 Site Description



The site is located approximately 350 m to the west of Hampstead London Underground Station, and fronts onto Oak Hill Way to the north. It is bounded to the east by a private access road, which runs parallel to Frognal and is bordered to the south by 113 Frognal, a two-storey detached house with at least one level of basement and to the west by private garages. The site may be additionally located by National Grid Reference 526130, 185990 and is shown on the map extract above.

The local topography slopes down in easterly and southerly directions and the site is on a number of levels. The site is currently occupied by a detached two-storey brick house, with an adjoining single storey garage and single storey building, known as the garden room, located along the eastern elevation of the main house, with another garden located along the western elevation.


Front of house


Rear of house


Rear garden, looking west


Rear garden, looking east


Eastern boundary of site

The front garden slopes up in a southerly direction to the house from 50.73 m TBM to 52.00 m TBM over a distance of roughly 10 m. The existing house is located on a relatively level plot at approximately 52 m TBM. The rear garden can be accessed externally through a gate located at the western end of the site and comprises two levels at roughly 52.00 m TBM and 51.85 m TBM. A paved area is present along the southern elevation of the house, with steps leading down to a central lawn with planted borders, predominantly comprising shrubs and bushes.

A tank used for the storage of heating oil is present in the eastern end of the garden. There are no signs of any leakage on the ground.

A couple of apple trees are present in the rear garden, along with other species and two lime trees are present in the front garden at each end of the site and are the subject of tree preservation orders.

2.2 Site History

The site history has been researched by reference to internet sources and historical Ordnance Survey (OS) maps obtained from the Envirocheck.

The earliest map studied, dated 1871, indicates that the site was already developed with what appears to be five buildings. A tributary of the River Westbourne was shown 200 m to the west of the site. By the time of the 1896 map, the tributary is no longer shown and the

buildings on site had been demolished and replaced by two adjoining buildings, labelled as a lodge. On the 1915 map, three trees were shown surrounding the lodge, but were not shown on the subsequent map, dated 1934. Between 1954 and 1966, the lodge was demolished and replaced by the existing house and garage along the eastern elevation. The neighbouring garages to the west were also constructed during this period. At some time between 1970 and 1974, two extensions were constructed, along the western and eastern elevations. The site has remained essentially unchanged to the present day.

2.3 Other Information

A search of public registers and databases has been made via the Envirocheck database and relevant extracts from the search are appended. Full results of the search can be provided if required.

The desk study research indicated that there are no registered landfills, historic landfills, registered waste transfer sites, waste management facilities or recorded pollution incidents within 500 m of the site. In addition, there has been no recorded pollution incidents within 500 m of the site.

Reference to records compiled by the Health Protection Agency (formerly the National Radiological Protection Board) indicates that the site falls within an area where less than 1% of homes are affected by radon emissions and therefore radon protective measures will not be necessary.

The site is not located within a Nitrate Vulnerable Zone or any other sensitive land uses, although the site is located in the Hampstead Conservation Area.

There are no listed fuel stations within 1 km of the site or contemporary trade directory entries within 240 m of the site.

There are no London Underground Tunnels or Network Rail tunnels located within 50 m of the site.

Reference to bomb damage map (Sheet 27) does not indicate any bomb damage to the site or immediate surrounding area.

A tree survey report has been undertaken for the site by Patrick Shileman Ltd on 20 April 2016 and 8 October 2016 (report references DS23031601 and DS23031601).

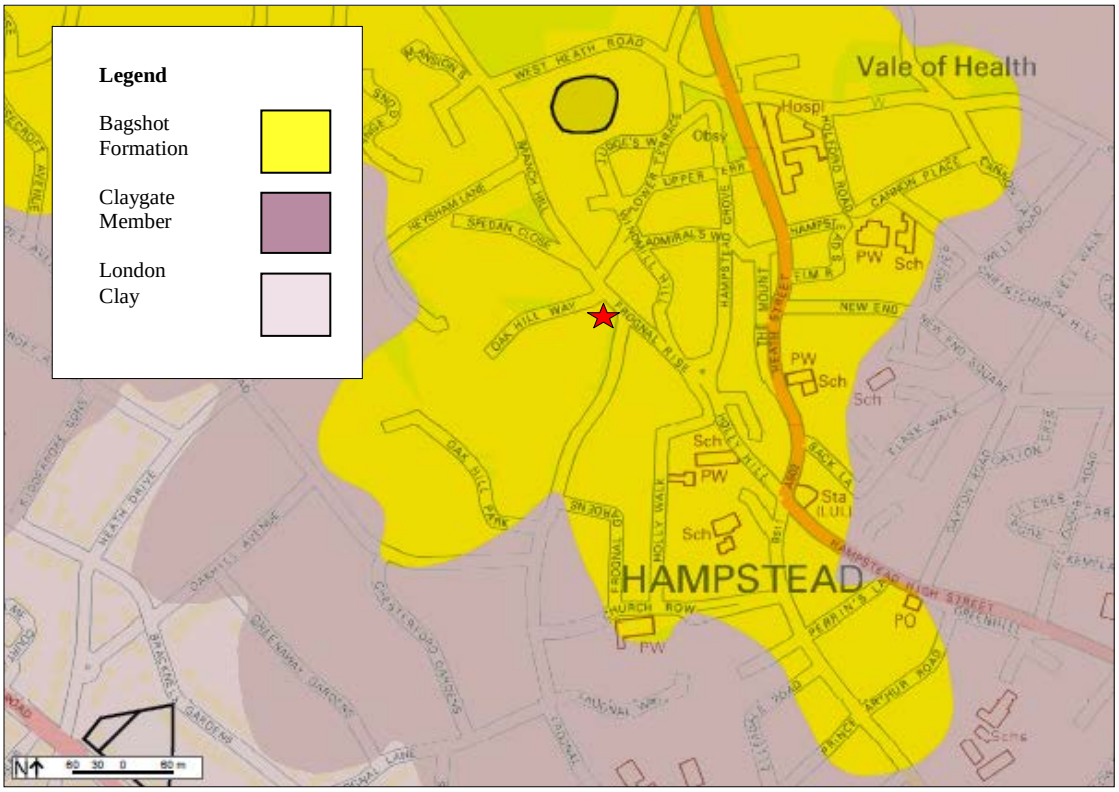
A search of the Camden online planning portal indicates that a planning application (reference 2016/5380/P) was submitted to the council on 4 October 2016 for erection of a two-storey, 4-bed dwelling house following demolition of existing dwelling house, and associated landscaping works. The application has yet to be determined. Other applications for the site relate to tree works including reduce the crowns and removing some trees.

At 113 Frognal, planning permission was granted in 2006 (reference 2006/3486/P) for alterations and extensions to the existing single dwelling house including excavation works to enlarge the basement, erection of single storey side extension, erection of a mansard roof with nine dormer windows, alterations to the fenestration on each elevation, a new opening in front of the boundary wall to create a main pedestrian entrance and a loft extension to the garage to form ancillary staff accommodation.

Planning permission was granted in 2015 (reference 2015/5165/P) for demolition of 1 Oak Hill Way and its replacement with a new six bedroom house, which is currently underway and the contiguous bored pile wall had been installed at the time of this investigation.

2.4 Geology

The British Geological Survey (BGS) map of the area (Sheet 256), dated 2006, indicates that the site is underlain by the Bagshot Formation, overlying the Claygate Member of the London Clay Formation, which is in turn underlain by the London Clay Formation. The site is not located within an area of Head Propensity. The boundary between the Claygate Member and the Bagshot Formation is shown to outcrop approximately 240 m to the south of the site. An extract from Findmaps is included below, indicating the location of the site with respect to the geological boundaries.



According to the British Geological Lexicon[4], the Bagshot Formation is "*composed of pale yellow-brown to pale grey or white, locally orange or crimson, fine- to coarse-grained sand that is frequently micaceous and locally clayey, with sparse glauconite and sparse seams of gravel. The sands are commonly cross-bedded but some are laminated. Thin beds and lenses of laminated pale grey to white sandy or silty clay or clay ('pipe-clay') occur sporadically, becoming thicker towards the top of the formation.*"

The Claygate Member "*comprises dark grey clays with sand laminae, passing up into thin alternations of clays, silts and fine-grained sand, with beds of bioturbated silt*". The London Clay Formation is described as "*bioturbated or poorly laminated, blue-grey or grey-brown, slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay. It commonly contains thin courses of carbonate concretions ('cementstone nodules') and disseminated pyrite. It also includes a few thin beds of shells and fine sand partings or pockets of sand, which commonly increase towards the base and towards the top of the formation.*"

[4] http://www.bgs.ac.uk/lexicon

The geology in this area is generally horizontally bedded such that the boundary between the geological formations roughly follows the ground surface contour lines. The existing house is located at a level of approximately 121 m OD. The Bagshot Formation is expected to extend to a level of approximately 115 m OD to 110 m OD in this area and the Claygate Member to levels of roughly between 90 m OD to 85 m OD.

A borehole drilled by the BGS on Hampstead Lane to the north of the site, generally referred to as the 'Hampstead Heath borehole', was advanced to a depth of 66.74 m (61.97 m OD) at National Grid Reference 526455, 186890. The borehole records indicate that the Bagshot Formation extends to a level of 109.71 m OD and penetrated the full thickness of the Claygate Member, which was found to extend to a level of 93.71 m OD.

There are no borehole records available nearby to the site held in the BGS borehole archive. However, GEA has previously carried out a number of investigations relating to basements in the vicinity of the site, on 99A Frognal, 7 Branch Hill, and 4 Frognal Rise.

The ground conditions encountered by GEA immediately to the south of the site at 113 Frognal comprised made ground, overlying fine clayey sand and sandy clay of the Bagshot Formation, proved to the maximum depth investigated of 6.00 m. In the local area, the Bagshot Formation was found to extend to depths of between 2.60 m and 6.80 m (116.92 m OD and 113.78 m OD).

A copy of the Basement Impact Assessment for No 1 Oak Hill Way is also available on the Camden planning portal. At this site, the Bagshot Formation comprised a variable sequence of interbedded layers of firm orange-brown sandy silty clay and clayey sand extending to 15 m (approximately 107 m OD.). The underlying Claygate Member comprised very stiff dark grey sandy silty clay, proved to a depth of 20 m (about 102 m OD).

2.5 Hydrology and Hydrogeology

The Bagshot Formation and the Claygate Member are designated by the Environment Agency (EA) as Secondary 'A' Aquifers, which refers to permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. The underlying London Clay is classified as unproductive strata.

The site is not located within a designated Groundwater Source Protection Zone (SPZs) and there are no Environment Agency registered water abstraction points within 1 km of the site. The nearest surface water feature is Whitestone Pond located 299 m northeast of the site.

The site lies outside the catchment of the Hampstead Heath chain of ponds.

Groundwater is likely to be present within the Bagshot Formation and the Claygate Member. Spring lines are present at the interface of the Bagshot Formation and the Claygate Member, and to a much lesser extent at a lower level at the boundary between the Claygate Member and the underlying essentially impermeable London Clay. These springs have been the source of a number of London's "lost" rivers, notably the Fleet, Westbourne and Tyburn, which all rose on Hampstead Heath.

Groundwater was measured in the standpipes at depths of between 9.30 m and 10.50 m (110.22 m OD and 108.68 m OD) at 99A Frognal. At 113 Frognal, a seepage of groundwater was observed in Borehole No 1 during drilling at a depth of 2.75 m, but the remaining boreholes were dry. Groundwater monitoring standpipes were installed in Borehole Nos 1 and 2 to a depth of 6.0 m and subsequent monitoring revealed both standpipes to be dry three weeks after installation.

At 1 Oak Hill Way, LBH Wembley encountered groundwater during the investigation at a level of 116 m OD and subsequent monitoring measured groundwater at a level of 112.5 m OD.

Reference to the Lost Rivers of London[5] indicates that a tributary of the River Westbourne flowed 200 m to the west of the site and two further tributaries of the River Westbourne rose 440 m south of the site. The River Westbourne ran from Hampstead Heath, through Kilburn and Paddington, across Hyde Park to the Thames at Chelsea. It is understood that the Westbourne is now covered and culverted and forms part of the surface water sewerage system.

Infiltration of rain water into the ground beneath the site is limited to the areas of soft landscaping in the front and rear garden.

The site is not at risk of flooding from rivers or sea, or by reservoirs as defined by the Environment Agency. However, the Environment Agency website6 shows that the site may have a low risk of surface water flooding. Frognal is not listed as a street that flooded in 1975 or 2002 flood events, according to the report of the floods published by Camden in June 2003.

2.6 Preliminary Risk Assessment

Part IIA of the Environmental Protection Act 1990, which was inserted into that Act by Section 57 of the Environment Act 1995, provides the main regulatory regime for the identification and remediation of contaminated land. The determination of contaminated sites is based on a "suitable for use" approach which involves managing the risks posed by contaminated land by making risk-based decisions. This risk assessment is carried out on the basis of a source-pathway-receptor approach.

2.6.1 Source

The desk study research has indicated that the site was already developed by 1871 with five buildings, of unknown but presumably residential use. Between 1871 and 1896, the site had been redeveloped and two buildings occupied the site by this time, labelled as Lodge. The site was redeveloped again some time from 1954 and 1966 and replaced with the existing house, which has occupied the site since this time

The site is not considered to have had a contaminative history. However, as with any previously developed site, localised areas of contamination may be present.

A heating oil tank is present at the rear of the house along its eastern boundary. The tank is located on soft ground but no spillages or leaks were noted on the surface.

Demolition of the previous buildings on the site is likely to have resulted in the presence of a moderate thickness of made ground. This would mostly be inert rubble, but is likely to include small quantities of contaminants such as lead, present in paintwork, and other metals.

There are no historical or existing landfill sites within 500 m of the site and made ground associated with demolition of the house previously present on the site is likely to be predominantly inert demolition rubble without a potential for soil gas generation. No infilled ponds have been identified within the immediate vicinity of the site.

5 Nicholas Barton and Stephen Myers (2016) *London's Lost Rivers. Revised Edition.* Historical Publications Ltd
6 *http://apps.environment-agency.gov.uk/wiyby/default.aspx*

2.6.2 Receptor

The continued use of the site for residential purposes represents a relatively high sensitivity end-use and end users are considered to be sensitive receptors. Buried services are likely to come into contact with any contaminants present within the soils through which they pass and site workers are likely to come into direct contact with any contaminants present in the soil and through inhalation of vapours during basement excavation and construction.

The site is underlain by Secondary 'A' Aquifer and therefore groundwater and adjacent sites should be considered moderately sensitive receptors. The presence of an Unproductive Stratum beneath the secondary aquifers means that the chalk aquifer at depth represents a relatively low sensitivity receptor.

2.6.3 Pathway

The largely granular Bagshot Formation will allow the migration of any contaminated groundwater through the shallow soils to surrounding sites. The presence of negligibly permeable London Clay beneath the Claygate Member will however limit the potential for groundwater percolation into the underlying chalk, and thus a pathway is not considered likely to exist to the major aquifer.

Within the site, end users will be largely isolated from direct contact with any contaminants present within the made ground by the presence of the building and the extent of the hardstanding. However, in proposed areas of soft landscaping potential contaminant exposure pathways exist with respect to end users.

Except for the pathway of direct contact for site workers, no new pathways will be created by the basement excavation and services will come into contact with any contamination within the soils in which they are laid.

There is thus considered to be limited potential for a significant contaminant pathway to be present between any potential contaminant source and a target for the particular contaminant beneath the new building and extent of any hardstanding and a moderate potential exists within any proposed soft landscaped or garden areas.

2.6.4 Preliminary Risk Appraisal

On the basis of the above it is considered that there is a LOW risk of there being a significant contaminant linkage at this site, which would result in a requirement for major remediation work. Furthermore, there is not considered to be a significant potential for hazardous soil gas to be present on or migrating towards the site; there should thus be no need to consider soil gas exclusion systems.

3.0 SCREENING

The London Borough of Camden guidance suggests that any development proposal that includes a subterranean basement should be screened to determine whether or not a full Basement Impact Assessment (BIA) required.

3.1 Screening Assessment

A number of screening tools are included in the Arup report and for the purposes of this report reference has been made to Appendix E which includes a series of questions within a screening flowchart for three categories; groundwater flow; land stability; and surface water flow. Responses to the questions are tabulated on the following pages.

3.2 Subterranean (groundwater) Screening Assessment

Question	Response for 115 Frognal
1a. Is the site located directly above an aquifer?	*Yes, the site is located above a Secondary 'A' Aquifer as designated by the EA.*
1b. Will the proposed basement extend beneath the water table surface?	Unlikely. From the available data, the proposed basement is likely to be above the water table in the Bagshot Formation.
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	No.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No Figure 14 of the Arup report indicates that the site is not located within this catchment area.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	*Yes. The building footprint will increase by about 70%. This has potential cumulative impact on groundwater resources if no surface water drainage to ground.*
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	No.

The above assessment has identified the following potential issues that need to be assessed:

Q1a The site is above a Secondary 'A' Aquifer.
Q4 There will be a substantial increase in hard surfaced areas.

3.3 Stability Screening Assessment

Question	Response for 115 Frognal
1. Does the existing site include slopes, natural or manmade, greater than 7°?	*Yes. There is one localised area in the front of the driveway where the slope is greater than 7°.*
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No.
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	No. With reference to the Arup report, the site is about 100m to the north of an area with slopes greater than 7°.
5. Is the London Clay the shallowest strata at the site?	No. The underlying soil is indicated as the Bagshot Formation
6. Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	Yes. *It is understood that some trees may be removed for the development.*
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	*Possibly. Soils of the Bagshot Formation are predominantly granular soils and therefore non-shrinkable, although layers of clay may be present that may be prone to volume changes.*
8. Is the site within 100 m of a watercourse or potential spring line?	No. A review of historical maps and Ordnance Survey maps has not revealed any water course of potential spring lines within 100 m.
9. Is the site within an area of previously worked ground?	No. Historical maps do not indicate any evidence of worked ground at the site.

Question	Response for 115 Frognal
10a. Is the site within an aquifer?	*Yes. The site is located above a Secondary 'A' Aquifer as designated by the EA*
10b. Will the proposed basement extend beneath the water table such that dewatering may be required during construction?	Unlikely, based on nearby investigations.
11. Is the site within 50 m of Hampstead Heath ponds?	No. The site is over 500m from the Hampstead Heath ponds.
12. Is the site within 5 m of a highway or pedestrian right of way?	*Yes. The site fronts onto the public highway of Oak Hill Way and a pedestrian right of way for neighbouring properties to the south. The proposed basement will be located in excess of 10 m from Oak Hill Way and 2 m from the private access road to 113 Frognal.*
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Possibly. 113 Frognal had permission granted for a single level basement in October 2006 (planning application 2006/3486/P). It is not known if the basement has yet been constructed. This should be confirmed with Camden or the neighbours, prior to construction.
14. Is the site over (or within the exclusion zone of) any tunnels, eg railway lines?	No.

The above assessment has identified the following potential issues that need to be assessed:

Q1 The site has a localised area with a slope greater than 7 degrees.
Q6 Trees may be felled as part of the development proposals.
Q7 The site is in an area likely to be affected by seasonal shrink-swell.
Q10 The site is located directly above a Secondary 'A' Aquifer.
Q12 The site is located within 5 m of a highway or pedestrian right of way.
Q13 The proposed basement may increase the differential depth of foundations relative to neighbouring properties.

3.4 Surface Flow and Flooding Screening Assessment

Question	Response for 115 Frognal
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No. Figure 14 of the Arup report confirms that the site is not located within this catchment area.
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	No. Any additional surface water from the increase hardstanding area will be either attenuated and discharged into the Thames Water sewers or infiltrated to ensure the surface water flow regime will be unchanged. The basement will largely be beneath the building footprint and therefore the 1m distance between the roof of the basement and ground surface as recommended by the Arup report and para 2.16 of the CPG4 does not apply across these areas. However, as the basement and development will also extend into parts of the site that are currently permeable, these parts (namely the rear garden) will have a distance between the roof/floor slab of the basement and ground surface of less than 1m. It is considered that the use of SUDS will mitigate any impact by not meeting the 1m requirement.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	*Yes.* *The basement and new dwelling footprint will cover a larger proportion of the site which is currently permeable (namely across the rear garden).*

Question	Response for 115 Frognal
	SUDS attenuation/infiltration will reduce the impact to acceptable levels.
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	No. Any additional surface water from the increased hardstanding area will be either attenuated and discharged into the Thames Water sewers or infiltrated to ensure the surface water flow regime will be unchanged.
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No. The proposed basement and development is very unlikely to result in any changes to the quality of surface water being received by adjacent properties or downstream watercourses. It is proposed to allow for new SUDS measures to control how water is dealt with from additional hardstanding areas and it will be unpolluted roof water or low pollution hazard land uses draining from the site.
6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk of flooding, for example because the proposed basement is below the static water level or nearby surface water feature?	No. The findings of this BIA together with the Camden Flood Risk Management Strategy dated 2013, and Figures 3iv, 4e, 5a and 5b of the SFRA dated 2014, and Environment Agency online flood maps show that the site has a very low flooding risk from surface water, sewers, reservoirs (and other artificial sources), groundwater and fluvial/tidal watercourses. In accordance with paragraph 5.11 of the CPG a positive pumped device will be installed in the basement in order to further protect the site from sewer flooding. The site is located within the Critical Drainage Area number GROUP3-010, and is in a Local Flood Risk Zone (Frognal Lane), as identified in the Camden SWMP and Updated SFRA Figure 6/Rev 2.

The above assessment has identified the following potential issues that need to be assessed:

Q3 There will be a significant increase in the amount of hardstanding.

4.0 SCOPING AND SITE INVESTIGATION

The purpose of scoping is to assess in more detail the factors to be investigated in the impact assessment. Potential impacts are assessed for each of the identified potential impact factors.

The potential impacts of the proposed development on surface flow, flooding and subterranean flow will need to be dealt with in separate assessments, such that the following section focuses on the potential impacts that may have an impact on slope stability.

4.1 Potential Impacts

The following potential impacts have been identified.

Potential Impact	Consequence
The site is underlain by a Secondary 'A' Aquifer.	The site is underlain by the Bagshot Formation, which is classified as a Secondary 'A' Aquifer. This has the potential of being able to support local water supplies as well as forming an important source of base flow for local rivers. There is the potential for the hydrogeological setting to be affected by a

Potential Impact	Consequence
	basement development.
Increase in proportion of hard-standing and paved areas.	Less soft covering for surface water infiltration and thus potential for a cumulative impact on groundwater recharge.
The existing site includes limited areas where the slopes are greater than 7°.	The proposed development could lead to slope instability in the surrounding area. Low permeability clay layers within the Bagshot Formation may lead to perched water tables which can affect slope stability.
Trees will be felled as part of the proposals.	Heave of the clay soils resulting in structural damage to the buildings.
Seasonal shrink-swell.	If a new basement is not dug to below the depth likely to be affected by tree roots this could lead to damaging differential movement between the subject site and adjoining properties.
Site is within 5 m of a highway or pedestrian right of way.	Excavation of a basement may result in structural damage to the road or footway.
Founding depths relative to neighbours.	If not designed and constructed appropriately, the excavation of a basement may result in structural damage to neighbouring buildings and structures.

These potential impacts have been investigated through the site investigation, as detailed in Section 10.

4.2 Exploratory Work

In view of the limited access to the rear of the site and in order to meet the objectives described in Section 1.2 and to assess the potential impacts identified in the screening exercise of the BIA, a single cable percussion borehole was advanced to a depth of 20.00 m, by means of a standard cable percussion drilling rig on the front driveway. In addition, a further two boreholes were drilled to depths of 6.45 m, using an open-drive percussive sampler to provide additional coverage of the site. Standard Penetration Tests (SPTs) were carried out at regular intervals in the boreholes to provide quantitative data on the strength of soils encountered.

Groundwater monitoring standpipes were installed in three boreholes, with two pipes installed to a depth of 6.00 m and the third standpipe to a depth of 12.00 m. The standpipes have been monitored on three occasions to date, over a period of roughly five weeks.
Two trial pits were manually excavated to provide information on the existing foundations of the house and garage.

All of the above work was carried out under the supervision of a geotechnical engineer from GEA.

A selection of the samples recovered from the boreholes and trial pits were submitted to a soil mechanics laboratory for a programme of geotechnical testing and an analytical laboratory for a programme of contamination testing.

The borehole and trial pit records and results of the laboratory analyses are appended, together with a site plan indicating the exploratory positions. The Temporary Bench Mark (TBM) levels shown on the borehole and trial pit records have been interpolated from spot heights shown on a site survey drawing by Greenhatch Group (reference 2366a_01_p rev 0, dated April 2016) which was provided by the consulting engineers. The temporary benchmark levels shown on the drawing were measured relative to a TBM on the corner of Frognal and

Oak Hill Way, which was assigned a level of 50 m OD. This TBM is estimated to be at an Ordnance Datum (OD) level of roughly 119 m OD.

4.3 Sampling Strategy

The scope of the works was specified by the consulting engineers with input from GEA, in order to meet CPG4 requirements. The locations of the boreholes and trial pits were specified by the consulting engineers and positioned on site by GEA in accessible locations, whilst avoiding the areas of known services.

Laboratory geotechnical classification and strength tests were undertaken on samples of the natural soil.

Five samples of the shallow soils were subjected to analysis for a range of common industrial contaminants and contamination indicative parameters. For this investigation the analytical suite for the soil included a range of metals, speciation of total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH), total cyanide and monohydric phenols. The soil samples were selected to provide a general view of the chemical conditions of the soils that are likely to be involved in a human exposure. In addition the five samples of made ground were screened for asbestos as a precautionary measure.

The contamination analyses were carried out at an MCERTs accredited laboratory with the majority of the testing suite accredited to MCERTS standards. Details of the MCERTs accreditation and test methods are included in the Appendix together with the analytical results.

A number of samples recovered from the boreholes were submitted to a geotechnical laboratory for a programme of testing that included moisture content and Atterberg limit tests, Particle Size Distribution tests, undrained triaxial compression tests and soluble sulphate and pH level analysis.

5.0 GROUND CONDITIONS

The Bagshot Formation predominantly comprises sand deposits, whereas the Claygate Member comprises a sequence of clays, silt and fine grained sand. The base of the Bagshot Formation is marked in the Hampstead area by a layer of coarse sand and rounded flint gravel. On the basis of an inspection of the recovered soil, it has been interpreted that the investigation encountered a moderate thickness of topsoil and or made ground, overlying the Bagshot Formation, underlain by the Claygate Member of the London Clay, proved to the maximum depth investigated, of 20.00 m.

5.1 Made Ground / Topsoil

Beneath a grass covering in Borehole Nos 2 and 3, topsoil was encountered to depths of 0.15 m (52.20 m TBM) and 0.28 m (51.53 m OD) comprised of greyish brown gravelly silty sand with rootlets.

Below the topsoil or hardstanding as in Borehole No 1 and Trial Pit Nos 1 and 2, the made ground was found to extend to a maximum depth of 1.20 m (50.73 m TBM). The made ground generally comprised brown gravelly silty sand, except in Borehole No 2, where it comprised brown silty sandy gravelly clay. Extraneous fragments were noted of brick, ash and burnt coal. Fragments of marble were noted in Borehole No 3.

No visual or olfactory evidence of contamination was noted in the made ground, apart from the presence of extraneous material such as burnt coal and ash fragments. Five samples of the made ground have tested for the presence of contamination as a precautionary measure and the results are presented in Section 5.5.

5.2 Bagshot Formation

The base of this formation is marked in the Hampstead area by a layer of coarse sand and rounded flint gravel, but this marker layer was not encountered, so the base of the formation has been interpreted on the basis of an inspection of the recovered soil.

The Bagshot Formation was encountered to the full depth of the open-drive sampler boreholes and was found to extend to a depth of 11.70 m (40.25 m TBM) in the cable percussion borehole. On the basis of the assumed surface OD level, this means that the base of the Bagshot Formation is at 110.25 m OD, which is consistent with other investigations in the area and the elevation expected from the geology map.

This stratum was variable but generally comprised an upper horizon of firm or stiff orange-brown mottled brown, greenish grey and reddish brown silty sandy clay, which extended to depths of 4.80 m (47.15 m TBM), 4.50 m (47.85 m TBM) and 2.50 m (49.31 m TBM), in Borehole Nos 1, 2 and 3, respectively. Flint gravel was encountered in Borehole Nos 1 and 2 within this horizon. In Borehole No 2, a horizon of brown mottled orange-brown and purplish grey silty fine sand was encountered, which extended to a depth of 1.70 m (50.65m TBM), overlying the clay horizon.

Below the upper clay horizon, this stratum generally comprised medium dense brown clayey silty fine sand, interbedded with firm or stiff orange-brown mottled grey silty sandy clay, which extended to a depth of about 8.10 m (43.85 m TBM), overlying medium dense brown mottled orange-brown silty fine sand with occasional pockets of clay, which extended to a depth of 11.70 m (40.25 m TBM).

Rootlets were noted to a maximum depth of 4.80 m.
Suspected desiccated clay soils were encountered in Borehole Nos 1 and 3 during the fieldwork and laboratory testing has confirmed the presence of desiccation. In Borehole No 3 the desiccated clay extended to a depth of 1.50 m and in Borehole No 1 the desiccated clay soils extend to depths of between 2.00 m and 3.00 m.

Laboratory undrained triaxial compression tests were undertaken on a single sample of clay from a depth of 3.00 m and the results indicate the clay of the Bagshot Formation to be of high strength.

Atterberg limit laboratory tests carried out on samples of the clay indicate it to be of medium volume change potential.

These soils were observed to be free of any visual or olfactory evidence of soil contamination.

5.3 Claygate Member

The Claygate Member comprised an upper weathered horizon of firm becoming stiff high strength brown silty sandy clay, extending to a depth of 12.20 m (39.75 m TBM), overlying stiff, locally firm high strength and very high strength grey silty clay, proved to the maximum depth investigated of 20.00 m (31.95 m TBM). The clay is thought to have been water softened locally.

The undrained shear strength generally increases with depth, although slight variations in strength occur, which is considered to be a result of the sandy and very silty zones within the clay leading to disturbance during recovery of the undisturbed samples.

Atterberg limit laboratory tests carried out on samples of the clay indicate it to be of high volume change potential.

These soils were observed to be free of any visual or olfactory evidence of soil contamination.

5.4 Groundwater

Groundwater strikes were encountered during drilling in Borehole No 1 only, at depths of 9.00 m and 16.00 m; in Borehole No 3, the soil was noted to be damp at a depth of 1.60 m. On completion of Borehole No 1, the water level was standing at a depth of 13.50 m.

Monitoring of the standpipes installed in the boreholes has been carried out on four occasions to date, over a period of approximately five weeks, and the results are shown in the table below.

Date	Borehole No	Depth to water (m) [Level (m TBM)]
09/11/2016	1	8.15 [43.80]
	2	Dry to 6.00 [46.35]
	3	Dry to 6.00 [45.81]
22/11/2016	1	Not monitored
	2	Dry to 6.00 [46.35]
	3	Dry to 6.00 [45.81]
29/11/2016	1	8.25 [43.70]
	2	Dry to 6.00 [46.35]
	3	Dry to 6.00 [45.81]
09/12/206	1	Not monitored
	2	Dry to 6.00 [46.35]
	3	Dry to 6.00 [45.81]

5.5 Soil Contamination

The table below sets out the values measured within five samples of made ground analysed; all concentrations are in mg/kg unless otherwise stated.

Determinant	BH1: 0.30 m	BH2: 0.30 m	BH3: 0.20 m	TP1: 0.50 m	TP2: 0.50 m
pH	7.8	6.6	7.3	8.5	8.3

Determinant	BH1: 0.30 m	BH2: 0.30 m	BH3: 0.20 m	TP1: 0.50 m	TP2: 0.50 m
Arsenic	17	20	33	19	18
Cadmium	<0.2	<0.2	0.5	<0.2	<0.2
Chromium	37	39	50	28	30
Copper	18	20	47	34	17
Mercury	<0.3	1.0	2.3	0.6	<0.3
Nickel	8.2	8.1	19	11	6.7
Lead	99	160	**270**	**460**	94
Selenium	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc	37	38	160	96	32
Total Cyanide	<1.0	<1.0	<1.0	<1.0	<1.0
Total Phenols	<1.0	<1.0	<1.0	<1.0	<1.0
Sulphide	<1.0	<1.0	<1.0	<1.0	<1.0
Total PAH	<1.60	<1.60	5.09	<1.60	<1.60
Benzo(a)pyrene	<0.10	<0.10	0.38	<0.10	<0.10
Naphthalene	<0.05	<0.05	<0.05	<0.05	<0.05
TPH C8-C10	<0.10	<0.10	<0.10	<0.10	<0.10
TPH C10-C12	<2.0	<2.0	<2.0	<2.0	<2.0
TPH C12-C16	<4.0	<4.0	<4.0	<4.0	<4.0
TPH C16-C21	<1.0	<1.0	7.0	6.9	<1.0
TPH C21-C35	<1.0	<1.0	13	5.5	<1.0
Total organic carbon %	0.5	0.7	2.1	0.6	0.4
Asbestos	Not detected	Not detected	Not detected	Not detected	Not detected

Note; Figures in bold exceed general screening values.

5.5.1 Generic Quantitative Risk Assessment

The use of a risk-based approach has been adopted to provide an initial screening of the test results to assess the need for subsequent site-specific risk assessments. To this end the table below indicates those contaminants of concern that have values in excess of a generic human health risk based guideline values which are either that of the CLEA[7] Soil Guideline Value where available, or is a Generic Screening Value calculated using the CLEA UK Version 1.06[8] software assuming a residential end use, with plant uptake or is based on the DEFRA Category 4 Screening values[9]. The key generic assumptions for this end use are as follows:

[7] *Updated Technical Background to the CLEA Model (Science Report SC050021/SR3) Jan 2009* and Soil Guideline Value reports for specific contaminants; all DEFRA and Environment Agency.
[8] Contaminated Land Exposure Assessment (CL|EA) Software Version 1.06 Environment Agency 2009
[9] CL:AIRE (2013) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Final Project Report SP1010 and DEFRA (2014) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Policy Companion Document SP1010

- that groundwater will not be a critical risk receptor;
- that the critical receptor for human health will be a young female child aged 0 to six years old;
- that young children will not have prolonged exposure to the site;
- that the exposure duration will be six years;
- that the critical exposure pathways will be direct soil and indoor dust ingestion, consumption of homegrown produce, consumption of soil adhering to homegrown produce, skin contact with soils and dust, and inhalation of dust and vapours; and
- that the building type equates to a two-storey small terraced house.

It is considered that these assumptions are acceptable for this generic assessment of this site, albeit conservative as no new pathways will be introduced.

The tables of generic screening values derived by GEA and an explanation of how each value has been derived are included in the Appendix.

Where contaminant concentrations are measured at concentrations below the generic screening value it is considered that they pose an acceptable level of risk and thus further consideration of these contaminant concentrations is not required. However, where concentrations are measured in excess of these generic screening values there is considered to be a potential that they could pose an unacceptable risk and thus further action will be required which could include;

- additional testing to zone the extent of the contaminated material and thus reduce the uncertainty with regard to its potential risk;
- site specific risk assessment to refine the assessment criteria and allow an assessment to be made as to whether the concentration present would pose an unacceptable risk at this site; or
- soil remediation or risk management to mitigate the risk posed by the contaminant to a degree that it poses an acceptable risk.

The results of the contamination testing have revealed elevated concentrations of lead within two of the five samples of made ground above the generic screening values for a residential end use with plant uptake. All of the other contaminants were found to be below their respective generic guideline value and of generally low concentrations. In addition, the samples of made ground were screened for asbestos and no asbestos was detected within the sample tested. This assessment is based upon the potential for risk to human health, which at this site is considered to be the critical risk receptor.

The significance of the contamination results is considered further in Part 2 of the report.

5.6 Existing Foundations

Two trial pits were excavated to expose the foundations of the existing buildings and the findings are summarised in the table overleaf. Trial pit records and photographs are included within the appendix.

Trial Pit No	Structure	Foundation detail	Bearing Stratum
1	Main house	Brick over concrete Top 0.90 m Base 1.25 m Lateral projection 200 mm	Natural soil. Firm brown mottled orange-brown silty sandy CLAY with rare coarse subangular flint gravel
2	Garden room Section A-A'	Brick over concrete Top 1.08 m Base of footing not proved Lateral projection at least 150 mm	Not proved
	Garage Section B-B'	Brick over concrete Top 0.75 m Base 1.00 m Lateral projection 230 mm	Made Ground

Part 2: DESIGN BASIS REPORT

This section of the report provides an interpretation of the findings detailed in Part 1, in the form of a ground model, and then provides advice and recommendations with respect to the basement excavation and the potential impact on the hydrogeology.

6.0 INTRODUCTION

The proposal is to demolish the existing building and construct a new two-storey house with a single level basement to 3.0 m depth beneath the eastern part of the site footprint,with a formation level at roughly 49.00 m TBM.

It is understood that it is proposed that the basement will be supported by a contiguous bored piled wall and the house will be supported on piles.

7.0 GROUND MODEL

The desk study has revealed that the site has been occupied by a number of buildings prior to being redeveloped with the existing house between 1954 and 1966. On the basis of the fieldwork, the ground conditions at this site can be characterised as follows:

- the investigation encountered a moderate thickness of topsoil / made ground, overlying the Bagshot Formation, underlain by the Claygate Member;
- topsoil was encountered beneath the rear garden, extending to depths of 0.15 m (52.20 m TBM) and 0.28 m (51.53 m OD), comprising greyish brown gravelly silty sand with rootlets;
- below topsoil or hardstanding, made ground was encountered and extended to a maximum depth of 1.20 m (50.75 m TBM);
- the made ground generally comprises brown gravelly silty sand and locally silty sandy gravelly clay with fragments of brick, ash and burnt coal;
- the Bagshot Formation generally comprises an upper horizon of firm or stiff brown mottled orange-brown, greenish grey and reddish brown silty sandy clay, overlying a sequence of medium clayey silty fine sand interbedded with firm or stiff brown silty sandy clay, in turn overlying medium dense silty fine sand with occasional pockets of clay;
- the base of the Bagshot Formation was encountered at a depth of 11.70 m (40.25 m TBM);
- the Claygate Member comprises an upper weathered horizon of firm becoming stiff high strength brown silty sandy clay, extending to a depth of 12.20 m (39.75 m TBM),
- below this depth, stiff, locally water softened high strength and very high strength dark grey silty sandy clay was proved to the maximum depth investigated of 20.00 m (31.95 m TBM);

- rootlets were noted to a maximum depth of 4.80 m and desiccated clay soils have been identified on site, within the vicinity of existing trees, extending to a depth of about 3.00 m;
- the clay of the Bagshot Formation is of medium volume change potential;
- groundwater monitoring has measured groundwater at a depth of 8.15 m (43.80 m TBM; and
- elevated concentrations of lead have been measured within the made ground, within an area where the proposed basement is to be excavated.

8.0 ADVICE AND RECOMMENDATIONS

It may be possible to adopt spread foundations for the new house from ground level and basement level, provided that desiccated and potentially desiccated clay soils are bypassed. Where they span clay and granular material, foundations should be reinforced to protect against differential settlement. Piled foundations would also provide a suitable solution.

Formation level for the proposed single level basement will be within the Bagshot Formation, above the groundwater table by approximately 5.00 m.

Excavations for the proposed basement structure will require temporary support to prevent any excessive ground movements and the stability of neighbouring structures will need to be ensured at all times.

8.1 Basement Construction

8.1.1 Basement Excavation

The proposed single level basement to be constructed beneath the eastern part of the new house will extend to a depth of approximately 3.00 m below existing ground level. Formation level is likely to be within the firm silty sandy clay horizon of the Bagshot Formation at roughly 49 m TBM, which approximately equates to roughly 118 m OD.

The Bagshot Formation has been found to extend to a depth of 11.70 m (40.25 m TBM), such that the Bagshot / Claygate boundary is at approximately 109.25 m OD, similar to elsewhere in the local Hampstead area.

Groundwater has been measured within the deep standpipe to be present towards the base of the Bagshot Formation at a depth of 8.15 m (43.80 m TBM) at approximately 112.60 m OD, which is consistent with the water level of 112.50 m OD measured by LBH Wembley on the neighbouring 1 Oak Hill Way site to the west. As with any basement development it would be prudent to continue groundwater monitoring for as long as possible to determine the extent of seasonal fluctuations.

The proposed 3.00 m deep basement will be located roughly 5.00 m to 5.50 m above the water table within the Bagshot Formation, although it is possible that inflows will be encountered from perched water tables trapped within sand layers between bands of clays in the upper horizon of the Bagshot Formation. Significant groundwater inflows are not however anticipated during basement excavation and should be adequately with through sump pumping.

There are a number of methods by which the sides of the basement excavation could be supported in the temporary and permanent conditions. The choice of wall may be governed to a large extent by whether it is to be incorporated into the permanent works and have a load bearing function.

Consideration may be given to a sheet piled wall as a temporary measure to ensure the stability of the basement walls and overcome the need to protect against any groundwater seepages from the sides of the excavation, prior to the construction of a permanent structure following the completion of the basement excavation. Consideration may need to be given to a "silent" installation method, in view of the neighbouring houses, although the use of water jetting should be avoided in view of the risk of inducing ground movement.

A bored pile wall would be a suitable option for supporting the basement excavation, and would have the benefit of providing support for structural loads in the permanent condition. On the basis of the groundwater observations to date, it should be possible to utilise a contiguous bored pile without the requirement for significant groundwater control, with additional grouting between the piles if necessary. At 1 Oak Hill Way, a contiguous bored piled wall has apparently been installed successfully without the requirement for secondary groundwater control within the single level basement excavation.

The ground movements associated with the basement excavation will depend on the method of excavation and support and the overall stiffness of the basement structure in the temporary condition. Thus, a suitable amount of propping will be required to provide the necessary rigidity. In this respect the timing of the provision of support to the wall will have an important effect on movements. The stability of the excavation and adjacent foundations will need to be ensured at all times. A ground movement analysis and building damage assessment has been undertaken and the results are presented in Section 3 of this report.

8.1.2 Basement Retaining Walls

The following parameters are suggested for the design of the permanent basement retaining walls. It has been assumed that the embedded walls will extend to a depth of roughly 7.50 m (44.5 m TBM).

Stratum	Bulk Density (kg/m^3)	Effective Cohesion (c' – kN/m^2)	Effective Friction Angle (Φ' – degrees)
Made Ground	1700	Zero	20
Bagshot Formation Silty sandy CLAY	1850	Zero	26
Bagshot Formation Clayey silty SAND / SAND	1850	Zero	31

Groundwater has been measured within the deep standpipe on the front driveway at a depth of 8.15 m (43.80 m TBM). Groundwater is not anticipated to be encountered in the proposed basement excavation, which will extend to a depth of 3.00 m and a level of roughly 49.00 m TBM. Monitoring of the standpipe should be continued in order to determine the extent of any seasonal fluctuations.

Provided that a fully effective drainage system can be ensured in order to prevent the build-up of groundwater behind the retaining walls from surface water inflows and periodic seepages within the made ground and Bagshot Formation, it should be possible to design the basement on the basis that water will not collect behind the walls. If an effective drainage system cannot be ensured, then a water level of two-thirds of the basement depth should be assumed. The

advice in BS8102:2009[10] should be followed in this respect and with regard to the provision of suitable waterproofing.

8.1.3 Basement Heave

The proposed construction of the 3.00 m deep excavation will result in an approximate unloading of between 50 kN/m^2 and 60 kN/m^2, which will result in an elastic heave. However, this is unlikely to be significant due to the predominantly granular nature of the material and as a result of the load applied by the new foundations. A detailed analysis of the heave movements has been undertaken and the results are presented in Section 3 of this report.

8.2 Spread Foundations

Proposed loads are anticipated to be light to moderate and typical for this type of development. It should therefore be possible to adopt spread foundations for the proposed new house, provided that all new foundations bypass any made ground and desiccated or potentially desiccated clay soils of the Bagshot Formation.

Where no basement structure is proposed, moderate width strip or pad foundations bearing on the loose silty sand or firm silty sandy clay of the Bagshot Formation should be placed at a minimum depth of 1.25 m, assuming that no restrictions are applied on planting of shrubs in the vicinity of foundations, and that a no planting zone is applied in accordance with Table 4 of NBHC Standards Chapter 4.2 (2014). If trees are excluded within the zone of influence shown in Table 2 of the NHBC guidance, the minimum depth can be reduced to 0.90 m, subject also to the further advice on new tree and shrub planting as detailed in the NHBC guidelines. The foundations may be designed to apply a net allowable bearing pressure of 100 kN/m^2. Where spread foundations are constructed from basement level, an increased net allowable bearing pressure of 140 kN/m^2 may be adopted. These values incorporates an adequate factor of safety against bearing capacity failure and should ensure that settlement remains within normal tolerable limits. The recommended bearing pressure takes account of the variable nature of the soils and any foundations should be nominally reinforced where they span clay and granular material to protect against differential settlement.

Where trees are to be removed the required founding depth should be determined on the basis of the existing tree height if it is less than 50% of the mature height and on the basis of full mature height if the current height is more than 50% of the mature height. Where a tree is to be retained the final mature height should be adopted. Notwithstanding NHBC guidelines, all foundations should extend beyond the zone of desiccation. In this respect it would be prudent to have all foundation excavations inspected by a suitably experienced engineer. Due allowance should be made for future growth of the trees. Medium volume change clay soils should be assumed. The requirement for compressible material alongside foundations should be determined by reference to the NHBC guidelines.

A check should be made on the potential effects of foundation loadings on slopes that are below the foundation level. As an initial check it should be ensured that when a line is drawn at an angle of 45^o from the underside of the new foundation, it does not “exit” a slope face, but further analysis should ideally be carried out once proposed development details are finalised.

If for any reason spread foundations are not considered appropriate, piled foundations would provide a suitable alternative.

10 BS8102 (2009) *Code of practice for protection of below ground structures against water from the ground*

8.3 Basement Raft Foundation

The suitability of a raft foundation will be governed by the net load of the new house, taking into consideration the weight of soil removed by the basement excavation. Further analyses should be carried out once the proposed uniform distributed load is known.

8.4 Piled Foundations

For the ground conditions at this site some form of bored pile is likely to be the most appropriate. A conventional rotary augered pile may be appropriate but consideration will need to be given to the possible instability and water ingress in the Bagshot Formation and Claygate Member. The use of bored piles installed using continuous flight auger (cfa) techniques may therefore be the most appropriate as this would overcome the need for casing.

The following tables of ultimate coefficients may be used for the preliminary design of bored piles, based on the measured SPT and cohesion / depth graph in the appendix. The groundwater table has been assumed to be present at a depth of 8.15 m (43.8 m TBM), within the sand horizon of the Bagshot Formation..

Stratum	Depth (m) (Level m TBM)	kN / m^2
Skin Friction		
Made Ground / Bagshot Formation	All soil above 3.00 (49.00)	Ignore - basement
Bagshot Formation (CLAY α=0.4)	3.00 to 4.80 (49.00 to 47.15)	35
Bagshot Formation –clayey SAND (unsaturated)	4.80 to 8.15 (47.15 to 43.80)	Increasing from 35 to 62
Bagshot Formation SAND (saturated) (ϕ =31)	8.15 to 11.70 (43.80 to 40.25)	Increasing linearly from 62 to 74
Claygate Member (CLAY α=0.4)	11.70 to 20.00 (40.25 to 31.95)	Increasing linearly from 44 to 60
End Bearing		
Claygate Member	11.70 to 20.00 (40.25 to 31.95)	Increasing linearly from 990 to 1350

In the asbsence of pile tests, a factor of safety of 3.0 should be adopted for piles in the Bagshot Formation and Claygate Member. On the basis of the above coefficients and a factor of safety of 3.0, the following pile capacities have been estimated.

Pile Diameter mm	Pile length (m below basement level)	Safe Working Load (kN)
450	13	330
600	11	405

The above examples are not intended to constitute any form of recommendation with regard to pile size or type, but merely serve to illustrate the use of the above coefficients. Specialist piling contractors should be consulted with regard to the design of an appropriate piling

scheme and their attention should be drawn to potential groundwater inflows within the Bagshot Formation and Claygate Member.

In the design of piled foundations the effect of potential future shrinkage and swelling of the clay should be taken into account. In designing for compressive loads it should be assumed that further desiccation, and hence shrinkage of the clay, could continue where trees are to remain. Pile shaft adhesion within the theoretical maximum future desiccated thickness should therefore be ignored.

Consideration will also need to be given to the effects of heave as a result of the basement excavation.

8.5 Basement and Ground Floor Slabs

Following the excavation of the basement, it is likely that the floor slab for the proposed basement will need to be suspended over a void to accommodate the anticipated heave and any potential uplift forces from groundwater pressures unless the slab can be suitably reinforced to cope with these movements. This should be reviewed once the levels and loads are known.

Where the new house does not include a basement, the ground floor slab will need to be suspended over a void in accordance with NHBC guidelines within the zone of influence of any existing or proposed trees. Outside the zone of influence of trees and following the removal of the made ground and a proof rolling exercise it should be possible to adopt a ground bearing floor slab bearing on the natural soils.

8.6 Shallow Excavations

On the basis of the borehole findings and trial pits, it is considered that shallow excavations for foundations and services that extend through the made ground or Bagshot Formation should remain generally stable in the short term, although some instability may occur.

However, should deeper excavations be considered or if excavations are to remain open for prolonged periods it is recommended that provision be made for battered side slopes or lateral support. Where personnel are required to enter excavations, a risk assessment should be carried out and temporary lateral support or battering of the excavation sides considered in order to comply with normal safety requirements.

Inflows of groundwater into shallow excavations are not generally anticipated although inflows of perched water may occur from within sandy layers of the Bagshot Formation. Any inflows should be suitably controlled by sump pumping.

8.7 Effect of Sulphates

Chemical analyses carried out on eight samples including six sample of made ground and two samples of Bagshot Formation.

The results for the made ground have revealed concentrations of soluble sulphate and pH in accordance with Class DS-1 to DS-3. The measured pH value of the samples show that an ACEC class of AC-1, AC-2 and AC-2Z and AC-3. This assumes a static water condition at the site.

On the natural soils, Class DS-1 would be appropriate and the PH concentration is slightly acidic and an ACEC class of AC-3Z would be appropriate The guidelines contained in the above digest should be followed in the design of foundation concrete.

8.8 Site Specific Risk Assessment

The desk study research has indicated that the site has not had a potentially contaminative history, having been occupied by a number of buildings, assumed to have been of residential use, prior to being redeveloped with the existing house between 1954 and 1966. It is not unusual to find some elevated determinants within the made ground in residential gardens of properties in London. However, these rarely lead to a requirement for significant remediation.

The results of the contamination testing have revealed elevated concentrations of lead within two of the five samples of made ground at concentrations of 270 mg/kg and 460 mg/kg, above the generic screening values for a residential end use with plant uptake of 200 mg/kg. The source of the lead contamination is likely to be fragments of metal, paint, ash and coal dust.

No other concentrations of contaminants were measured above the generic risk based screening values for a residential end use with plant uptake.

The lead compounds are considered to be non-volatile or of a low volatility and of a low solubility and they do not thus present a significant vapour risk or a significant risk of leaching and migration within groundwater. These contaminants could, however, pose an unacceptable risk to human health through direct contact, accidental ingestion or inhalation of soil or soil derived dust.

End users will be effectively isolated from direct contact with the identified contaminants by the extent of the new house and areas of external hardstanding. Only in proposed garden areas could end users conceivably come into direct contact with the contaminated soils, although this pathway is already in existence. The elevated lead concentrations were measured in Borehole No 3 at a depth of 0.20 m and Trial Pit No 1 at a depth of 0.50 m. At both of these locations the made ground will be removed for the excavation of the basement beneath the eastern part of the site.

As only a limited number of samples have been tested, it would be prudent to carry out contamination testing on additional samples of made ground / topsoil recovered from the areas of the site that are to remain as soft landscaped gardens, in order to ensure the absence of any significant contamination.

Site workers will be protected from the contamination through adherence to normal high standards of site safety.

8.8.1 Site Workers

Site workers should be made aware of the contamination and a programme of working should be identified to protect workers handling any soil. The method of site working should be in accordance with guidelines set out by HSE[11] and CIRIA[12] and the requirements of the Local Authority Environmental Health Officer.

11 HSE (1992) HS(G)66 *Protection of workers and the general public during the development of contaminated land* HMSO

12 CIRIA (1996) *A guide for safe working on contaminated sites* Report 132, Construction Industry Research and Information Association

8.9 Waste Disposal

Under the European Waste Directive, waste is classified as being either Hazardous or Non-Hazardous and landfills receiving waste are classified as accepting hazardous or non-hazardous wastes or the non-hazardous sub-category of inert waste in accordance with the Waste Directive. Waste classification is a staged process and this investigation represents the preliminary sampling exercise of that process. Once the extent and location of the waste that is to be removed has been defined, further sampling and testing may be necessary. The results from this ground investigation should be used to help define the sampling plan for such further testing, which could include WAC leaching tests where the totals analysis indicates the soil to be a hazardous waste or inert waste from a contaminated site. It should however be noted that the Environment Agency guidance WM3[13] states that landfill WAC analysis, specifically leaching test results, must not be used for waste classification purposes.

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE[14] guidance, will need to be disposed of to a licensed tip. Waste going to landfill is subject to landfill tax at either the standard rate of £86.10 per tonne (about £150 per m^3) or at the lower rate of £2.70 per tonne (roughly £5 per m^3). However, the classifications for tax purposes and disposal purposes differ and currently all made ground and topsoil is taxable at the 'standard' rate and only naturally occurring soil and stones, which are accurately described as such in terms of the 2011 Order, would qualify for the 'lower rate' of landfill tax.

Based upon on the technical guidance provided by the Environment Agency it is considered likely that the soils encountered during this ground investigation, as represented by the five chemical analyses carried out, would be generally classified as follows;

Soil Type	Waste Classification (Waste Code)	WAC Testing Required Prior to Landfill Disposal?	Comments
Made ground	Non-hazardous (17 05 04)	No	-
Bagshot Formation	Inert (17 05 04)	Should not be required but confirm with receiving landfill	-
Claygate Member	Inert (17 05 04)	Should not be required but confirm with receiving landfill	-

Under the requirements of the European Waste Directive all waste needs to be pre-treated prior to disposal. The pre-treatment process must be physical, thermal, chemical or biological, including sorting. It must change the characteristics of the waste in order to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment but they will need to provide documentation to prove that this has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a position paper[15] which states that in certain circumstances, segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be segregated onsite prior to excavation by sufficiently characterising the soils insitu prior to excavation.

13 Environment Agency 2015. *Guidance on the classification and assessment of waste.* Technical Guidance WM3 First Edition
14 CL:AIRE March 2011. *The Definition of Waste: Development Industry Code of Practice* Version 2
15 Environment Agency 23 Oct 2007 *Regulatory Position Statement Treating non-hazardous waste for landfill - Enforcing the new requirement*

The above opinion with regard to the classification of the excavated soils is provided for guidance only and should be confirmed by the receiving landfill once the soils to be discarded have been identified.

The local waste regulation department of the Environment Agency (EA) should be contacted to obtain details of tips that are licensed to accept the soil represented by the test results. The tips will be able to provide costs for disposing of this material but may require further testing.

9.0 BASEMENT IMPACT ASSESSMENT

The screening identified a number of potential impacts. The desk study and ground investigation information has been used below to review the potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

The table below summarises the previously identified potential impacts and the additional information that is now available from the site investigation in consideration of each impact.

The current development proposal includes the demolition of the existing house and construction of a new detached house with a single level basement below part of the site.

The site investigation indicates that the site is underlain by a moderate thickness of made ground, directly overlying the Bagshot Formation to a depth of 11.70 m, in turn overlying the Claygate Member, proved to the maximum depth investigated of 20 m.

The proposed basement is unlikely to have any significant effect on groundwater levels as it is 5 m above the water table within the Bagshot Formation, such that the groundwater flow regime beneath the site will be unaffected by the basement excavation and construction.

Potential Impact	Site Investigation Conclusions
The site is underlain by a Secondary 'A' Aquifer.	Both the Bagshot Formation and Claygate Member are classified as Secondary 'A' Aquifers. The proposed 3.00 m deep basement beneath the eastern part of the new detached house will have a formation level within the Bagshot Formation, roughly 5 m above the water table . As such the proposed basement will not change the local groundwater regime.
Increase in proportion of hard-standing and paved areas.	The proposed development for the site will increase the amount of hard-standing and paved areas by about 70%. Consideration may need to be given to permeable paving to mitigate a potential loss of groundwater recharge.
The existing site includes limited areas where the slopes are greater than 7°.	The slope angle of the driveway has been estimated to be 8°. Slopes of 8° or greater are indicated in the Arup report to be potentially unstable, but this is based on the properties of the Claygate Member. Where sand is present, a higher critical slope angle may be adopted. The proposed basement will not cut into the slope at the front of the site in any case and there are currently no signs of failure or movement and thus slope stability is not considered to be an issue.
Trees may be felled as part of the proposals.	Removal of trees may result in long term swelling of clay. Foundations will need to bypass the zone affected by tree root activity, but this should be confirmed once proposals and founding levels are finalised. A check will also need to undertaken to ensure that the removal of any trees on site is not within the zone of influence of neighbouring structures.

Potential Impact	Site Investigation Conclusions
Seasonal shrink-swell.	Tests on the sandy silty clay of the Bagshot Formation have indicated a medium volume change potential. Shrinkable clay is present within a depth that can be affected by tree roots and desiccation of the clay soils was noted and should be bypassed when constructing new foundations. New foundations will however need to be designed in accordance with NHBC guidelines to protect from future shrinking and swelling associated with tree removal / growth. Subject to inspection of foundation excavations in the normal way.
Site is within 5 m of a highway or pedestrian right of way.	The investigation has not indicated any specific problems, such as weak or unstable ground, voids or a high water table that would make working within 5 m of public infrastructure particularly problematic at this site. The actual basement excavations are in any case over 5 m from Oak Hill Way.
Founding depths relative to neighbours.	The site is currently occupied by a detached house and the foundations comprise concrete strip footings founded at a depth of 1.25 m on natural soils of the Bagshot Formation. The neighbouring garages to the west are likely to have shallow strip footings. GEA's investigation in 2006 at No 113 Frognal to the south of the site found the northern elevation of the house to comprise concrete footings bearing on clayey fine sand at a depth of about 0.6 m. It is understood that permission was granted for a basement in 2006 and foundation depths may now be greater for this property and extend to a depth of roughly 3 m below ground level.

The results of the site investigation have been used below to review the remaining potential impacts, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

The site is underlain by a Secondary 'A' Aquifer but will not extend below water table

The investigation has indicated that the site is directly underlain by the Bagshot Formation, with the Claygate Member present at depth. Both strata are classified as Secondary 'A' Aquifers.

The measured groundwater table is approximately 5 m below the level of the proposed basement excavation. There will therefore be adequate space for water to flow beneath the existing basement and between neighbouring structures, such that there will not be a cumulative impact on any groundwater flow.

On the basis of all of the above, it is still concluded that the proposed development will not have an impact on the hydrogeological setting.

There will be an increase in the proportion of hardstanding

The proposals will increase the amount of hardstanding by 70% and some mitigation measures may be required, such as permeable paving.

The site includes slopes of greater than 7°

The site is underlain by the Bagshot Formation, which generally comprises an initial layer of clay, overlying clayey sand, in turn overlying sand and at depth clay of the Claygate Member.

The proposed new house will sit on an essentially level plot, although there is roughly 0.5 m difference in ground level in the northern and southern half of the basement excavation. At the front of the site is a slope, which is 8° but the new proposal will not cut into the existing slope. At the time of the investigation there were no visual signs of movement of the slope.

The basement excavation will be sat within the initial clay horizon and it is possible that there will be some instability during basement excavation. The basement construction will be suitably shored in the short term and suitably designed to retain and support the soils in the long term.

Felling of trees – heave of clay soils

Removal of trees may result in long term swelling of upper clay horizon. However the foundations of the basement will extend beyond the zone of tree root activity, but consideration will need to be given to possible effect on the foundations of neighbouring properties and where no basement is not proposed on the site.

Shrink / swell potential

Shrinkable clay of the Bagshot Formation is present within a depth that can be affected by tree roots. There is no evidence of structural movement within the existing building, but desiccated clay of the Bagshot Formation was noted within the cable percussion borehole, undertaken in close proximity to an existing mature lime tree.

NHBC guidance should be followed to ensure all new foundations extend to a suitable depth and all foundation excavations should be inspected by a suitably qualified geotechnical engineer to ensure foundations have bypassed any desiccated soils.

Site within 5 m of highway

The site is located within 5 m of Oak Hill Way to the north and a private access road to the east. A retention system will need to be adopted that maintains the stability of the excavation at all times to protect the highways. This is however standard construction practice.

Differential founding depths

The property is detached and is set back some distance from neighbouring properties. A ground movement assessment has been completed to determine the damage to the neighbouring properties and the results are presented in Part 3 of this report.

9.1 Non-Technical Summary

This section provides a short summary of the evidence acquired and used to form the conclusions made within the BIA.

9.1.1 Screening

The following table provides the evidence used to answer the surface water flow and flooding screening questions.

Question	Evidence
1. Is the site within the catchment of the pond chains on Hampstead Heath?	Figures 12 and 14 of the Arup report.

Question	Evidence
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	A site walkover and existing plans of the site have confirmed the proportions of hardstanding and soft landscaping, which have been compared to the proposed drawings to determine the changes in the proportions.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	As above.
5. Will the proposed basement result in changes to the quantity of surface water being received by adjacent properties or downstream watercourses?	
6. Is the site in an area known to be at risk from surface water flooding such as South Hampstead, West Hampstead, Gospel Oak and Kings Cross, or is it at risk of flooding because the proposed basement is below the static water level of a nearby surface water feature?	Flood risk maps acquired from the Environment Agency as part of the desk study, Figure 15 of the Arup report, the Camden Flood Risk Management Strategy dated 2013 and the North London Strategic Flood Risk Assessment dated 2008.

The following table provides the evidence used to answer the subterranean (groundwater flow) screening questions.

Question	Evidence
1a. Is the site located directly above an aquifer?	Aquifer designation maps acquired from the Environment Agency as part of the desk study and Figures 3, 5 and 8 of the Arup report.
1b. Will the proposed basement extend beneath the water table surface?	Previous nearby GEA investigations.
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	Historical maps acquired as part of the desk study and Figures 11 and 12 of the Arup report.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	Figures 12 and 14 of the Arup report.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	A site walkover and existing plans of the site have confirmed the proportions of hardstanding and soft landscaping, which have been compared to the proposed drawings to determine the changes in the proportions.
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	The details of the proposed development do not indicate the use soakaway drainage.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	Topographical maps acquired as part of the desk study and Figures 11 and 12 of the Arup report.

The following table provides the evidence used to answer the subterranean (groundwater flow) screening questions.

Question	Evidence
1. Does the existing site include slopes, natural or manmade, greater than 7°?	Site survey drawing and Figures 16 and 17 of the Arup report and confirmed during a site walkover
2. Will the proposed re-profiling of landscaping at the site	The details of the proposed development provided do not

Question	Evidence
change slopes at the property boundary to more than 7°?	include the re-profiling of the site to create new slopes
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	Topographical maps and Figures 16 and 17 of the Arup report and confirmed during a site walkover
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	
5. Is the London Clay the shallowest strata at the site?	Geological maps and Figures 3, 5 and 8 of the Arup report
6. Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	A site walkover confirmed that there are trees on site. An arboriculturist should be consulted if any trees are to be removed from the site.
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	Knowledge on the ground conditions of the area was used to make an assessment of this, in addition to a visual inspection of the buildings carried out during the site walkover
8. Is the site within 100 m of a watercourse or potential spring line?	Topographical maps acquired as part of the desk study and Figures 11 and 12 of the Arup report
9. Is the site within an area of previously worked ground?	Geological maps and Figures 3, 5 and 8 of the Arup report
10. Is the site within an aquifer?	Aquifer designation maps acquired from the Environment Agency as part of the desk study and Figures 3, 5 and 8 of the Arup report.
11. Is the site within 50 m of Hampstead Heath ponds?	Topographical maps acquired as part of the desk study and Figures 12 and 14 of the Arup report.
12. Is the site within 5 m of a highway or pedestrian right of way?	Site plans and the site walkover.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Camden planning portal and the site walkover confirmed the position of the proposed basement relative the neighbouring properties.
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	Maps and plans of infrastructure tunnels were reviewed.

9.1.2 Scoping and Site Investigation

The questions in the screening stage that required further assessment, were taken forward to a scoping stage and the potential impacts discussed in Section 4.0 of this report, with reference to the possible impacts outlined in the Arup report.

A ground investigation was carried out, which has allowed an assessment of the potential impacts of the basement development on the various receptors identified from the screening and scoping stages. Principally the investigation aimed to establish the ground conditions, including the groundwater level, the engineering properties of the underlying soils to enable suitable design of the basement development and the configuration of existing party wall foundations. The findings of the investigation are discussed in Section 5.0 of this report and summarised in both Section 7.0 and the Executive Summary.

9.1.3 Impact Assessment

Section 9.0 of this report summarises whether or not, on the basis of the findings of the investigation, the potential impacts still need to be given consideration and identifies ongoing risks that will require suitable engineering mitigation. Section 8.0 of this report also provides recommendations for the design of the proposed development.

A Ground Movement Analysis including a building damage assessment has been completed and the results are presented in Part 3 of this report.

Part 3: GROUND MOVEMENT ANALYSIS

This section of the report comprises an analysis of the ground movements arising from the proposed basement and foundation scheme discussed in Part 2 and the information obtained from the investigation, presented in Part 1 of the report.

10.0 INTRODUCTION

The sides of a basement excavation will move to some extent regardless of how they are supported. The movement will typically be both horizontal and vertical and will be influenced by the engineering properties of the ground, groundwater level and flow, the efficiency of the various support systems employed during piling and excavation and the efficiency or stiffness of any support structures used.

An analysis has been carried out of the likely movements arising from the proposed basement excavation and the results of this analysis have been used to predict the effect of these movements on surrounding structures.

10.1 Construction Sequence

For the purposes of the ground movement assessment, the datum is taken as the existing ground floor level, at an arbitrary level of zero. It is proposed to construct a basement to 3.0 m depth beneath the eastern part of the site footprint. The proposed basement walls will be formed by means of a contiguous piled wall which it is assumed will be embedded to about 7.5 m below existing ground level.

The following sequence of operations has been assumed to enable analysis of the ground movements around the proposed basement both during and after construction.

In general, the sequence of works for basement construction will comprise the following stages.

1. Construct contiguous piled walls; and

2. excavate new basement and temporarily retain and strengthen, with sufficient propping and walling beams, the new retaining walls. Construct new ground beams.

It is assumed that the corners of the excavation will be supported by cross-bracing or similar and that the new retaining walls will not be cantilevered at any stage during the construction process.

The detail of the support provided to adjacent walls is beyond the scope of this report at this stage and the structural engineer will be best placed to agree a methodology with the underpinning contractor once appointed.

When the final excavation depths have been reached the permanent works will be formed, which are likely to comprise reinforced concrete walls with a drained cavity lining the inside of the contiguous piled wall. Reinforced concrete will be used for the floor slabs and it is anticipated that heave protection may be installed beneath the basement slab. Following this, the floor slab will be constructed at basement depth and the temporary props will be removed.

10.2 Ground Movements

An assessment of ground movements within and surrounding the excavation has been undertaken using the X-Disp and P-Disp computer programs licensed from the OASYS suite of geotechnical modelling software from Arup. These programs are commonly used within the ground engineering industry and are considered to be appropriate tools for this analysis.

The X-Disp program has been used to predict ground movements likely to arise from the construction of the proposed basement. This includes the settlement of the ground (vertical movement) and the lateral movement of soil behind the proposed retaining walls (horizontal movement).

The analysis of potential ground movements within the excavation, as a result of unloading of the underlying soils, has been carried out using the Oasys P-Disp software package and is based on the assumption that the soils behave elastically, which provides a reasonable approximation to soil behaviour at small strains.

For the purpose of these analyses, the corners have been defined by x and y coordinates, with the x-direction being approximately west-east and the y-direction being north-south. Vertical movement is in the z-direction.

It is assumed that suitable propping will be provided during the construction of the basement and in the permanent condition.

The full outputs of all the analyses can be provided on request but samples of the output movement contour plots are included within the appendix

10.3 Ground Movements – Surrounding the Basement

10.3.1 Model Used

For the X-Disp analysis, the soil movement relationships used for the embedded retaining walls are the default values within CIRIA report C580[16], which were derived from a number of historic case studies in clay of the short term movements that result from wall installation and basement excavation, on the basis that the basement excavation will be formed within a predominantly clay horizon.

The analysis has adopted the values for 'installation of a contiguous bored pile wall' when considering the installation of the new retaining walls, which are considered to be the most appropriate due to the likely construction method to be utilised. The toe of the new retaining wall is assumed to be installed to a depth of 7.50 m below existing ground level. The movement curve for 'excavation in front of a high stiffness wall in stiff clay' has been adopted for the excavation phase which is considered the most appropriate given the cohesive nature of the Bagshot Formation for the majority of the retaining wall height.

The magnitudes of ground differential movement predicted by the program have been assessed.

10.3.2 Results

The movements predicted by X-Disp are summarised in the table below; the results are presented below and in subsequent tables to the degree of accuracy required to allow predicted variations in ground movements around the structure to be illustrated, but may not

[16] Gaba, A, Simpson, B, Powrie, W and Beadman, D (2003) *Embedded retaining walls – guidance for economic design* .CIRIA Report C580.

reflect the anticipated accuracy of the predictions.

Phase of Works	Wall Movement (mm)	
	Vertical Settlement	Horizontal Movement
Installation of piled retaining walls	5 to 6	4 to 5
Combined Movements	7 to 8	9 to 10

The analysis has indicated that the maximum vertical and horizontal settlements that will result from wall installation are likely to be approximately 5 mm to 6 mm, whilst the movements arising from the combined piled wall installation and excavation phases are likely to be between 7 mm and 8 mm of vertical settlement immediately outside of the excavation, reducing to about 2 mm to 3 mm approximately 5 m from the edge of the excavation. The maximum horizontal movements are anticipated to be in the order of between 9 mm and 10 mm immediately outside of the excavation, reducing to approximately 3 mm to 4 mm, about 5 m from the edge of the excavation.

The estimated movements are considered to represent a worst case scenario, particularly as the movements resulting from basement excavation will be minimised due to control of the propping in the temporary works. A regime of monitoring should be in place to enable to excavation to be fully controlled.

10.4 Movements within the Excavation (Heave)

10.4.1 Model Used

At this site unloading of the Bagshot Formation will take place as a result of the basement excavation and the reduction in vertical stress will cause heave to take place. Undrained soil parameters have been used to estimate the potential short term movements, which include the "immediate" or elastic movements as a result of the basement excavation. Drained parameters have been used to provide an estimate of the total long-term movement.

As the Bagshot Formation was found to consist predominantly of clay where the proposed basement will be placed and roughly 2 m below the excavation, clayey sand will be encountered to a depth of about 12 m before clay soils of the Claygate Member. Relationships of $E_u = 500\ C_u$ and $E' = 300\ C_u$ have been adopted for the cohesive soils and 2000 x SPT 'N' for granular soils have been used to obtain values of Young's modulus.

The proposed construction of the 3.0 m deep basement will result in an unloading of about 55 kN/m².

The soil parameters used in this assessment are tabulated below.

Stratum	Depth range (m) [Level range mOD]	Eu (MPa)	E' (MPa)
Made Ground	G/L to 1.0	10	6
Bagshot Formation (Clay)	1.0 to 5.0	17	10.2
Bagshot Formation (Sand)	5.0 to 12.0	36	36
Claygate Member (Clay)	12.0 to 36.0	55 to 112.5	33 to 67.5
London Clay*	36.0 to 60.0	165 to 265	99 to 159

**London Clay parameters derived from Burland JB, Standing, JR, and Jardine, FM (2001) Building response to tunnelling, case studies from construction of the Jubilee Line Extension. CIRIA Special Publication 200*

A rigid boundary for the analysis has been set at a depth of 60 m below existing ground level, which is the maximum depth to which the London Clay is indicated in nearby BGS records.

10.4.2 Results

An assessment of ground movements within the basement excavation has been undertaken by GEA using the P-Disp computer program licensed from the OASYS suite of programs from Arup. The predicted movements are summarised in the table below.

Location	Movement (mm)	
	Short-term Heave (Excavation)	Total Heave
Centre of excavations	11 to 12	25 to 26
Edge of excavations	5 to 6	11 to 12
Corner of excavations	5 to 6	11 to 12
At 5 m outside of the edge of excavations	2 to 3	5 to 6

The P-Disp analysis indicates that, by the time the basement construction is complete, up to 12 mm of heave is likely to have taken place within the centre of the excavation, reducing to about 6 mm of heave at the edges. This value is further reduced approximately 5 m away from the excavation where between 2 mm and 3 mm of heave is likely to occur.

An additional 15 mm of long term heave may theoretically occur at the centre of the proposed excavation following construction while an additional 6 mm of heave may occur at the edges of the excavation.

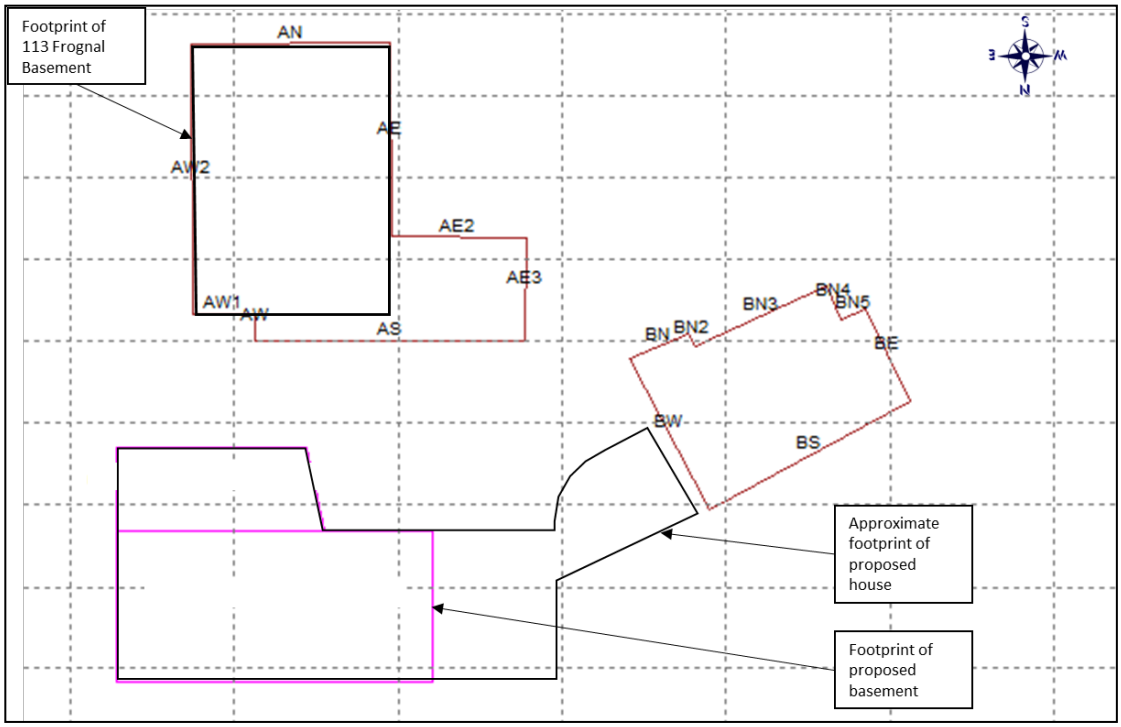
It is understood that it is proposed to design the basement floor slab to be suspended over a void to accommodate the likely heave movements which should be designed in accordance with the overall movements provided in the above table.

11.0 DAMAGE ASSESSMENT

In addition to the above assessment of the likely movements that will result from the proposed development, some of the neighbouring structures have been considered as sensitive structures, requiring Building Damage Assessments, on the basis of the classification given in Table 2.5 of C580 . These include:

- the adjacent property 113 Frognal (Sensitive Structure A) and the 4.0 m high garage (sensitive structure B).

The sensitive structures outlined above have been modelled as lines in the analysis, along which the damage assessment has been undertaken, as shown on the plan overleaf.



Drawing No 200603 C 01 C (dated 06/06), which was supplied by the consulting engineer, shows No 113 Frognal to have a single storey basement beneath the western part of the building footprint. Drawings shown on the council planning database indicate the foundations for the basement to have been excavated to 3.6 m depth. The remaining founding depth of 113 Frognal (Structure A) was determined during a previous investigation conducted by GEA at 0.6 m below ground level. The founding depths for Structure B (single storey garage building) are unknown and have been assumed at 0.5 m depth.

The height of each wall has been estimated from site observations as well as sectional drawings supplied by the consulting engineer.

11.1 Damage to Neighbouring Structures

The combined movements resulting from both pile installation and basement excavation calculated using the X-Disp modelling software have been used to carry out an assessment of the likely damage to adjacent properties and the results are summarised in the table below.

Building Damage Assessment		
Sensitive Structure	**Elevation**	**Category of Damage***
Structure A	AN	0 (Negligible)
	AE	0 (Negligible)
	AE2	0 (Negligible)
	AE3	0 (Negligible)
	AS	0 (Negligible)
	AW	0 (Negligible)
	AW1	0 (Negligible)
	AW2	0 (Negligible)

Building Damage Assessment		
Sensitive Structure	**Elevation**	**Category of Damage***
Structure B	BN	0 (Negligible)
	BN2	0 (Negligible)
	BN3	0 (Negligible)
	BN4	0 (Negligible)
	BN5	0 (Negligible)
	BE	0 (Negligible)
	BS	0 (Negligible)
	BW	0 (Negligible)

**From Table 2.5 of C580: Classification of visible damage to walls.*

The building damage analysis for sensitive structures highlighted in the above table predicts that the damage to the adjoining and nearby structures included in the above analysis would generally be Category 0 (Negligible) which falls within acceptable limits.

11.2 Monitoring of Ground Movements

Given the predicted negligible ground movements it is unlikely that monitoring of the neighbouring properties will be necessary. However, if a monitoring regime is required condition surveys of the above existing structures should be carried out before and after the proposed works. The precise monitoring strategy would be developed at a later stage and it would be subject to discussions and agreements with the owners of the adjacent properties and structures. Contingency measures would be implemented if movements of the adjacent structures exceed predefined trigger levels. Both contingency measures and trigger levels will need to be developed within a future monitoring specification for the works.

12.0 CONCLUSIONS

The analysis has concluded that the predicted damage to the neighbouring properties would generally be between 'negligible' which falls within acceptable limits.

The separate phases of work, including the installation of contiguous bored pile retaining walls and subsequent excavation of the proposed basement, will in practice be separated by a number of weeks. This will provide an opportunity for the ground movements during and immediately after excavation to be measured, and the data acquired can be fed back into the design and compared with the predicted values. Such a comparison will allow the ground model to be reviewed and the predicted wall movements to be reassessed prior to the main excavation taking place so that propping arrangements can be adjusted if required.

13.0 OUTSTANDING RISKS AND ISSUES

This section of the report aims to highlight areas where further work is required as a result of limitations on the scope of this investigation, or where issues have been identified by this investigation that warrant further consideration. The scope of risks and issues discussed in this section is by no means exhaustive, but covers the main areas where additional work is considered to be required.

The ground is a heterogeneous natural material and variations will inevitably arise between the locations at which it is investigated. This report provides an assessment of the ground conditions based on the discrete points at which the ground was sampled, but the ground conditions should be subject to review as the work proceeds to ensure that any variations from the Ground Model are properly assessed by a suitably qualified person.

Further groundwater monitoring should be carried out to confirm longer term groundwater levels.

All new foundations should extend beyond the zone of desiccation. In this respect it would be prudent to have all foundation excavations inspected by a suitably experienced engineer.

If during ground works any visual or olfactory evidence of contamination is identified further investigation should be carried out and the risk assessment reviewed.

Further testing is likely to be required in areas of soft landscaping, once the proposals have been finalised, in order to determine if remediation will be required to protect end users and ensure successful plant growth.

These items should be drawn to the attention of prospective contractors and further investigation will be required or sufficient contingency should be provided to cover the outstanding risk.

APPENDIX

Borehole Records

Trial Pit Records

Geotechnical Laboratory Test Results

SPT & Cu / Depth Plot

Chemical Analysis (Soil)

Generic Risk Based Screening Values

Envirocheck Report Summary

Historical Maps

Site Plan

SOIL DISPLACEMENT MODEL RESULTS

X-DISP ANALYSIS

Wall Installation

Contour Plots of Vertical Movements and Horizontal Movements

Wall Installation and Basement Excavation

Contour Plots of Combined Vertical Movements and Horizontal Movements

P-DISP ANALYSIS

Short Term Movement

Total Movement

Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware,Herts SG12 7QE	**Site** 115 Frognal, London, NW3 6XR	**Borehole Number** **BH1**

Boring Method	**Casing Diameter**	**Ground Level (mTBM)**	**Client**	**Job Number**
Cable Percussion	150mm cased to 13.50m	51.95	Mr Paul Crocker	J16245
	Location	**Dates** 02/11/2016	**Engineer** Fluid Structures	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mTBM)	Depth (m) (Thickness)	Description	Legend	Water
					51.80	(0.15) 0.15	MADE GROUND (paving slab (50 mm thick), overlying concrete)		
0.20	D1				51.65	(0.15) 0.30	MADE GROUND (brownish grey clayey sand with occasional flint gravel, roots, red brick and burnt coal)		
0.60	D2					(0.90)	MADE GROUND (light brown sand with occasional flint gravel, carbonaceous material and rare brick fragments)		
1.00	D3				50.75	1.20			
1.20-1.65	U4						'Stiff' orange-brown mottled greenish grey and reddish brown silty sandy CLAY with occasional fine to coarse subangular to well rounded flint gravel and rare carbonaceous material and rootlets. Roots noted to a depth of 2.00 m. Cobble noted at a depth of 1.20 m. Soil noted to be dry and desiccated		
1.70	D5								
1.90	D6								
2.00-2.45	SPT N60=18	1.50	DRY	3,7/3,4,4,4		(1.80)			
2.00	D7								
2.70	D8								
3.00-3.45	U9				48.95	3.00			
3.50	D10						Firm becoming stiff high strength brown mottled pale grey and orange-brown silty sandy CLAY. At 3.80 m, layer of light brown fine sand with abundant pockets of firm brown clay. Live rootlets noted to a depth of 4.00 m		
3.80	D11					(1.80)			
4.00-4.45	SPT N60=14	1.50	DRY	1,2/2,3,3,4					
4.00	D12								
4.00-4.45	B13								
4.80	D14				47.15	4.80			
5.00-5.45	SPT N60=14	1.50	DRY	3,2/3,3,3,3			Medium dense brown clayey silty fine SAND, interbedded with firm or stiff orange-brown mottled grey silty sandy clay. At 6.00 m, rare medium well rounded flint gravel noted		
5.00	D15								
5.00-5.45	B16								
6.00-6.45	SPT N60=25	1.50	DRY	3,4/4,5,5,7					
6.00	D17								
6.00-6.45	B18					(3.30)			
7.50-7.95	SPT N60=17	1.50	DRY	1,2/3,3,4,4					
7.50	D19								
					43.85	8.10	Medium dense brown mottled orange-brown silty fine SAND with occasional pockets of clay		
9.00	D20			Slow (1) at 9.00m, rose to 8.80m in 20 mins, sealed at 13.50m.				▼1 ▽1	
9.00-9.45	SPT N60=19	1.50	DRY	2,3/4,3,4,5					

Remarks
Hand-dug starter pit to a depth of 1.20 m (75 minutes)
Groundwater not added during drilling
Standpipe installed to a depth of 12.00 m - response zone from 1.20 m to 12.00 m
Groundwater measured at a depth of 8.15 m on 09/11/2016 and 8.25 m on 29/11/2016

Scale (approx)	**Logged By**
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Figure No.
J16245.BH1

Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware,Herts SG12 7QE	**Site** 115 Frognal, London, NW3 6XR	**Borehole Number** **BH1**

Boring Method	**Casing Diameter**	**Ground Level (mTBM)**	**Client**	**Job Number**
Cable Percussion	150mm cased to 13.50m	51.95	Mr Paul Crocker	J16245
	Location	**Dates** 02/11/2016	**Engineer** Fluid Structures	**Sheet** 2/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mTBM)	Depth (m) (Thickness)	Description	Legend	Water
						(3.60)			
10.50-10.95 10.50	SPT N60=23 D21	10.50	10.30	3,4/4,5,5,5					
					40.25	11.70	Firm becoming stiff high strength brown silty sandy CLAY		
						(0.50)			
12.00-12.45	U22				39.75	12.20	Stiff locally firm high strength and very high strength dark grey silty sandy CLAY - locally water softened		
12.50	D23								
13.50-13.95 13.50	SPT N60=22 D24	13.50	DRY	3,4/4,4,5,5					
15.00-15.45	U25								
15.50	D26								▼2
				Slow(2) at 16.00m, rose to 15.80m in 20 mins, not sealed.		(7.80)			▽2
16.50-16.95	U27								
17.00	D28								
18.00-18.45	U29								
18.50	D30								
19.50-19.95 19.50	SPT N60=37 D31	13.50	DRY	4,5/6,7,9,9					
					31.95	20.00			

Remarks

Scale (approx)	**Logged By**
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Figure No.
J16245.BH1

GEA Geotechnical & Environmental Associates Widbury Barn Widbury Hill Ware,Herts SG12 7QE	**Site** 115 Frognal, London, NW3 6XR		**Number** **BH2**
Excavation Method Open-drive sampler	**Dimensions** 118mm to 1.00m	**Ground Level (mTBM)** 52.35	**Client** Mr Paul Crocker	**Job Number** J16245
	Location	**Dates** 31/10/2016	**Engineer** Fluid Structures	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mTBM)	Depth (m) (Thickness)	Description	Legend	Water
				52.20	(0.15) 0.15	TOPSOIL (grass covering, over greyish brown silty sand with rare flint gravel and fine rootlets)		
0.30	D1			51.95	(0.25) 0.40	MADE GROUND (brown mottled orange-brown becoming light brown silty sandy clay with flint gravel, rootlets and fragments of brick and ash)		
0.70	D2					Loose light brown mottled orange-brown with rare purplish sgrey mottling silty fine SAND with rare to occasional fine to medium subrounded to well rounded flint gravel and rare pockets of clay. Rootlets noted throughout and a root was encountered at a depth of 1.70 m		
1.00-1.45 1.00	SPT N60=6 D3	DRY	1,1/1,2,2,1		(1.30)			
1.50	D4			50.65	1.70			
1.70 1.85 2.00-2.45 2.10	D5 D6 SPT N60=11 D7	DRY	2,2/2,3,3,3			Firm light brown mottled orange-brown, light grey, reddish brown and purplish grey silty very sandy CLAY with rare medium to coarse rounded flint gravel. Decayed rootlets noted to a depth of 4.00 m. Live rootlets noted to a depth of 2.40 m		
2.65	D8							
3.00-3.45 3.00 3.20	SPT N60=10 D9 D10	DRY	1,2/2,2,3,3		(2.80)			
3.50	D11							
3.90 4.00-4.45	D12 SPT N60=16	DRY	2,3/4,3,5,4			...becomes stiff		
4.35	D13			47.85	4.50			
4.60	D14					Medium dense light brown silty fine SAND. From a depth of 4.90 m, rare orange-brown mottling and rare pockets of firm purplish grey silty sandy clay was encountered		
4.85 5.00-5.45 5.10	D15 SPT N60=16 D16	DRY	2,2/3,4,4,5		(0.75)			
5.50	D17			47.10	5.25	Stiff brown mottled orange-brown silty sandy CLAY. Between 5.50 m and 5.75 m, very sandy		
6.00-6.45 6.00	SPT N60=19 D18	DRY	2,2/3,4,5,7		(1.20)			
				45.90	6.45	Complete at 6.45m		

Remarks
Borehole recorded to be dry on completion of drilling
Groundwater not encountered during drilling
Hand-dug starter pit
Standpipe installed to a depth of 6.00 m - response zone from 1.00 m to 6.00 m
Standpipe recorded to be dry on 09/11/2016, 22/11/2016, 29/11/2016 and 09/11/2016

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Figure No.
J16245.BH2

GEA Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware,Herts SG12 7QE	**Site** 115 Frognal, London, NW3 6XR	**Number** **BH3**

Excavation Method	**Dimensions**	**Ground Level (mTBM)**	**Client**	**Job Number**
Open-drive sampler	118mm to 1.00m	51.81	Mr Paul Crocker	J16245
	Location	**Dates** 31/10/2016	**Engineer** Fluid Structures	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mTBM)	Depth (m) (Thickness)	Description	Legend	Water
					(0.28)	TOPSOIL (dark brown silty sand with occasional flint gravel, clay pockets and brick fragments. Frequent roots and rootlets noted)		
0.20	D1			51.53	0.28			
0.35	D2				(0.32)			
0.50	D3			51.21	0.60	MADE GROUND (greyish brown mottled reddish brown silty sand with flint gravel, fragments of red and yellow brick, marble, burnt coal, ash and rootlets. Becoming clayey from a depth of 0.40 m)		
0.70	D4							
1.00-1.45	SPT N60=14	DRY	3,2/3,3,4,4		(0.90)			
1.00	D5					'Very stiff' light brown mottled light grey silty sandy CLAY with roots and rootlets. Becomes stiff at a depth of 1.00 m. Soil noted to be dry and possibly desiccated		
1.30	D6			50.31	1.50			
1.60	D7					Firm orange-brown mottled brown silty sandy CLAY with rootlets. Between 1.75 m and 1.80 m, black silty fine sand		
1.70	D8							
1.90	D9				(1.00)			
2.00-2.45	SPT N60=13	DRY	2,1/2,3,4,4					
2.20	D10							
2.50	D11			49.31	2.50	Light brown clayey silty fine SAND		
2.70	D12				(0.70)			
3.00-3.45	SPT N60=13	DRY	2,2/2,3,4,4					
3.30	D13			48.61	3.20	Stiff light brown silty sandy CLAY with rootlets. At a depth of 3.70 m, layer of light grey clay		
					(0.40)			
3.60	D14			48.21	3.60	Orange-brown silty fine SAND. Rootlets noted to a depth of 3.90 m		
					(0.40)			
4.00-4.45	SPT N60=13	DRY	2,2/3,3,3,4	47.81	4.00	Poor recovery between 4.00 m and 5.00 m - soil recovered as stiff light brown mottled orange-brown silty sandy CLAY with pockets of grey clay with rare carbonaceous material		
4.50	D15				(1.00)			
5.00-5.45	SPT N60=15	DRY	2,2/3,4,4,4	46.81	5.00	Medium dense light brown silty fine SAND with rare orange-brown mottling		
5.50	D16				(1.00)			
6.00-6.45	SPT N60=14	DRY	2,2/3,4,3,4	45.81	6.00	Complete at 6.45m		

Remarks
Hand-dug starter pit
Soil noted to be damp at a depth of 1.60 m
Poor recovery between 4.00 m and 5.00 m - reason unknown
Borehole recorded to be dry on completion of hole
Standpipe installed to a depth of 6.00 m - response zone from a depth of 1.00 m to 6.00 m
Standpipe recorded to be dry on 09/11/2016, 22/11/2016, 29/11/2016 and 09/11/2016

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Figure No.
J16245.BH3

GEA Geotechnical & Environmental Associates

Widbury Barn
Widbury Hill
Ware,Herts
SG12 7QE

Standard Penetration Test Results

Site : 115 Frognal, London, NW3 6XR

Client : Mr Paul Crocker

Engineer : Fluid Structures

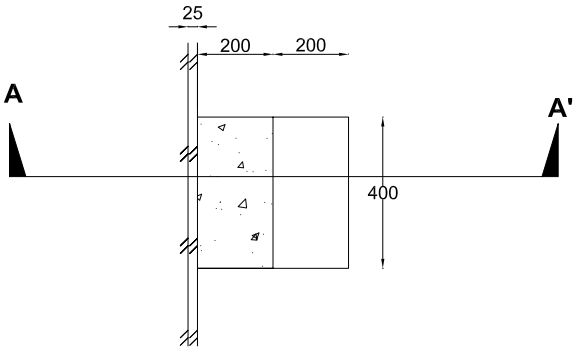
Job Number J16245

Sheet 1 / 1

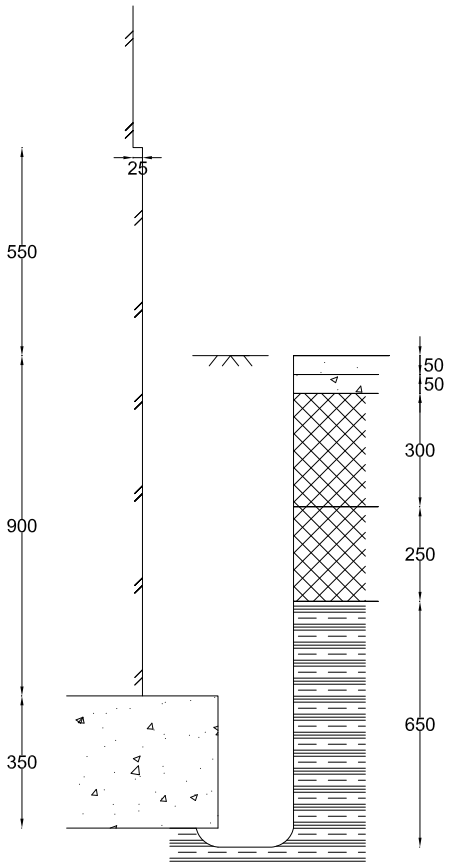
Borehole Number	Base of Borehole (m)	End of Seating Drive (m)	End of Test Drive (m)	Test Type	Seating Blows per 75mm		Blows for each 75mm penetration				Result	Comments
					1	2	1	2	3	4		
BH1	2.00	2.15	2.45	SPT	3	7	3	4	4	4	N60=18	
BH1	4.00	4.15	4.45	SPT	1	2	2	3	3	4	N60=14	
BH1	5.00	5.15	5.45	SPT	3	2	3	3	3	3	N60=14	
BH1	6.00	6.15	6.45	SPT	3	4	4	5	5	7	N60=25	
BH1	7.50	7.65	7.95	SPT	1	2	3	3	4	4	N60=17	
BH1	9.00	9.15	9.45	SPT	2	3	4	3	4	5	N60=19	
BH1	10.50	10.65	10.95	SPT	3	4	4	5	5	5	N60=23	
BH1	13.50	13.65	13.95	SPT	3	4	4	4	5	5	N60=22	
BH1	19.50	19.65	19.95	SPT	4	5	6	7	9	9	N60=37	
BH2	1.00	1.15	1.45	SPT	1	1	1	2	2	1	N60=6	
BH2	2.00	2.15	2.45	SPT	2	2	2	3	3	3	N60=11	
BH2	3.00	3.15	3.45	SPT	1	2	2	2	3	3	N60=10	
BH2	4.00	4.15	4.45	SPT	2	3	4	3	5	4	N60=16	
BH2	5.00	5.15	5.45	SPT	2	2	3	4	4	5	N60=16	
BH2	6.00	6.15	6.45	SPT	2	2	3	4	5	7	N60=19	
BH3	1.00	1.15	1.45	SPT	3	2	3	3	4	4	N60=14	
BH3	2.00	2.15	2.45	SPT	2	1	2	3	4	4	N60=13	
BH3	3.00	3.15	3.45	SPT	2	2	2	3	4	4	N60=13	
BH3	4.00	4.15	4.45	SPT	2	2	3	3	3	4	N60=13	
BH3	5.00	5.15	5.45	SPT	2	2	3	4	4	4	N60=15	
BH3	6.00	6.15	6.45	SPT	2	2	3	4	3	4	N60=14	

GEA Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware Herts SG12 7QE	**Site** 115 Frognal, London, NW3 6XR	**Trial Pit Number** TP1	
Excavation Method Manual	**Dimensions** 425 x 400 x 1300 mm	**Ground Level (m OD)**	**Client** Mr Paul Crocker	**Job Number** J16245
	Location	**Date** 31/10/16	**Engineer** Fluid Structures	**Sheet Number** 1 of 1

Plan



Section A - A'



Paving Slab

CONCRETE

MADE GROUND (black clayey silty sand with frequent roots and rootlets, flint gravel, brick and concrete)

MADE GROUND (brown mottled black sandy clay with rootlets, flint gravel, coal/ash, brick and ceramic fragments)

Firm light brown silty very sandy CLAY with rare coarse sub-angular flint gravel

Proven under by probing

Notes:
Groundwater not encountered

Scale
1 : 20

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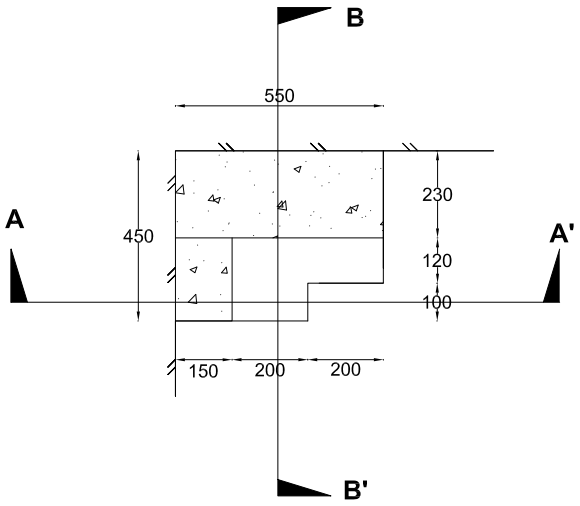
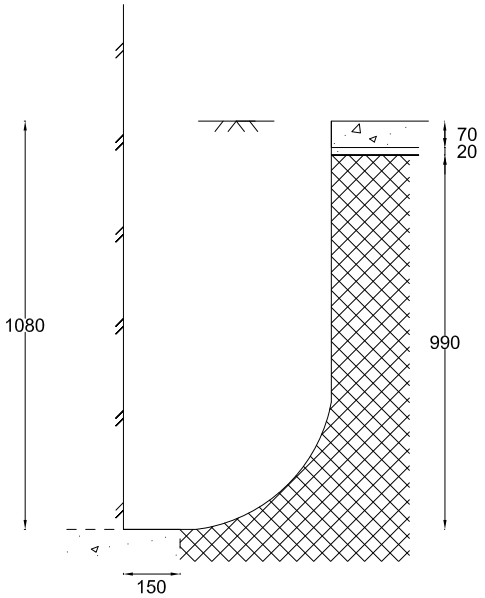
GEA Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware Herts SG12 7QE	**Site** 115 Frognal, London, NW3 6XR	**Trial Pit Number** TP2	
Excavation Method Manual	**Dimensions** 550 x 450 x 1100 mm	**Ground Level (m OD)**	**Client** Mr Paul Crocker	**Job Number** J16245
	Location	**Date** 31/10/16	**Engineer** Fluid Structures	**Sheet Number** 1 of 2

Plan



Section A - A'



Paving Slab
CONCRETE
MADE GROUND (light brown silty sand with roots and rootlets, gravel, chalk and occasional brick)

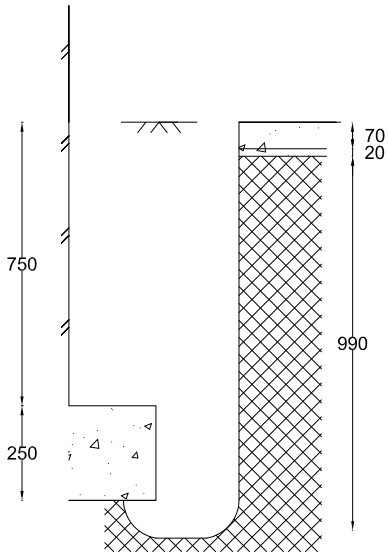
Notes:
Groundwater not encountered

Scale
1 : 20

Logged By
HD

GEA Geotechnical & Environmental Associates	Widbury Barn Widbury Hill Ware Herts SG12 7QE	**Site** 115 Frognal, London, NW3 6XR	**Trial Pit Number** TP2
Excavation Method Manual	**Dimensions** 550 x 450 x 1100 mm	**Ground Level (m OD)**	**Client** Mr Paul Crocker	**Job Number** J16245
	Location	**Date** 31/10/16	**Engineer** Fluid Structures	**Sheet Number** 2 of 2

Section B - B'



70 Paving Slab
20 CONCRETE
MADE GROUND (light brown silty sand with roots and rootlets, gravel, chalk and occasional brick)

Proven under by probing

Notes:
Groundwater not encountered

Scale
1 : 20

Logged By
HD

SUMMARY OF GEOTECHNICAL TESTING

Sample details					Classification Tests					Density Tests		Undrained Triaxial Compression			Chemical Tests			Other tests and comments
Borehole / Trial Pit	Sample Ref	Depth (m)	Type	Description	WC (%)	LL (%)	PL (%)	PI (%)	<425 µm (%)	Bulk Mg/m³	Dry Mg/m³	Cell Pressure kPa	Deviator Stress kPa	Shear Stress kPa	pH	2:1 W/S SO4 (g/L)	W/S Mg (mg/L)	
BH1	U1	1.20	U	Stiff yellow brown slightly sandy gravelly CLAY.	8.6													QUTxl cancelled - too disturbed to test
BH1	D7	2.00	D	Yellowish brown and light grey silty CLAY.	17.7	44	19	25	100									
BH1	U2	3.00	U	Firm light brown fine sandy silty CLAY.	24.4					1.98	1.59	60	171	86				
BH1	D10	3.50	D	Yellowish brown silty CLAY.	18.9													
BH1	D12	4.00	D	Yellowish brown mottled light brown silty CLAY.	22.5	50	17	33	100									
BH1	U3	12.00	U	Stiff multicoloured fine sandy CLAY.	20.8					2.00	1.66	240	238	119				
BH1	U4	15.00	U	Stiff dark grey CLAY with rare fine sand.	25.4	68	23	45	100	2.02	1.61	300	358	179				
BH1	U5	16.50	U	Firm dark brown fine sandy silty CLAY.	22.9					2.07	1.68	330	360	180				
BH1	U6	18.00	U	Firm dark grey fine sandy silty CLAY.	26.4					2.06	1.63	360	213	107				
BH2		0.30	D												6.4	0.02		

Sample type: B (Bulk disturb.) BLK (Block) C (Core) D (Disturbed) LB (Large Bulk dist.) U (Undisturbed)

Checked and Approved by

J Sturges - Operations Manager
22/12/2016

Project Number:

GEO / 25090

Project Name:

115 FROGNAL, LONDON, NW3 6XR
J16245

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SUMMARY OF GEOTECHNICAL TESTING

Sample details					Classification Tests					Density Tests		Undrained Triaxial Compression			Chemical Tests			Other tests and comments
Borehole / Trial Pit	Sample Ref	Depth (m)	Type	Description	WC (%)	LL (%)	PL (%)	PI (%)	<425 µm (%)	Bulk Mg/m³	Dry Mg/m³	Cell Pressure kPa	Deviator Stress kPa	Shear Stress kPa	pH	2:1 W/S SO4 (g/L)	W/S Mg (mg/L)	
BH2	D3	1.00	D	Yellowish brown clayey fine SAND.														Particle Size Distribution
BH2	D8	2.65	D												4.6	0.04		
BH3	D4	0.70	D	Yellowish brown mottled light brown silty CLAY.	14.8													
BH3	D5	1.00	D	Yellowish brown mottled light brown silty CLAY.	12.2	43	17	26	100									
BH3	D6	1.30	D	Light grey silty CLAY.	18.0													
BH3	D7	1.60	D	Yellowish brown silty CLAY.	23.3										5.3	0.04		
BH3	D8	1.70	D	Yellowish brown and light grey silty CLAY.	26.0													
BH3	D9	1.90	D	Yellowish brown silty CLAY.	23.4	39	19	20	100									
BH3	D10	2.20	D	Yellowish brown silty CLAY.	23.9													
BH3	D13	3.30	D	Light brown silty CLAY.	20.0													

Sample type: B (Bulk disturb.) BLK (Block) C (Core) D (Disturbed) LB (Large Bulk dist.) U (Undisturbed)

Checked and Approved by

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22/12/2016

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GEOLABS®

SUMMARY OF GEOTECHNICAL TESTING

Sample details					Classification Tests					Density Tests		Undrained Triaxial Compression			Chemical Tests			Other tests and comments
Borehole / Trial Pit	Sample Ref	Depth (m)	Type	Description	WC (%)	LL (%)	PL (%)	PI (%)	<425 µm (%)	Bulk Mg/m³	Dry Mg/m³	Cell Pressure kPa	Deviator Stress kPa	Shear Stress kPa	pH	2:1 W/S SO4 (g/L)	W/S Mg (mg/L)	
BH3	D15	4.50	D	Light brown silty CLAY.	22.6													

Sample type: B (Bulk disturb.) BLK (Block) C (Core) D (Disturbed) LB (Large Bulk dist.) U (Undisturbed)

Checked and Approved by

J Sturges - Operations Manager
22/12/2016

Project Number:

GEO / 25090

Project Name:

115 FROGNAL, LONDON, NW3 6XR
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BS 1377 : Part 7 : 1990 Clause 8

QUICK UNDRAINED TRIAXIAL COMPRESSION TEST

BH/TP No	BH1
Sample Ref	U2
Depth (m)	3.00
Sample Type	U

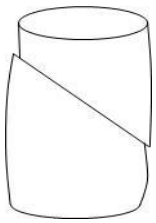
Description:

Firm light brown fine sandy silty CLAY.

Specimen Details

Specimen conditions		Undisturbed
Length	(mm)	202.7
Diameter	(mm)	103.4
Moisture Content	(%)	24.4
Bulk Density	(Mg/m³)	1.98
Dry Density	(Mg/m³)	1.59
Test Details		
Latex membrane thickness	(mm)	0.3
Membrane correction	(kPa)	1.1
Axial displacement rate	(%/min)	2.0
Cell pressure	(kPa)	60
Strain at failure	(%)	19.7
Maximum Deviator Stress	(kPa)	171
Shear Stress Cu	(kPa)	86

Mode of failure



Orientation of the sample	Vertical
Distance from top of tube mm	55

Checked and Approved by:

J Sturges - Operations Manager
02/12/2016

Project Number:

GEO / 25090

Project Name:

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BS 1377 : Part 7 : 1990 Clause 8

QUICK UNDRAINED TRIAXIAL COMPRESSION TEST

BH/TP No	BH1
Sample Ref	U3
Depth (m)	12.00
Sample Type	U

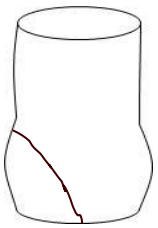
Description:

Stiff multicoloured fine sandy CLAY.

Specimen Details

Specimen conditions		Undisturbed
Length	(mm)	202.5
Diameter	(mm)	102.9
Moisture Content	(%)	20.8
Bulk Density	(Mg/m³)	2.00
Dry Density	(Mg/m³)	1.66
Test Details		
Latex membrane thickness	(mm)	0.3
Membrane correction	(kPa)	0.5
Axial displacement rate	(%/min)	2.0
Cell pressure	(kPa)	240
Strain at failure	(%)	6.9
Maximum Deviator Stress	(kPa)	238
Shear Stress Cu	(kPa)	119

Mode of failure



Orientation of the sample	Vertical
Distance from top of tube mm	50

Checked and Approved by:

J Sturges - Operations Manager
02/12/2016

Project Number:

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Project Name:

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BS 1377 : Part 7 : 1990 Clause 8

QUICK UNDRAINED TRIAXIAL COMPRESSION TEST

BH/TP No	BH1
Sample Ref	U4
Depth (m)	15.00
Sample Type	U

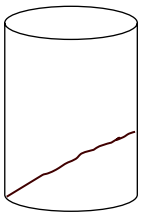
Description:

Stiff dark grey CLAY with rare fine sand.

Specimen Details

Specimen conditions		Undisturbed
Length	(mm)	202.5
Diameter	(mm)	103.5
Moisture Content	(%)	25.4
Bulk Density	(Mg/m³)	2.02
Dry Density	(Mg/m³)	1.61
Test Details		
Latex membrane thickness	(mm)	0.3
Membrane correction	(kPa)	0.5
Axial displacement rate	(%/min)	2.0
Cell pressure	(kPa)	300
Strain at failure	(%)	6.4
Maximum Deviator Stress	(kPa)	358
Shear Stress Cu	(kPa)	179

Mode of failure



Orientation of the sample	Vertical
Distance from top of tube mm	80

Checked and Approved by:

J Sturges - Operations Manager
02/12/2016

Project Number:

GEO / 25090

Project Name:

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BS 1377 : Part 7 : 1990 Clause 8

QUICK UNDRAINED TRIAXIAL COMPRESSION TEST

BH/TP No	BH1
Sample Ref	U5
Depth (m)	16.50
Sample Type	U

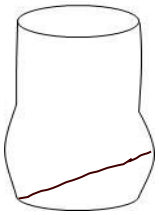
Description:

Firm dark brown fine sandy silty CLAY.

Specimen Details

Specimen conditions		Undisturbed
Length	(mm)	202.3
Diameter	(mm)	102.9
Moisture Content	(%)	22.9
Bulk Density	(Mg/m³)	2.07
Dry Density	(Mg/m³)	1.68
Test Details		
Latex membrane thickness	(mm)	0.3
Membrane correction	(kPa)	0.7
Axial displacement rate	(%/min)	2.0
Cell pressure	(kPa)	330
Strain at failure	(%)	10.9
Maximum Deviator Stress	(kPa)	360
Shear Stress Cu	(kPa)	180

Mode of failure



Orientation of the sample	Vertical
Distance from top of tube mm	10

Checked and Approved by:

J Sturges - Operations Manager
13/12/2016

Project Number:

GEO / 25090

Project Name:

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BS 1377 : Part 7 : 1990 Clause 8

QUICK UNDRAINED TRIAXIAL COMPRESSION TEST

BH/TP No	BH1
Sample Ref	U6
Depth (m)	18.00
Sample Type	U

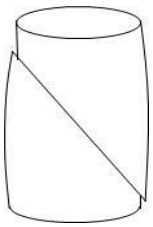
Description:

Firm dark grey fine sandy silty CLAY.

Specimen Details

Specimen conditions		Undisturbed
Length	(mm)	202.7
Diameter	(mm)	102.9
Moisture Content	(%)	26.4
Bulk Density	(Mg/m³)	2.06
Dry Density	(Mg/m³)	1.63
Test Details		
Latex membrane thickness	(mm)	0.3
Membrane correction	(kPa)	1.1
Axial displacement rate	(%/min)	2.0
Cell pressure	(kPa)	360
Strain at failure	(%)	19.7
Maximum Deviator Stress	(kPa)	213
Shear Stress Cu	(kPa)	107

Mode of failure



Orientation of the sample	Vertical
Distance from top of tube mm	45

Checked and Approved by:

J Sturges - Operations Manager
02/12/2016

Project Number:

GEO / 25090

Project Name:

115 FROGNAL, LONDON, NW3 6XR

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BS1377 : Part 2 : Clause 9 : 1990

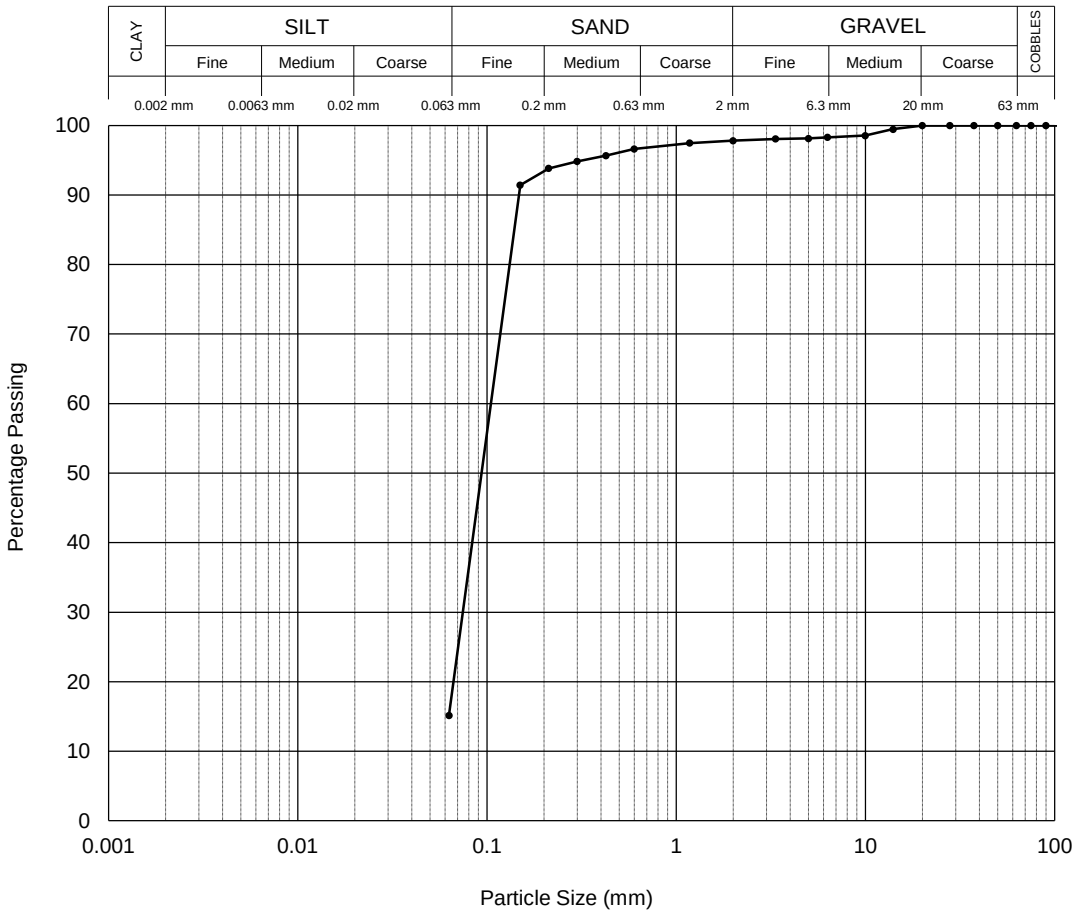
PARTICLE SIZE DISTRIBUTION

BH/TP No:	BH2
Sample Ref.	D3
Depth (m):	1.00
Sample Type	D

Description:
Yellowish brown clayey fine SAND.

BS1377 : Part 2 : Clause 9.2 : 1990 Wet Sieving Method

Sieve	
Sieve (mm)	% pass
200	100
125	100
90	100
75	100
63	100
50	100
37.5	100
28	100
20	100
14	99
10	99
6.3	98
5	98
3.35	98
2	98
1.18	97
0.6	97
0.425	96
0.3	95
0.212	94
0.15	91
0.063	15



Particle Proportions	
Cobbles	0.0 %
Gravel	2.2 %
Sand	82.7 %
Silt & Clay	15.1 %

Checked and Approved by

J Sturges - Operations Manager
02/12/2016

Project Number:

GEO / 25090

Project Name:

115 FROGNAL, LONDON, NW3 6XR

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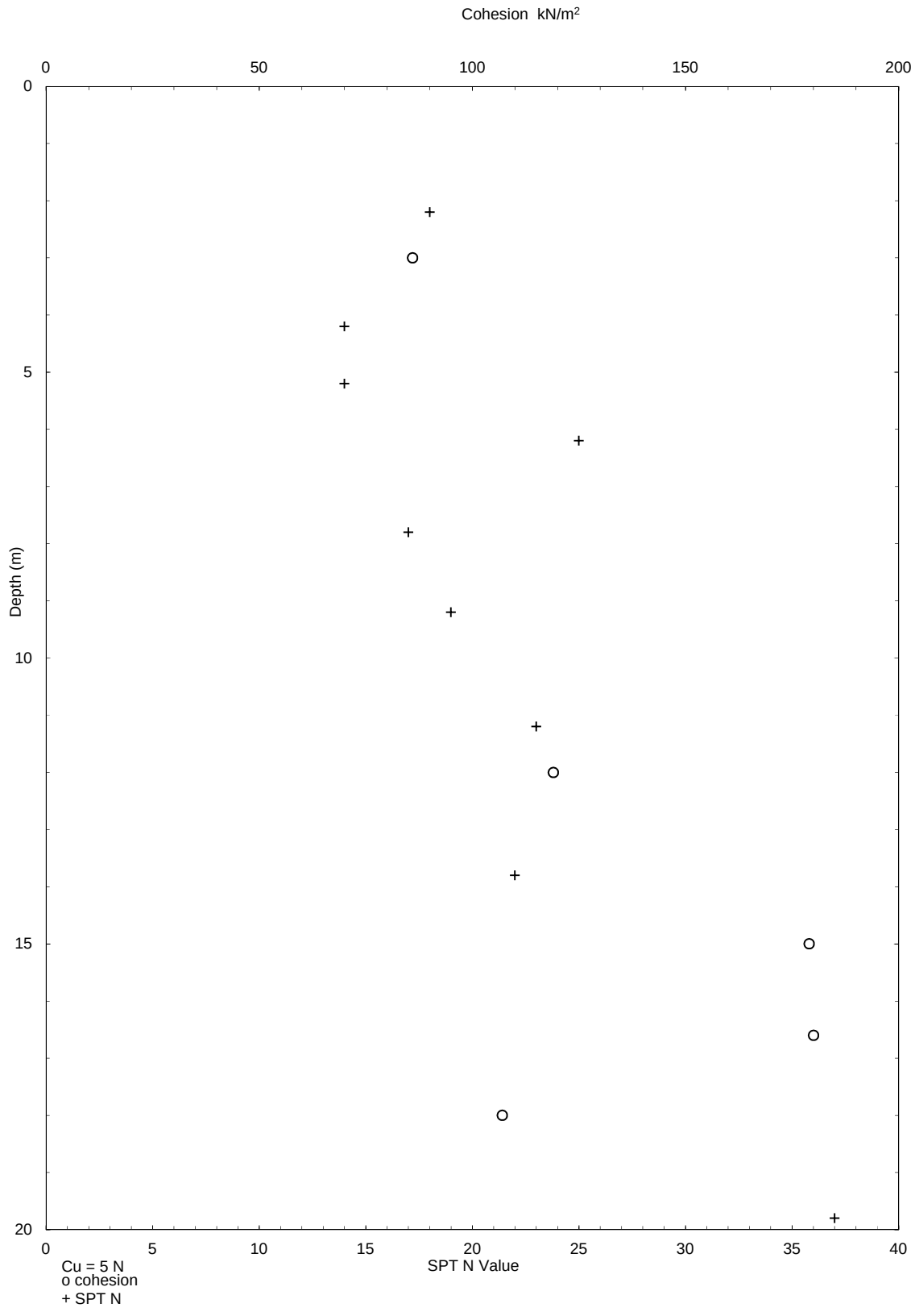
GEA Geotechnical & Environmental Associates
Widbury Barn
Widbury Hill
Ware
Herts SG12 7QE

SPT & Cohesion / Depth Graph

Site	115 Frognal, London, NW3 6XR
Client	Mr Paul Crocker
Engineer	Fluid Structures

Job Number J16245

Sheet 1 / 1



Analytical Report Number: 16-31754

Project / Site name: 115 Frognal
Your Order No: J16245

Lab Sample Number				652816	652817	652818	652819	652820
Sample Reference				BH1	BH2	BH3	TP1	TP2
Sample Number				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Depth (m)				0.30	0.30	0.20	0.50	0.50
Date Sampled				02/11/2016	31/10/2016	31/10/2016	31/10/2016	31/10/2016
Time Taken				None Supplied	None Supplied	None Supplied	None Supplied	None Supplied
Analytical Parameter (Soil Analysis)	**Units**	**Limit of detection**	**Accreditation Status**					
Stone Content	%	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Moisture Content	%	N/A	NONE	7.8	7.8	14	12	4.9
Total mass of sample received	kg	0.001	NONE	1.3	1.2	0.91	1.3	1.2
Asbestos in Soil	Type	N/A	ISO 17025	Not-detected	Not-detected	Not-detected	Not-detected	Not-detected
General Inorganics								
pH - Automated	pH Units	N/A	MCERTS	7.8	6.6	7.3	8.5	8.3
Total Cyanide	mg/kg	1	MCERTS	< 1	< 1	< 1	< 1	< 1
Total Sulphate as SO_4	mg/kg	50	MCERTS	340	290	590	530	1600
Water Soluble SO4 16hr extraction (2:1 Leachate Equivalent)	g/l	0.00125	MCERTS	0.014	0.0066	0.015	0.024	0.58
Sulphide	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Water Soluble Chloride (2:1)	mg/kg	1	MCERTS	10	7.3	10	7.8	12
Total Organic Carbon (TOC)	%	0.1	MCERTS	0.5	0.7	2.1	0.6	0.4
Total Phenols								
Total Phenols (monohydric)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Speciated PAHs								
Naphthalene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Acenaphthylene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Acenaphthene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluorene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Phenanthrene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	0.43	0.19	< 0.10
Anthracene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Fluoranthene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	1.1	0.43	< 0.10
Pyrene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	0.96	0.36	< 0.10
Benzo(a)anthracene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	0.89	0.37	< 0.10
Chrysene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	0.55	0.19	< 0.05
Benzo(b)fluoranthene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	0.44	< 0.10	< 0.10
Benzo(k)fluoranthene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	0.33	< 0.10	< 0.10
Benzo(a)pyrene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	0.38	< 0.10	< 0.10
Indeno(1,2,3-cd)pyrene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Dibenz(a,h)anthracene	mg/kg	0.1	MCERTS	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Benzo(ghi)perylene	mg/kg	0.05	MCERTS	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Total PAH								
Speciated Total EPA-16 PAHs	mg/kg	1.6	MCERTS	< 1.60	< 1.60	5.09	< 1.60	< 1.60
Heavy Metals / Metalloids								
Arsenic (aqua regia extractable)	mg/kg	1	MCERTS	17	20	33	19	18
Cadmium (aqua regia extractable)	mg/kg	0.2	MCERTS	< 0.2	< 0.2	0.5	< 0.2	< 0.2
Chromium (aqua regia extractable)	mg/kg	1	MCERTS	37	39	50	28	30
Copper (aqua regia extractable)	mg/kg	1	MCERTS	18	20	47	34	17
Lead (aqua regia extractable)	mg/kg	1	MCERTS	99	160	270	460	94
Mercury (aqua regia extractable)	mg/kg	0.3	MCERTS	< 0.3	1.0	2.3	0.6	< 0.3
Nickel (aqua regia extractable)	mg/kg	1	MCERTS	8.2	8.1	19	11	6.7
Selenium (aqua regia extractable)	mg/kg	1	MCERTS	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Zinc (aqua regia extractable)	mg/kg	1	MCERTS	37	38	160	96	32
Petroleum Hydrocarbons								
TPH (C8 - C10)	mg/kg	0.1	NONE	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
TPH (C10 - C12)	mg/kg	2	ISO 17025	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
TPH (C12 - C16)	mg/kg	4	ISO 17025	< 4.0	< 4.0	< 4.0	< 4.0	< 4.0
TPH (C16 - C21)	mg/kg	1	ISO 17025	< 1.0	< 1.0	7.0	6.9	< 1.0
TPH (C21 - C35)	mg/kg	1	ISO 17025	< 1.0	< 1.0	13	5.5	< 1.0

GEA Geotechnical & Environmental Associates

Widbury Barn
Widbury Hill
Ware
Herts SG12 7QE

Generic Risk-Based Soil Screening Values

Site	115 Frognal, London, NW3 6XR
Client	Mr Paul Crocker
Engineer	Fluid Structures

Job Number J16245

Sheet 1 / 2

Proposed End Use Residential with plant uptake

Soil pH 7

Soil Organic Matter content % 2.5

Contaminant	Screening Value mg/kg	Data Source
Metals		
Arsenic	37	C4SL
Cadmium	26	C4SL
Chromium (III)	3000	LQM/CIEH
Chromium (VI)	21	C4SL
Copper	2,330	LQM/CIEH
Lead	200	C4SL
Elemental Mercury	1	SGV
Inorganic Mercury	170	SGV
Nickel	97	LQM/CIEH
Selenium	350	SGV
Zinc	3,750	LQM/CIEH
Hydrocarbons		
Benzene	0.34	C4SL
Toluene	320	SGV
Ethyl Benzene	180	SGV
Xylene	120	SGV
Aliphatic C5-C6	55	LQM/CIEH
Aliphatic C6-C8	160	LQM/CIEH
Aliphatic C8-C10	46	LQM/CIEH
Aliphatic C10-C12	230	LQM/CIEH
Aliphatic C12-C16	1700	LQM/CIEH
Aliphatic C16-C35	64,000	LQM/CIEH
Aromatic C6-C7	See Benzene	LQM/CIEH
Aromatic C7-C8	See Toluene	LQM/CIEH
Aromatic C8-C10	65	LQM/CIEH
Aromatic C10-C12	160	LQM/CIEH
Aromatic C12-C16	310	LQM/CIEH
Aromatic C16-C21	480	LQM/CIEH
Aromatic C21-C35	1100	LQM/CIEH
PRO (C_5 –C_{10})	646	Calc
DRO (C_{12} –C_{28})	66,490	Calc
Lube Oil (C_{28} –C_{44})	65,100	Calc
TPH	**1000**	Trigger for speciated testing

Contaminant	Screening Value mg/kg	Data Source
Anions		
Soluble Sulphate	500 mg/l	Structures
Sulphide	50	Structures
Chloride	400	Structures
Others		
Organic Carbon (%)	6	Methanogenic potential
Total Cyanide	140	WRAS
Total Mono Phenols	290	SGV
PAH		
Naphthalene	5.30	C4SL exp & LQM/CIEH
Acenaphthylene	400	LQM/CIEH
Acenaphthene	480	LQM/CIEH
Fluorene	380	LQM/CIEH
Phenanthrene	200	LQM/CIEH
Anthracene	4,900	LQM/CIEH
Fluoranthene	460	LQM/CIEH
Pyrene	1,000	LQM/CIEH
Benzo(a) Anthracene	6.7	C4SL exp & LQM/CIEH
Chrysene	11	C4SL exp & LQM/CIEH
Benzo(b) Fluoranthene	9.5	C4SL exp & LQM/CIEH
Benzo(k) Fluoranthene	14.1	C4SL exp & LQM/CIEH
Benzo(a) pyrene	4.40	C4SL
Indeno(1 2 3 cd) Pyrene	5.6	C4SL exp & LQM/CIEH
Dibenzo(a h) Anthracene	1.27	C4SL exp & LQM/CIEH
Benzo (g h i) Perylene	69	C4SL exp & LQM/CIEH
Screening value for PAH	**62.9**	B(a)P / 0.15
Chlorinated Solvents		
1,1,1 trichloroethane (TCA)	27.2	LQM/CIEH
tetrachloroethane (PCA)	1.25	LQM/CIEH
tetrachloroethene (PCE)	2.32	LQM/CIEH
trichloroethene (TCE)	0.308	LQM/CIEH
1,2-dichloroethane (DCA)	0.008	LQM/CIEH
vinyl chloride (Chloroethene)	0.000184	LQM/CIEH
tetrachloromethane (Carbon tetra	0.039	LQM/CIEH
trichloromethane (Chloroform)	1.99	LQM/CIEH

Notes

Concentrations measured below the above values may be considered to represent 'uncontaminated conditions' which pose 'LOW' risk to human health. Concentrations measured in excess of these valuesindicate a potential risk which require further, site specific risk assessment.

SGV - Soil Guideline Value, derived from the CLEA model and published by Environment Agency 2009

LQM/CIEH - Generic Assessment Criteria for Human Health Risk Assessment 2nd edition (2009)derived using CLEA 1.04 model 2009

C4SL - Defra Category 4 Screening value based on Low Level of Toxicological Risk

C4SL exp & LQM/CIEH calculated using C4SL revisions to exposure assessment but LQM/CIEH health croiteria values

Calc - sum of nearest available carbon range specified including BTEX for PRO fraction

B(a)P / 0.15 - GEA experince indicates that Benzo(a) pyrene (one of the most common and most carcenogenic of the PAHs) rarely exceeds 15% of the total PAH concentration, hence this Total PAH threshold is regarded as being conservative

GEA Geotechnical & Environmental Associates

Widbury Barn
Widbury Hill
Ware
Herts SG12 7QE

Generic Risk-Based Soil Screening Values

Site	115 Frognal, London, NW3 6XR	**Job Number**	J16245
Client	Mr Paul Crocker	**Sheet**	2 / 2
Engineer	Fluid Structures		

Proposed End Use **Residential with plant uptake**

The key generic assumptions for this end use are as follows;

- ❑ that groundwater will not be a critical risk receptor;
- ❑ that the critical receptor for human health will be a young female aged 0 to 6 years old;
- ❑ that the exposure duration will be six years;
- ❑ that the building type equates to a terraced house.
- ❑ that the critical exposure pathways will be direct soil and indoor dust ingestion, consumption of home grown produce, consumption of soil adhering to home grown produce, skin contact with soils and dust, and inhalation of dust and vapours

Where contaminant concentrations are measured at concentrations below the generic screening value it is considered that they pose an acceptable level of risk and thus further consideration of these contaminant concentrations is not required. However, where concentrations are measured in excess of the generic screening value there is considered to be a potential that they could pose an unacceptable risk and thus further action will be required which could include:

- ❑ additional testing to zone the extent of the contaminated material and thus reduce the uncertainty with regard to its potential risk;
- ❑ site specific risk assessment to refine the assessment criteria and allow an assessment to be made as to whether the concentration present would pose an unacceptable risk at this site; or
- ❑ soil remediation or risk management to mitigate the risk posed by the contaminant to a degree that it poses an acceptable risk.

Envirocheck® Report:

Datasheet

Order Details:

Order Number:
101643504_1_1

Customer Reference:
J15245

National Grid Reference:
526130, 185990

Slice:
A

Site Area (Ha):
0.1

Search Buffer (m):
1000

Site Details:

115 Frognal
LONDON
NW3 6XR

Client Details:

Mr S Branch
GEA Ltd
Widbury Barn
Widbury Hill
Ware
Herts
SG12 7QE

Contents

Introduction

The Environment Act 1995 has made site sensitivity a key issue, as the legislation pays as much attention to the pathways by which contamination could spread, and to the vulnerable targets of contamination, as it does the potential sources of contamination.
For this reason, Landmark's Site Sensitivity maps and Datasheet(s) place great emphasis on statutory data provided by the Environment Agency/Natural Resources Wales and the Scottish Environment Protection Agency; it also incorporates data from Natural England (and the Scottish and Welsh equivalents) and Local Authorities; and highlights hydrogeological features required by environmental and geotechnical consultants. It does not include any information concerning past uses of land. The datasheet is produced by querying the Landmark database to a distance defined by the client from a site boundary provided by the client.

In the attached datasheet the National Grid References (NGRs) are rounded to the nearest 10m in accordance with Landmark's agreements with a number of Data Suppliers.

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Ove Arup Copyright Notice

Peter Brett Associates Copyright Notice

Radon Potential dataset Copyright Notice

Report Version v50.0

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Agency & Hydrological					
BGS Groundwater Flooding Susceptibility	pg 1	Yes			n/a
Contaminated Land Register Entries and Notices					
Discharge Consents	pg 1		1		1
Prosecutions Relating to Controlled Waters			n/a	n/a	n/a
Enforcement and Prohibition Notices					
Integrated Pollution Controls					
Integrated Pollution Prevention And Control					
Local Authority Integrated Pollution Prevention And Control					
Local Authority Pollution Prevention and Controls	pg 1			1	3
Local Authority Pollution Prevention and Control Enforcements					
Nearest Surface Water Feature	pg 2			Yes	
Pollution Incidents to Controlled Waters					
Prosecutions Relating to Authorised Processes					
Registered Radioactive Substances					
River Quality					
River Quality Biology Sampling Points					
River Quality Chemistry Sampling Points					
Substantiated Pollution Incident Register					
Water Abstractions	pg 2				(*4)
Water Industry Act Referrals					
Groundwater Vulnerability	pg 2	Yes	n/a	n/a	n/a
Drift Deposits			n/a	n/a	n/a
Bedrock Aquifer Designations	pg 3	Yes	n/a	n/a	n/a
Superficial Aquifer Designations			n/a	n/a	n/a
Source Protection Zones					
Extreme Flooding from Rivers or Sea without Defences				n/a	n/a
Flooding from Rivers or Sea without Defences				n/a	n/a
Areas Benefiting from Flood Defences				n/a	n/a
Flood Water Storage Areas				n/a	n/a
Flood Defences				n/a	n/a
Detailed River Network Lines					n/a
Detailed River Network Offline Drainage					n/a

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Waste					
BGS Recorded Landfill Sites					
Historical Landfill Sites					
Integrated Pollution Control Registered Waste Sites					
Licensed Waste Management Facilities (Landfill Boundaries)					
Licensed Waste Management Facilities (Locations)					
Local Authority Landfill Coverage		1	n/a	n/a	n/a
Local Authority Recorded Landfill Sites					
Potentially Infilled Land (Non-Water)	pg 4				3
Potentially Infilled Land (Water)	pg 4				2
Registered Landfill Sites					
Registered Waste Transfer Sites					
Registered Waste Treatment or Disposal Sites					
Hazardous Substances					
Control of Major Accident Hazards Sites (COMAH)					
Explosive Sites					
Notification of Installations Handling Hazardous Substances (NIHHS)					
Planning Hazardous Substance Consents					
Planning Hazardous Substance Enforcements					

Geotechnical & Environmental Associates

Summary

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Geological					
BGS 1:625,000 Solid Geology	pg 5	Yes	n/a	n/a	n/a
BGS Estimated Soil Chemistry					
BGS Recorded Mineral Sites					
BGS Urban Soil Chemistry	pg 5			Yes	Yes
BGS Urban Soil Chemistry Averages	pg 8	Yes			
Brine Compensation Area			n/a	n/a	n/a
Coal Mining Affected Areas			n/a	n/a	n/a
Mining Instability			n/a	n/a	n/a
Man-Made Mining Cavities					
Natural Cavities					
Non Coal Mining Areas of Great Britain				n/a	n/a
Potential for Collapsible Ground Stability Hazards	pg 8	Yes		n/a	n/a
Potential for Compressible Ground Stability Hazards				n/a	n/a
Potential for Ground Dissolution Stability Hazards				n/a	n/a
Potential for Landslide Ground Stability Hazards	pg 8	Yes		n/a	n/a
Potential for Running Sand Ground Stability Hazards	pg 8	Yes	Yes	n/a	n/a
Potential for Shrinking or Swelling Clay Ground Stability Hazards	pg 8		Yes	n/a	n/a
Radon Potential - Radon Affected Areas			n/a	n/a	n/a
Radon Potential - Radon Protection Measures			n/a	n/a	n/a
Industrial Land Use					
Contemporary Trade Directory Entries	pg 9		1	21	67
Fuel Station Entries					
Points of Interest - Commercial Services	pg 16				8
Points of Interest - Education and Health	pg 17		1	2	
Points of Interest - Manufacturing and Production	pg 17				1
Points of Interest - Public Infrastructure	pg 17			2	5
Points of Interest - Recreational and Environmental	pg 18				1
Gas Pipelines					
Underground Electrical Cables	pg 18				10

Data Type	Page Number	On Site	0 to 250m	251 to 500m	501 to 1000m (*up to 2000m)
Sensitive Land Use					
Ancient Woodland	pg 20				1
Areas of Adopted Green Belt					
Areas of Unadopted Green Belt					
Areas of Outstanding Natural Beauty					
Environmentally Sensitive Areas					
Forest Parks					
Local Nature Reserves					
Marine Nature Reserves					
National Nature Reserves					
National Parks					
Nitrate Sensitive Areas					
Nitrate Vulnerable Zones					
Ramsar Sites					
Sites of Special Scientific Interest					
Special Areas of Conservation					
Special Protection Areas					
World Heritage Sites					

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
	BGS Groundwater Flooding Susceptibility Flooding Type: Limited Potential for Groundwater Flooding to Occur	A13SE (SE)	0	2	526134 185987
1	**Discharge Consents** Operator: Thames Water Utilities Ltd Property Type: Reservoir/Borehole Site Location: Hampstead Authority: Environment Agency, Thames Region Catchment Area: Not Supplied Reference: Temp.0140 Permit Version: 1 Effective Date: 15th September 1989 Issued Date: 15th September 1989 Revocation Date: 5th October 2000 Discharge Type: Trade Effluent Discharge Environment: Freshwater Stream/River Receiving Water: River Thames **Status: Authorisation revokedRevoked** Positional Accuracy: Located by supplier to within 100m	A13NE (NE)	109	3	526200 186100
2	**Discharge Consents** Operator: Thames Water Utilities Ltd Property Type: Reservoir/Borehole Site Location: Kidderpore Authority: Environment Agency, Thames Region Catchment Area: Not Supplied Reference: Temp.0165 Permit Version: 1 Effective Date: 15th September 1989 Issued Date: 15th September 1989 Revocation Date: 5th October 2000 Discharge Type: Trade Effluent Discharge Environment: Freshwater Stream/River Receiving Water: River Thames **Status: Authorisation revokedRevoked** Positional Accuracy: Located by supplier to within 100m	A12SW (W)	718	3	525400 185900
3	**Local Authority Pollution Prevention and Controls** Name: Perkins Dry Cleaners Location: 40 Heath Street, London, Nw3 6te Authority: London Borough of Camden, Pollution Projects Team Permit Reference: PPC/DC9 Dated: 12th January 2007 Process Type: Local Authority Pollution Prevention and Control Description: PG6/46 Dry cleaning **Status: Permitted** Positional Accuracy: Located by supplier to within 10m	A13SE (SE)	336	4	526374 185724
4	**Local Authority Pollution Prevention and Controls** Name: Cottontail Cleaners Location: 509 Finchley Road, London, Nw3 7bb Authority: London Borough of Camden, Pollution Projects Team Permit Reference: PPC/DC19 Dated: 5th February 2007 Process Type: Local Authority Pollution Prevention and Control Description: PG6/46 Dry cleaning **Status: Permitted** Positional Accuracy: Located by supplier to within 10m	A7NW (SW)	824	4	525456 185484
4	**Local Authority Pollution Prevention and Controls** Name: Cottontail Cleaners Location: 509 Finchley Road, London, Nw3 7bb Authority: London Borough of Camden, Pollution Projects Team Permit Reference: PPC/DC48 Dated: 1st January 2007 Process Type: Local Authority Pollution Prevention and Control Description: PG6/46 Dry cleaning **Status: Permitted** Positional Accuracy: Manually positioned to the address or location	A7NW (SW)	825	4	525454 185484
4	**Local Authority Pollution Prevention and Controls** Name: The London Dry Cleaning Company Location: 519a Finchley Road, London, Nw3 7bb Authority: London Borough of Camden, Pollution Projects Team Permit Reference: PPC/DC51 Dated: 1st March 2008 Process Type: Local Authority Pollution Prevention and Control Description: PG6/46 Dry cleaning **Status: Permitted** Positional Accuracy: Manually positioned to the address or location	A7NW (SW)	828	4	525432 185511

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
	Nearest Surface Water Feature	A13NE (NE)	299	-	526260 186282
	Water Abstractions Operator: London Borough Of Camden Licence Number: 28/39/39/0219 Permit Version: 1 Location: Swiss Cottage Open Space- Borehole Authority: Environment Agency, Thames Region Abstraction: Municipal Grounds: Spray Irrigation - Direct Abstraction Type: Water may be abstracted from a single point Source: Groundwater Daily Rate (m3): Not Supplied Yearly Rate (m3): Not Supplied Details: Swiss Cottage Open Space, Winchester Road, London. Authorised Start: 01 January Authorised End: 31 December Permit Start Date: 1st April 2008 Permit End Date: Not Supplied Positional Accuracy: Located by supplier to within 10m	(S)	1813	3	526800 184280
	Water Abstractions Operator: London Borough Of Camden Licence Number: Th/039/0039/087 Permit Version: 1 Location: Swiss Cottage Open Space- Borehole Authority: Environment Agency, Thames Region Abstraction: Municipal Grounds: Spray Irrigation - Direct Abstraction Type: Water may be abstracted from a single point Source: Groundwater Daily Rate (m3): Not Supplied Yearly Rate (m3): Not Supplied Details: Swiss Cottage Open Space, Winchester Road, London Authorised Start: 01 April Authorised End: 31 March Permit Start Date: 5th December 2013 Permit End Date: Not Supplied Positional Accuracy: Located by supplier to within 10m	(S)	1814	3	526750 184261
	Water Abstractions Operator: London Borough Of Camden Licence Number: Th/039/0039/087 Permit Version: 1 Location: Swiss Cottage Open Space- Borehole Authority: Environment Agency, Thames Region Abstraction: Municipal Grounds: General Washing/Process Washing Abstraction Type: Water may be abstracted from a single point Source: Groundwater Daily Rate (m3): Not Supplied Yearly Rate (m3): Not Supplied Details: Swiss Cottage Open Space, Winchester Road, London Authorised Start: 01 April Authorised End: 31 March Permit Start Date: 5th December 2013 Permit End Date: Not Supplied Positional Accuracy: Located by supplier to within 10m	(S)	1814	3	526750 184261
	Water Abstractions Operator: London Borough Of Camden Licence Number: Th/039/0039/087 Permit Version: 1 Location: Swiss Cottage Open Space- Borehole Authority: Environment Agency, Thames Region Abstraction: Municipal Grounds: Lake And Pond Throughflow Abstraction Type: Water may be abstracted from a single point Source: Groundwater Daily Rate (m3): Not Supplied Yearly Rate (m3): Not Supplied Details: Swiss Cottage Open Space, Winchester Road, London Authorised Start: 01 April Authorised End: 31 March Permit Start Date: 5th December 2013 Permit End Date: Not Supplied Positional Accuracy: Located by supplier to within 10m	(S)	1814	3	526750 184261
	Groundwater Vulnerability Soil Classification: Soils of High Leaching Potential (U) - Soil information for restored mineral workings and urban areas is based on fewer observations than elsewhere. A worst case vulnerability classification (H) assumed, until proved otherwise Map Sheet: Sheet 39 West London Scale: 1:100,000	A13SE (SE)	0	3	526134 185987

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
	Drift Deposits None				
	Bedrock Aquifer Designations Aquifer Designation: Secondary Aquifer - A	A13SE (SE)	0	2	526134 185987
	Superficial Aquifer Designations No Data Available				
	Extreme Flooding from Rivers or Sea without Defences None				
	Flooding from Rivers or Sea without Defences None				
	Areas Benefiting from Flood Defences None				
	Flood Water Storage Areas None				
	Flood Defences None				
	Detailed River Network Lines None				
	Detailed River Network Offline Drainage None				

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
	Local Authority Landfill Coverage Name: London Borough of Camden - Has no landfill data to supply		0	5	526134 185987
	Local Authority Landfill Coverage Name: London Borough of Barnet - Has supplied landfill data		690	6	525512 186326
5	**Potentially Infilled Land (Non-Water)** Bearing Ref: W Use: Unknown Filled Ground (Pit, quarry etc) Date of Mapping: 1996	A12NW (W)	813	8	525303 186054
6	**Potentially Infilled Land (Non-Water)** Bearing Ref: SE Use: Unknown Filled Ground (Pit, quarry etc) Date of Mapping: 1996	A9SW (SE)	822	8	526616 185296
7	**Potentially Infilled Land (Non-Water)** Bearing Ref: NE Use: Unknown Filled Ground (Pit, quarry etc) Date of Mapping: 1996	A19SE (NE)	951	8	527023 186376
8	**Potentially Infilled Land (Water)** Use: Unknown Filled Ground (Pond, marsh, river, stream, dock etc) Date of Mapping: 1896	A7NE (SW)	530	8	525731 185613
9	**Potentially Infilled Land (Water)** Use: Unknown Filled Ground (Pond, marsh, river, stream, dock etc) Date of Mapping: 1873	A14NE (E)	662	8	526813 186007

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
	BGS 1:625,000 Solid Geology Description: Bracklesham Group And Barton Group (Undifferentiated)	A13SE (SE)	0	2	526134 185987
	BGS Estimated Soil Chemistry No data available				
	BGS Measured Urban Soil Chemistry Source: British Geological Survey, National Geoscience Information Service Grid: 526223, 185630 Soil Sample Type: Topsoil Sample Area: London Arsenic Measured Concentration: 19.70 mg/kg Cadmium Measured Concentration: 0.50 mg/kg Chromium Measured Concentration: 127.10 mg/kg Lead Measured Concentration: 514.80 mg/kg Nickel Measured Concentration: 23.20 mg/kg	A8NE (S)	350	2	526223 185630
	BGS Measured Urban Soil Chemistry Source: British Geological Survey, National Geoscience Information Service Grid: 526219, 186357 Soil Sample Type: Topsoil Sample Area: London Arsenic Measured Concentration: 15.20 mg/kg Cadmium Measured Concentration: 0.30 mg/kg Chromium Measured Concentration: 91.10 mg/kg Lead Measured Concentration: 269.20 mg/kg Nickel Measured Concentration: 15.80 mg/kg	A18SE (N)	359	2	526219 186357
	BGS Measured Urban Soil Chemistry Source: British Geological Survey, National Geoscience Information Service Grid: 525663, 186188 Soil Sample Type: Topsoil Sample Area: London Arsenic Measured Concentration: 15.70 mg/kg Cadmium Measured Concentration: 0.70 mg/kg Chromium Measured Concentration: 156.80 mg/kg Lead Measured Concentration: 1130.60 mg/kg Nickel Measured Concentration: 23.00 mg/kg	A12NE (NW)	493	2	525663 186188
	BGS Measured Urban Soil Chemistry Source: British Geological Survey, National Geoscience Information Service Grid: 525676, 185669 Soil Sample Type: Topsoil Sample Area: London Arsenic Measured Concentration: 13.90 mg/kg Cadmium Measured Concentration: 0.50 mg/kg Chromium Measured Concentration: 116.40 mg/kg Lead Measured Concentration: 247.30 mg/kg Nickel Measured Concentration: 22.60 mg/kg	A12SE (SW)	537	2	525676 185669

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
	BGS Urban Soil Chemistry Averages Source: British Geological Survey, National Geoscience Information Service Sample Area: London Count Id: 7209 Arsenic Minimum Concentration: 1.00 mg/kg Arsenic Average Concentration: 17.00 mg/kg Arsenic Maximum Concentration: 161.00 mg/kg Cadmium Minimum Concentration: 0.10 mg/kg Cadmium Average Concentration: 0.90 mg/kg Cadmium Maximum Concentration: 165.20 mg/kg Chromium Minimum Concentration: 13.00 mg/kg Chromium Average Concentration: 79.00 mg/kg Chromium Maximum Concentration: 2094.00 mg/kg Lead Minimum Concentration: 11.00 mg/kg Lead Average Concentration: 280.00 mg/kg Lead Maximum Concentration: 10000.00 mg/kg Nickel Minimum Concentration: 2.00 mg/kg Nickel Average Concentration: 28.00 mg/kg Nickel Maximum Concentration: 506.00 mg/kg	A13SE (SE)	0	2	526134 185987
	Coal Mining Affected Areas In an area that might not be affected by coal mining				
	Non Coal Mining Areas of Great Britain No Hazard				
	Potential for Collapsible Ground Stability Hazards Hazard Potential: Very Low Source: British Geological Survey, National Geoscience Information Service	A13SE (SE)	0	2	526134 185987
	Potential for Compressible Ground Stability Hazards Hazard Potential: No Hazard Source: British Geological Survey, National Geoscience Information Service	A13SE (SE)	0	2	526134 185987
	Potential for Ground Dissolution Stability Hazards Hazard Potential: No Hazard Source: British Geological Survey, National Geoscience Information Service	A13SE (SE)	0	2	526134 185987
	Potential for Landslide Ground Stability Hazards Hazard Potential: Very Low Source: British Geological Survey, National Geoscience Information Service	A13SE (SE)	0	2	526134 185987
	Potential for Running Sand Ground Stability Hazards Hazard Potential: Low Source: British Geological Survey, National Geoscience Information Service	A13SE (SE)	0	2	526134 185987
	Potential for Running Sand Ground Stability Hazards Hazard Potential: Very Low Source: British Geological Survey, National Geoscience Information Service	A13NW (W)	177	2	525936 185994
	Potential for Shrinking or Swelling Clay Ground Stability Hazards Hazard Potential: No Hazard Source: British Geological Survey, National Geoscience Information Service	A13SE (SE)	0	2	526134 185987
	Potential for Shrinking or Swelling Clay Ground Stability Hazards Hazard Potential: Moderate Source: British Geological Survey, National Geoscience Information Service	A13NW (W)	177	2	525936 185994
	Radon Potential - Radon Affected Areas Affected Area: The property is in a Lower probability radon area (less than 1% of homes are estimated to be at or above the Action Level). Source: British Geological Survey, National Geoscience Information Service	A13SE (SE)	0	2	526134 185987
	Radon Potential - Radon Protection Measures Protection Measure: No radon protective measures are necessary in the construction of new dwellings or extensions Source: British Geological Survey, National Geoscience Information Service	A13SE (SE)	0	2	526134 185987

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
10	**Contemporary Trade Directory Entries** Name: Vape Emporium Location: 87, Heath Street, London, NW3 6UG Classification: Tobacco Products - Manufacturers **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A13SE (SE)	240	-	526367 185876
11	**Contemporary Trade Directory Entries** Name: Perkins Dry Cleaners Location: 6, Holly Bush Vale, London, NW3 6TX Classification: Dry Cleaners **Status: Active** Positional Accuracy: Automatically positioned to the address	A13SE (SE)	283	-	526343 185767
11	**Contemporary Trade Directory Entries** Name: Perkins Dry Cleaners Location: 6, Holly Bush Vale, London, NW3 6TX Classification: Dry Cleaners **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A13SE (SE)	283	-	526343 185767
12	**Contemporary Trade Directory Entries** Name: Scrap Yard In Hampstead Htt Location: Hampstead Station, Hampstead High Street, London, NW3 1QG Classification: Car Breakers & Dismantlers **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A13SE (SE)	312	-	526393 185780
12	**Contemporary Trade Directory Entries** Name: Hampstead Cleaners Location: 5, Flask Walk, London, NW3 1HJ Classification: Carpet, Curtain & Upholstery Cleaners **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A13SE (SE)	353	-	526429 185760
12	**Contemporary Trade Directory Entries** Name: Bubbles & Light Ltd Location: 9a, Flask Walk, London, NW3 1HJ Classification: Candle Manufacturers & Suppliers **Status: Active** Positional Accuracy: Automatically positioned to the address	A13SE (SE)	355	-	526436 185766
13	**Contemporary Trade Directory Entries** Name: Soul Revolver Location: 9, Back Lane, London, NW3 1HL Classification: Leather Garments & Products **Status: Active** Positional Accuracy: Automatically positioned to the address	A13SE (SE)	314	-	526425 185827
14	**Contemporary Trade Directory Entries** Name: American Dry Cleaning Location: 47, Hampstead High Street, London, NW3 1QG Classification: Dry Cleaners **Status: Active** Positional Accuracy: Automatically positioned to the address	A13SE (SE)	330	-	526400 185759
14	**Contemporary Trade Directory Entries** Name: Perkins Group Location: 40, Heath Street, London, NW3 6TE Classification: Dry Cleaners **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A13SE (SE)	336	-	526374 185724
15	**Contemporary Trade Directory Entries** Name: All Rubbish Cleared Location: Redington Rd, London, NW3 7QX Classification: Rubbish Clearance **Status: Inactive** Positional Accuracy: Manually positioned to the road within the address or location	A13SW (SW)	344	-	525919 185694
16	**Contemporary Trade Directory Entries** Name: Spotless Cleaning Location: 35, Flask Walk, London, NW3 1HH Classification: Cleaning Services - Domestic **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A14SW (SE)	360	-	526476 185825
16	**Contemporary Trade Directory Entries** Name: Hampstead Cleaners Location: 35, Flask Walk, London, NW3 1HH Classification: Carpet, Curtain & Upholstery Cleaners **Status: Active** Positional Accuracy: Automatically positioned to the address	A14SW (SE)	360	-	526476 185825

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
17	**Contemporary Trade Directory Entries** Name: Xyz Location: 10, Flask Walk, London, NW3 1HE Classification: Ceramic Manufacturers, Supplies & Services **Status: Inactive** Positional Accuracy: Manually positioned to the address or location	A13SE (SE)	368	-	526445 185756
17	**Contemporary Trade Directory Entries** Name: Hillsdown Holdings Ltd Location: 32, Hampstead High Street, London, NW3 1QD Classification: Food Products - Manufacturers **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A14SW (SE)	415	-	526475 185717
18	**Contemporary Trade Directory Entries** Name: Crabtree & Evelyn Location: 65, Hampstead High Street, London, NW3 1QP Classification: Toiletries **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A13SE (SE)	384	-	526422 185704
19	**Contemporary Trade Directory Entries** Name: Andrews Location: 22, Heath Street, London, NW3 6TE Classification: Hardware **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A13SE (SE)	385	-	526381 185666
19	**Contemporary Trade Directory Entries** Name: Destination Skin Location: 12, Heath Street, London, NW3 6TE Classification: Electrolysis **Status: Active** Positional Accuracy: Automatically positioned to the address	A13SE (SE)	403	-	526396 185655
20	**Contemporary Trade Directory Entries** Name: Rubbish Collection Location: Heath St, London, NW3 6TP Classification: Waste Disposal Services **Status: Inactive** Positional Accuracy: Manually positioned to the road within the address or location	A8NE (SE)	401	-	526372 185640
20	**Contemporary Trade Directory Entries** Name: Jeeves Of Belgravia Location: 11, Heath Street, London, NW3 6TP Classification: Dry Cleaners **Status: Active** Positional Accuracy: Automatically positioned to the address	A8NE (SE)	409	-	526365 185625
20	**Contemporary Trade Directory Entries** Name: Jeeves Of Belgravia Location: 11, Heath Street, London, NW3 6TP Classification: Dry Cleaners **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A8NE (SE)	409	-	526365 185625
20	**Contemporary Trade Directory Entries** Name: Hampstead Autos Location: 28, Perrins Walk, London, NW3 6TH Classification: Garage Services **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A8NE (SE)	428	-	526365 185603
20	**Contemporary Trade Directory Entries** Name: Office Cleaning Services Location: 3, Heath Street, London, NW3 6TP Classification: Commercial Cleaning Services **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A8NE (SE)	428	-	526373 185608
21	**Contemporary Trade Directory Entries** Name: Cleaners Of Hampstead Location: 15, Hampstead High Street, London, NW3 1PX Classification: Cleaning Services - Domestic **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A14SW (SE)	524	-	526573 185667
21	**Contemporary Trade Directory Entries** Name: Cleaners Of Hampstead Location: 15, Hampstead High Street, London, NW3 1PX Classification: Cleaning Services - Domestic **Status: Inactive** Positional Accuracy: Automatically positioned to the address	A14SW (SE)	524	-	526573 185667

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
52	**Points of Interest - Commercial Services** Name: 24 Hour Euro Windscreen Ltd Location: 571 Finchley Road, London, NW3 7BN Category: Repair and Servicing Class Code: Vehicle Repair, Testing and Servicing Positional Accuracy: Positioned to address or location	A12SW (W)	960	7	525173 185793
53	**Points of Interest - Education and Health** Name: The Royal Free Hospital Location: 30 Spedan Close, London, NW3 7XF Category: Health Practitioners and Establishments Class Code: Hospitals Positional Accuracy: Positioned to address or location	A13NW (W)	159	7	525961 186033
54	**Points of Interest - Education and Health** Name: Queen Marys House Location: 23 East Heath Road, London, NW3 1DU Category: Health Practitioners and Establishments Class Code: Hospitals Positional Accuracy: Positioned to address or location	A13NE (NE)	301	7	526353 186225
54	**Points of Interest - Education and Health** Name: Piercey Day Hospital Location: 23 East Heath Road, London, NW3 1DU Category: Health Practitioners and Establishments Class Code: Hospitals Positional Accuracy: Positioned to address or location	A13NE (NE)	320	7	526380 186224
55	**Points of Interest - Manufacturing and Production** Name: Stone of London Location: 485 Finchley Road, London, NW3 6HS Category: Extractive Industries Class Code: Stone Quarrying and Preparation Positional Accuracy: Positioned to address or location	A7NE (SW)	796	7	525601 185369
56	**Points of Interest - Public Infrastructure** Name: Grave Yard Location: NW3 Category: Infrastructure and Facilities Class Code: Cemeteries and Crematoria Positional Accuracy: Positioned to an adjacent address or location	A13SE (S)	286	7	526241 185701
56	**Points of Interest - Public Infrastructure** Name: Graveyard Location: Not Supplied Category: Infrastructure and Facilities Class Code: Cemeteries and Crematoria Positional Accuracy: Positioned to an adjacent address or location	A13SE (S)	288	7	526249 185702
57	**Points of Interest - Public Infrastructure** Name: Metropolitan Police Service Hampstead Location: Hampstead Police Station 26, Rosslyn Hill, London, NW3 1PD Category: Central and Local Government Class Code: Police Stations Positional Accuracy: Positioned to address or location	A9NE (SE)	839	7	526866 185540
57	**Points of Interest - Public Infrastructure** Name: Hampstead Police Station Location: Hampstead Police Station 26, Rosslyn Hill, London, NW3 1PD Category: Central and Local Government Class Code: Police Stations Positional Accuracy: Positioned to address or location	A9NE (SE)	854	7	526883 185539
58	**Points of Interest - Public Infrastructure** Name: Sluice Location: NW3 Category: Water Class Code: Weirs, Sluices and Dams Positional Accuracy: Positioned to an adjacent address or location	A19SE (NE)	904	7	526935 186450
59	**Points of Interest - Public Infrastructure** Name: Finchley Road & Frognal Rail Station Location: Finchley Road, NW3 Category: Public Transport, Stations and Infrastructure Class Code: Railway Stations, Junctions and Halts Positional Accuracy: Positioned to address or location	A8SW (S)	951	7	526047 185026
59	**Points of Interest - Public Infrastructure** Name: Finchley Road and Frognal Station Location: Finchley Road, NW3 Category: Public Transport, Stations and Infrastructure Class Code: Railway Stations, Junctions and Halts Positional Accuracy: Positioned to address or location	A8SW (S)	951	7	526047 185026

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
60	**Points of Interest - Recreational and Environmental** Name: Playing Area Location: Elm Walk, NW3 Category: Recreational Class Code: Playgrounds Positional Accuracy: Positioned to address or location	A17NE (NW)	971	7	525569 186795
61	**Underground Electrical Cables** Unique Feature Identifier: 265526 Cable Status: Commissioned Cable Type: Pilot (Communication) Record Last Updated: 4th June 2013	A14SW (E)	502	8	526645 185907
62	**Underground Electrical Cables** Unique Feature Identifier: 265406 Cable Status: Commissioned Cable Type: Pilot (Communication) Record Last Updated: 4th June 2013	A14SW (E)	504	8	526647 185906
63	**Underground Electrical Cables** Unique Feature Identifier: 265404 Cable Status: Commissioned Cable Type: Pilot (Communication) Record Last Updated: 4th June 2013	A14SW (E)	521	8	526671 185961
64	**Underground Electrical Cables** Unique Feature Identifier: 265528 Cable Status: Commissioned Cable Type: Pilot (Communication) Record Last Updated: 4th June 2013	A14SW (E)	524	8	526674 185967
65	**Underground Electrical Cables** Unique Feature Identifier: 265407 Cable Status: Commissioned Cable Type: Pilot (Communication) Record Last Updated: 4th June 2013	A19SW (NE)	670	8	526618 186482
66	**Underground Electrical Cables** Unique Feature Identifier: 265529 Cable Status: Commissioned Cable Type: Pilot (Communication) Record Last Updated: 4th June 2013	A19SW (NE)	670	8	526612 186487
67	**Underground Electrical Cables** Unique Feature Identifier: 265547 Cable Status: Commissioned Cable Type: Pilot (Communication) Record Last Updated: 4th June 2013	A9NW (SE)	673	8	526708 185599
68	**Underground Electrical Cables** Unique Feature Identifier: 265405 Cable Status: Commissioned Cable Type: Pilot (Communication) Record Last Updated: 4th June 2013	A9NW (SE)	680	8	526715 185598
69	**Underground Electrical Cables** Unique Feature Identifier: 265545 Cable Status: Commissioned Cable Type: Pilot (Communication) Record Last Updated: 4th June 2013	A9SW (SE)	875	8	526592 185218

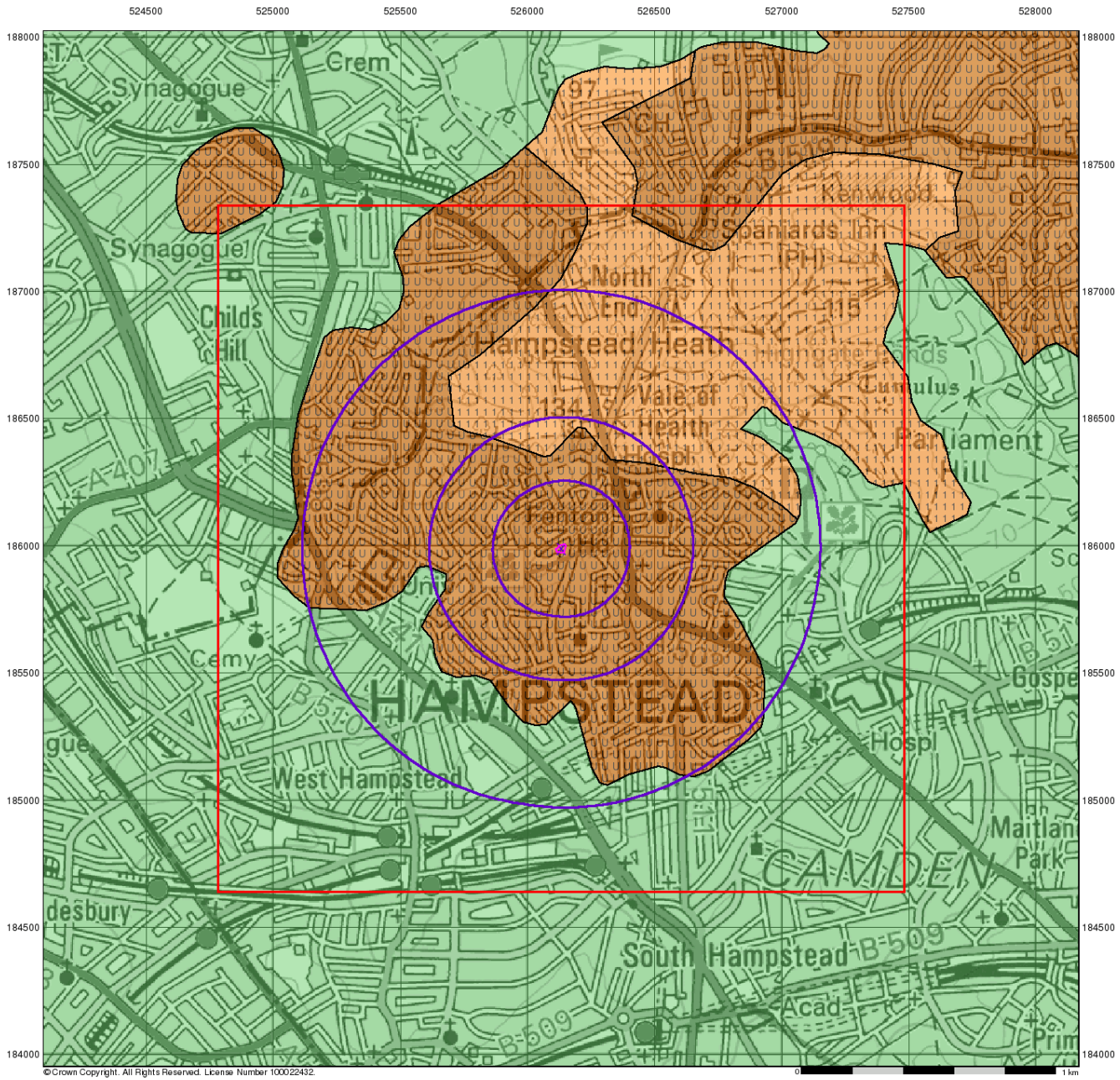
Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
70	**Underground Electrical Cables** Unique Feature Identifier: 264253 Cable Status: Commissioned Cable Type: Pilot (Communication) Record Last Updated: 4th June 2013	A9SW (SE)	877	8	526593 185217

Map ID	Details	Quadrant Reference (Compass Direction)	Estimated Distance From Site	Contact	NGR
71	**Ancient Woodland** Name: Bishops Wood Reference: 1495665 Area(m²): 146178.49 Type: Ancient and Semi-Natural Woodland	A18SE (N)	617	9	526250 186614

Useful Contacts

Contact	Name and Address	Contact Details
2	**British Geological Survey - Enquiry Service** British Geological Survey, Kingsley Dunham Centre, Keyworth, Nottingham, Nottinghamshire, NG12 5GG	Telephone: 0115 936 3143 Fax: 0115 936 3276 Email: enquiries@bgs.ac.uk Website: www.bgs.ac.uk
3	**Environment Agency - National Customer Contact Centre (NCCC)** PO Box 544, Templeborough, Rotherham, S60 1BY	Telephone: 03708 506 506 Email: enquiries@environment-agency.gov.uk
4	**London Borough of Camden - Pollution Projects Team** Seventh Floor, Town Hall Extension, Argyle Street, London, WC1H 8EQ	Telephone: 020 7278 4444 Fax: 020 7860 5713 Website: www.camden.gov.uk
5	**London Borough of Camden** Town Hall, Judd Street, London, WC1H 9JE	Telephone: 020 7974 4444 Fax: 020 7974 6866 Email: info@camden.gov.uk Website: www.camden.gov.uk
6	**London Borough of Barnet - Land Charges** The Town Hall, The Burroughs, Hendon, LONDON, NW4 4BQ	Telephone: 0208 3592482 Fax: 0208 3592493 Website: www.barnet.gov.uk
7	**PointX** 7 Abbey Court, Eagle Way, Sowton, Exeter, Devon, EX2 7HY	Website: www.pointx.co.uk
8	**Landmark Information Group Limited** Imperium, Imperial Way, Reading, Berkshire, RG2 0TD	Telephone: 0844 844 9952 Fax: 0844 844 9951 Email: customerservices@landmark.co.uk Website: www.landmark.co.uk
9	**Natural England** County Hall, Spetchley Road, Worcester, WR5 2NP	Telephone: 0300 060 3900 Email: enquiries@naturalengland.org.uk Website: www.naturalengland.org.uk
10	**Environment Agency - Head Office** Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol, Avon, BS32 4UD	Telephone: 01454 624400 Fax: 01454 624409
-	**Public Health England - Radon Survey, Centre for Radiation, Chemical and Environmental Hazards** Chilton, Didcot, Oxfordshire, OX11 0RQ	Telephone: 01235 822622 Fax: 01235 833891 Email: radon@phe.gov.uk Website: www.ukradon.org
-	**Landmark Information Group Limited** Imperium, Imperial Way, Reading, Berkshire, RG2 0TD	Telephone: 0844 844 9952 Fax: 0844 844 9951 Email: customerservices@landmarkinfo.co.uk Website: www.landmarkinfo.co.uk

Please note that the Environment Agency / Natural Resources Wales / SEPA have a charging policy in place for enquiries.



GEA Geotechnical & Environmental Associates

Groundwater Vulnerability

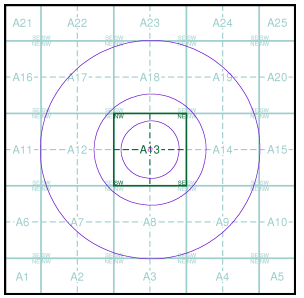
General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes	Soil Classes
Major Aquifer (Highly Permeable)	High (H) 1, 2, 3, U
	Intermediate (I) 1, 2
	Low
Minor Aquifer (Variably Permeable)	High (H) 1, 2, 3, U
	Intermediate (I) 1, 2
	Low
Non Aquifer (Negligibly Permeable)	
Water or Sea	
Drift Deposit	

Site Sensitivity Context Map - Slice A

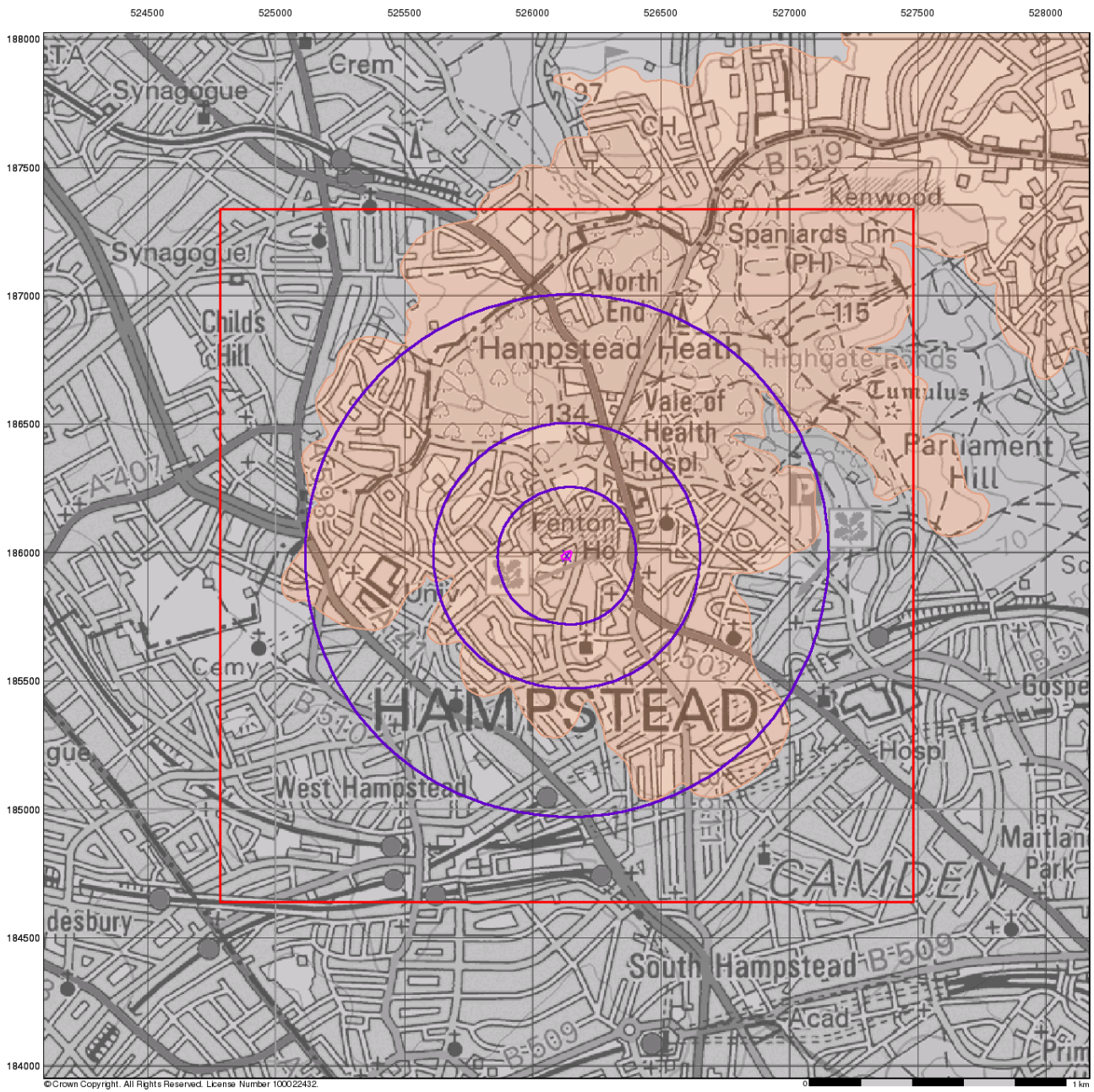


Order Details

Order Number:	101643504_1_1
Customer Ref:	J15245
National Grid Reference:	526130, 185990
Slice:	A
Site Area (Ha):	0.1
Search Buffer (m):	1000

Site Details

115 Frognal, LONDON, NW3 6XR



GEA Geotechnical & Environmental Associates

Bedrock Aquifer Designation

General

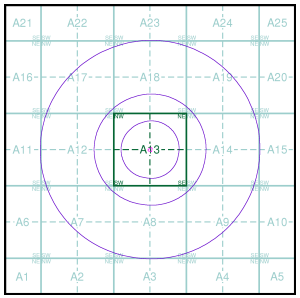
Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

Site Sensitivity Context Map - Slice A



Order Details

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Customer Ref:	J15245
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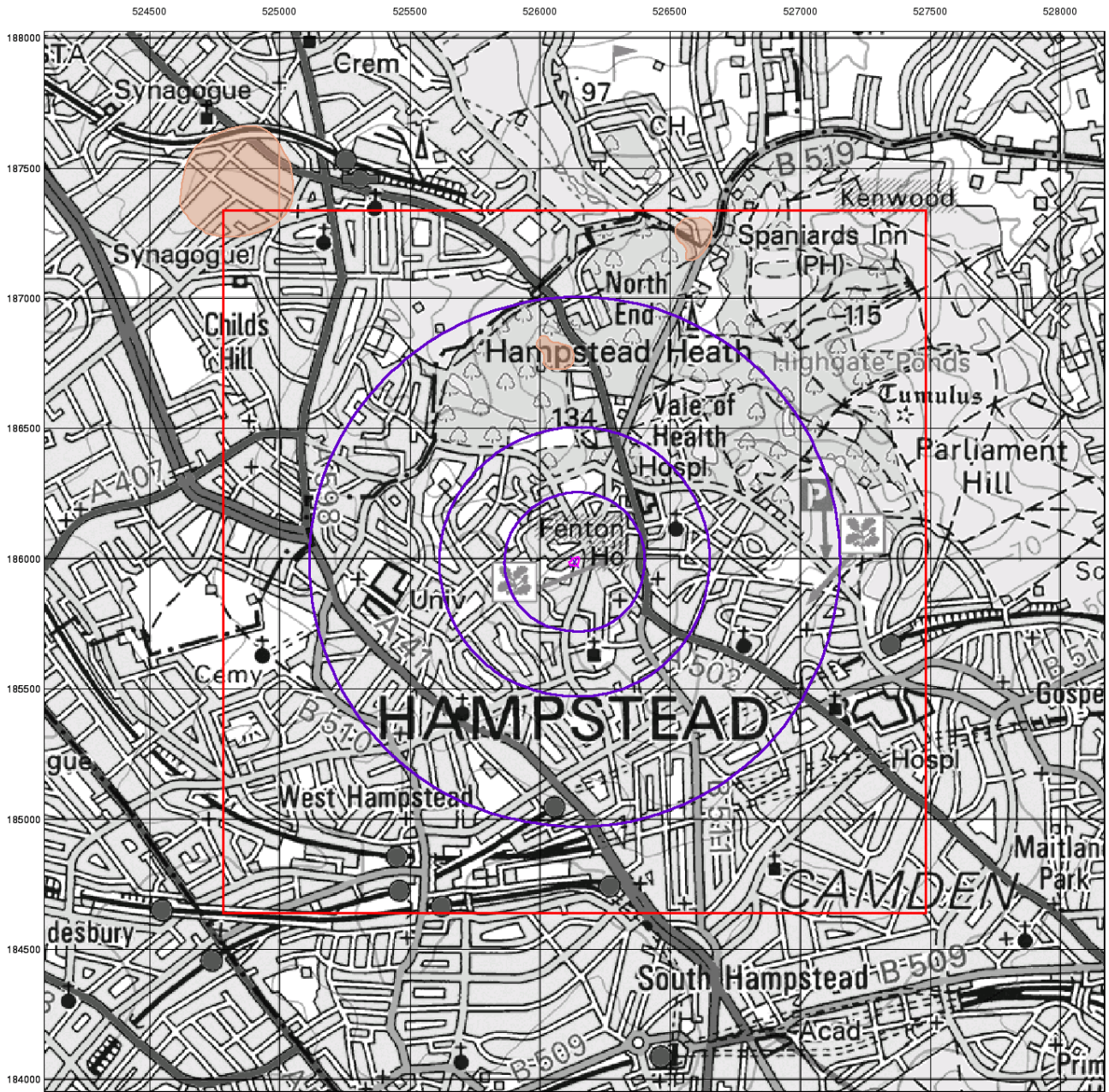
Site Details

115 Frognal, LONDON, NW3 6XR



GEA Geotechnical & Environmental Associates

Superficial Aquifer Designation

General

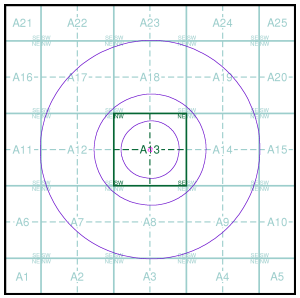
Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown
- Unknown (Lakes and Landslip)

Site Sensitivity Context Map - Slice A

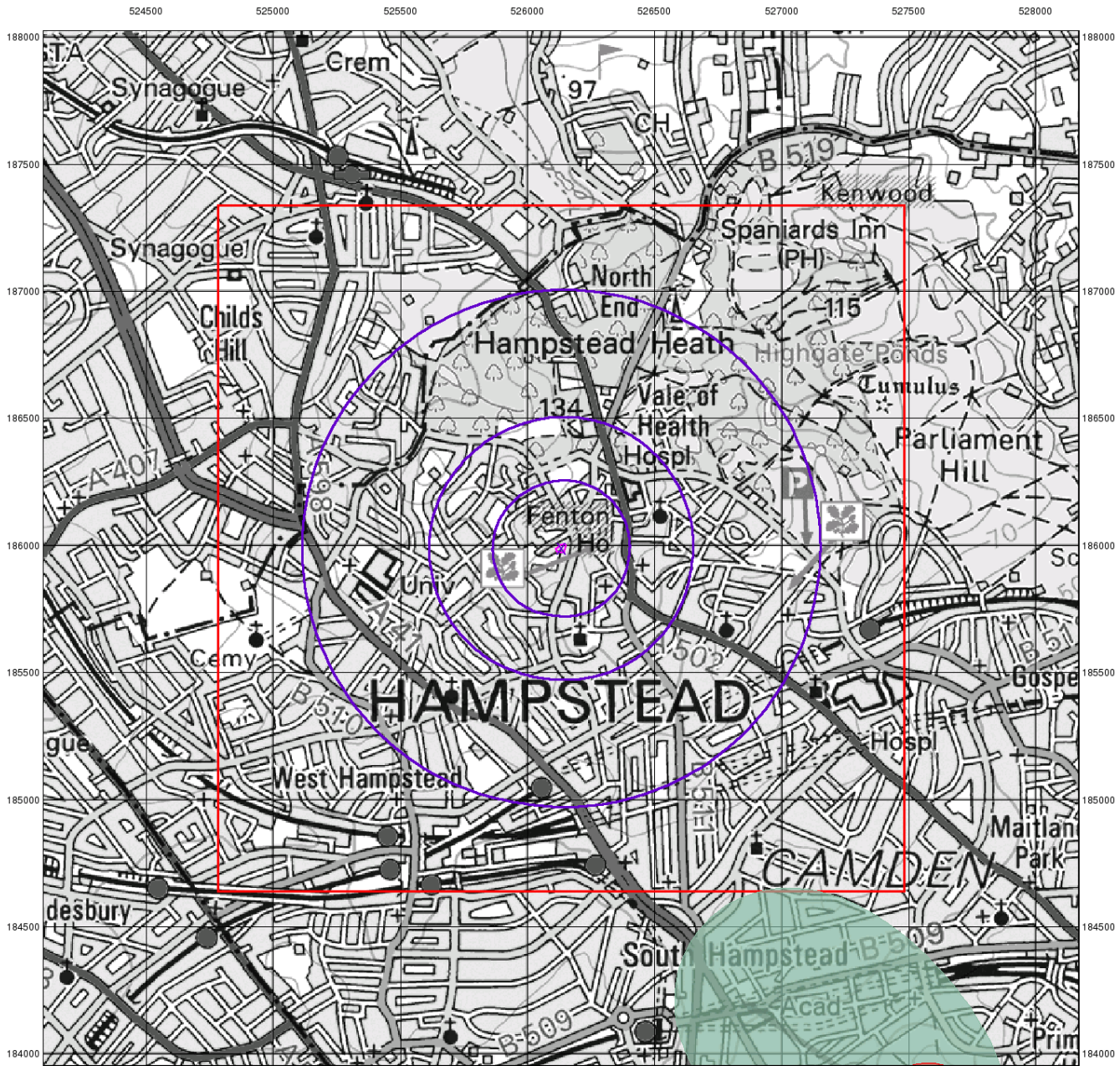


Order Details

Order Number:	101643504_1_1
Customer Ref:	J15245
National Grid Reference:	526130, 185990
Slice:	A
Site Area (Ha):	0.1
Search Buffer (m):	1000

Site Details

115 Frognal, LONDON, NW3 6XR



GEA Geotechnical & Environmental Associates

Source Protection Zones

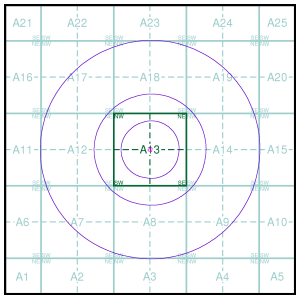
General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

- Inner zone (Zone 1)
- Inner zone - subsurface activity only (Zone 1c)
- Outer zone (Zone 2)
- Outer zone - subsurface activity only (Zone 2c)
- Total catchment (Zone 3)
- Total catchment - subsurface activity only (Zone 3c)
- Special interest (Zone 4)
- Source Protection Zone Borehole

Site Sensitivity Context Map - Slice A



Order Details

Order Number:	101643504_1_1
Customer Ref:	J15245
National Grid Reference:	526130, 185990
Slice:	A
Site Area (Ha):	0.1
Search Buffer (m):	1000

Site Details

115 Frognal, LONDON, NW3 6XR