Site Investigation and Basement Impact Assessment Report

56 Elsworthy Road
London NW3

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J12206

August 2013




Geotechnical & Environmental Associates

Document Control

Project title	56 Elsworthy Road, London NW3 3BU		**Project ref**	J12206
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Issue No	**Status**	**Date**	**Approved for Issue**
1	Final	21 September 2012	
2	Final (revised)	31 January 2013	
3	Final (revised)	7 August 2013	

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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 and Basement Impact Assessment (BIA) carried out by Geotechnical and Environmental Associates Ltd (GEA), on the instructions of Davies, Maguire and Whitby, on behalf of PPM (BVI) Ltd, with respect to the construction of a new basement, including a swimming pool and two storey extension to the existing residential building at this site. The purpose of the investigation has been to research the history of the site, to assess the potential for contamination, to determine the soil and hydrogeological conditions, and to provide information to assist with the design of the basement and suitable foundations for the proposed development. The report also includes a Land Stability Impact Assessment and Subterranean Flow Assessment, which form part of the Basement Impact Assessment procedure in accordance with guidelines from London Borough of Camden in support of a planning application. An initial Surface Flow and Flooding Screening Assessment has also been completed, although a full surface flow and flooding risk assessment did not form part of the brief for this project.

DESK STUDY FINDINGS

The earliest map studied, dated 1850, shows the site to be undeveloped, within fields. The site remained undeveloped until the existing house was constructed, at some time between 1896 and 1915, together with Elsworthy Road and the neighbouring houses. The maps do not show any significant changes to have occurred within or adjacent to the site since that time. The River Tyburn historically flowed close to or through the site in a roughly southwards direction towards the River Thames. There are no landfills, contaminated land register entries or notices or pollution incidents recorded in close vicinity to the site.

GROUND CONDITIONS

The investigation encountered a moderate thickness of made ground overlying London Clay, which was proved to the maximum depth investigated of 10.0 m. The made ground comprised brown clay with fragments of brick and clinker, with a thin layer of organic clay towards the base, and extended to depths of between 2.0 m and 3.0 m. The underlying London Clay typically comprised firm medium strength brown or orange-brown mottled grey silty clay, becoming fissured from a depth of around 4.0 m and high strength from a depth of around 5.0 m. Groundwater seepages were encountered at a depth of 2.0 m, towards the base of the made ground, in two of the four boreholes and on subsequent monitoring visits water has been recorded at depths of between 1.75 m and 2.05 m in the three standpipes. A hydrocarbon odour was noted towards the base of the made ground in a single borehole and the chemical analyses measured elevated TPH concentrations in the sample tested from this location, although the TPH was not measured at a concentration that may pose a risk to human health. Concentrations of lead and the PAH benzo(a)pyrene were measured at a concentration that may pose a risk to human health in a single sample of made ground.

RECOMENDATIONS

The formation level for the new basement will extend into the London Clay and foundations will need to be deepened in the vicinity of trees to bypass any desiccated soil. Perched groundwater is likely to be encountered within the made ground in the basement excavation, although it would be prudent to carry out trial excavations to the full basement depth to assess the likely volumes of inflows. It is likely that piles will be appropriate for the support of the basement excavation and to provide structural support. Following completion of the proposed development, the identified contaminated soil will be removed by the basement excavation and limited pathways will exist to expose end users to any contaminants remaining within the soil. Unless further investigation indicates that it is not required, a cover thickness of clean soil will be required in any areas of soft landscaping that remain following the extension. Consideration will also need to be given to the protection of site workers and buried services.

BASEMENT IMPACT ASSESSMENT

A land stability assessment and subterranean flow assessment have been carried out following the information and guidance published by the London Borough of Camden. It is concluded that the proposed development is unlikely to result in any specific land or slope stability issues, or cause harm to neighbouring properties.

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.

1.0 INTRODUCTION

Geotechnical and Environmental Associates Ltd (GEA) has been commissioned by Davies Maguire and Whitby, on behalf of PPM (BVI) Ltd, to carry out a desk study and ground investigation at 56 Elsworthy Road, London NW3 3BU.

This report also forms the slope stability and subterranean (groundwater) flow parts of a Basement Impact Assessment (BIA), which has been carried out in accordance with guidelines from the London Borough of Camden (LBC). A Surface Water Screening Assessment has also been completed, but a full flood risk assessment did not form part of the brief for this project.

1.1 Proposed Development

Consideration is being given to the redevelopment of this site through the construction of a new basement, including a swimming pool and two storey extension to the rear of the existing house.

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

1.2 Purpose of Work

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

- to determine the history of the site and surrounding area, particularly with respect to any previous or present potentially contaminative uses;
- to research the geology and hydrogeology of the site;
- to check records of data on groundwater, surface water and other publicly available environmental data;
- to use the information obtained in the above searches to carry out a qualitative risk assessment with respect to subsurface contamination;
- to provide preliminary advice with respect to the design of suitable foundations and retaining walls;
- to provide an assessment of the impact of the proposed development on land stability and local hydrogeology; and
- to provide a preliminary assessment of the impact of the proposed development on surface water and flooding.

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 the following activities:

- a review of readily available geological maps;
- a review of publicly available environmental data sourced from the Landmark Envirocheck database;
- a review of historical Ordnance Survey (OS) maps supplied by Landmark; and
- a walkover survey of the site.

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

- a single cable percussion borehole, advanced to a depth of 10.0 m, by means of a cable percussion drilling rig;
- standard penetration tests (SPTs), carried out at regular intervals in the cable percussion borehole, to provide additional quantitative data on the strength of the soils;
- three small diameter boreholes advanced using hand-held window sampling equipment to depths of 5.0 m;
- the installation of groundwater monitoring standpipes into three boreholes and two monitoring visits after a period of approximately one week and three weeks;
- a review of trial pit records provided by others for four trial pits excavated to a maximum depth of 0.94 m to expose the existing foundations;
- laboratory testing of selected soil samples for geotechnical purposes and for the presence of contamination; 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.

1.3.1 Basement Impact Assessment

The Basement Impact Assessment (BIA) comprises a subterranean (groundwater) flow assessment and a land stability assessment (also referred to as slope stability assessment) which has been prepared by GEA and is reported, and a surface water and flooding risk assessment, which has not been carried out in full although the results of the initial screening

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

have been prepared by GEA and are reported. These assessments form part of the Basement Impact Assessment (BIA) procedure specified in the London Borough of Camden Planning Guidance CPG4[2] and their Guidance for Subterranean Development[3] prepared by Arup.

The aim of the assessment is to provide information on land stability and in particular to assess whether the development will affect the stability of neighbouring properties. In addition, the assessment will identify potential groundwater impacts that the development may have and how any identified impacts can be appropriately mitigated by the design of the development.

1.4 Qualifications

The land stability assessment 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 20 years specialist experience in ground engineering. The subterranean (groundwater) flow assessment has been carried out by John Evans, a qualified Hydrogeologist, Chartered Geologist (CGeol) and Fellow of the Geological Society of London (FGS). 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 25 years experience in geotechnical engineering and engineering geology. All assessors meet the Geotechnical Adviser criteria of the Site Investigation Steering Group and satisfy the qualification requirements of the Council guidance.

1.5 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.

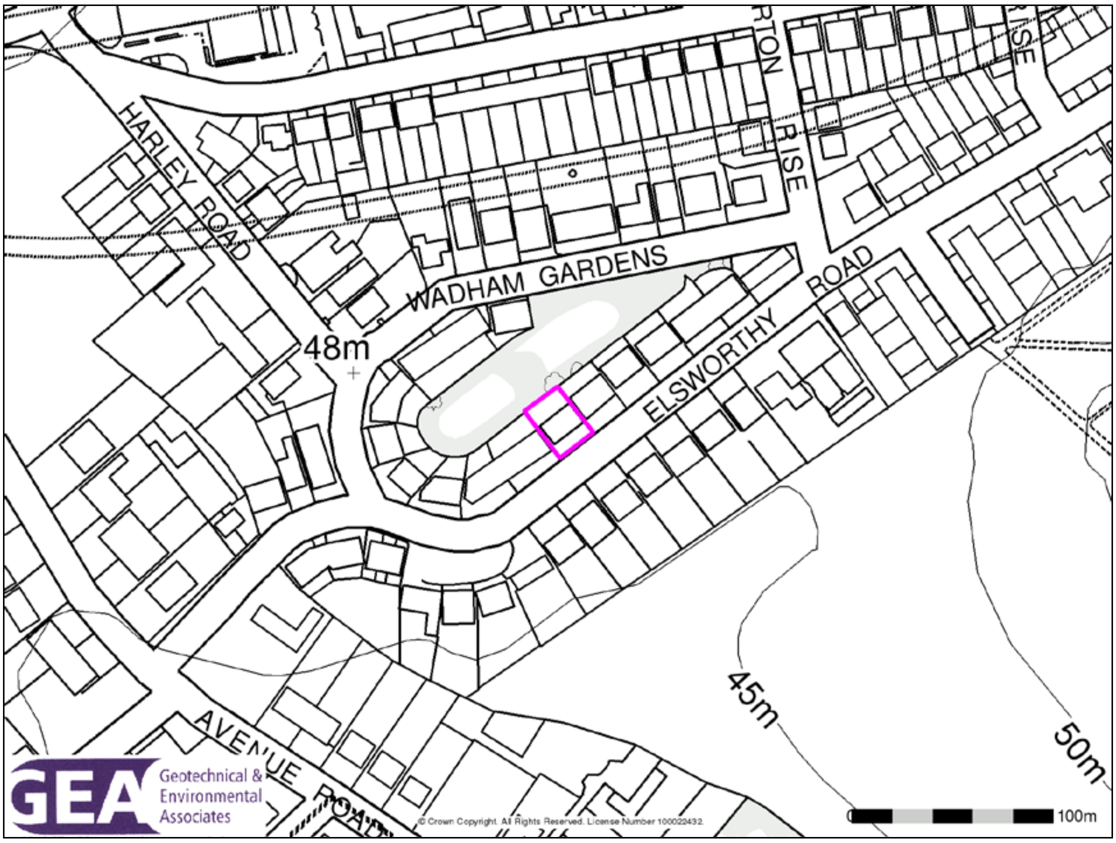
2.0 THE SITE

2.1 Site Description

The site is located in the London Borough of Camden, approximately 100 m northwest of Primrose Hill and 600 m southeast of Swiss Cottage London Underground station. It is rectangular in shape, measuring approximately 20 m by 30 m. It fronts onto Elsworthy Road to the southeast and is bounded to the northeast and southwest by neighbouring detached houses and associated gardens and to the northwest by communal gardens, beyond which are houses fronting onto Wadham Gardens.

The site is shown on the map below and may be additionally located by National Grid Reference 527160, 183960.

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



A walkover survey of the site was carried out by a geotechnical engineer from GEA on 20 August 2012 and some photographs are presented below. The site is occupied by a three storey detached house with a basement, with small garden areas to the front and rear. During the site investigation an open drain was noted in the basement with water running out towards the rear. The front garden is mostly grassed, with a 2 m to 3 m high hedge around the perimeter. The rear garden is predominantly hard-surfaced, with a concrete slab that is in poor condition with weeds growing through cracks, and bushes in planted borders around the perimeter. Mature deciduous trees are present in the communal gardens close to the rear of the site.

The site lies at an elevation between 45 m OD and 50 m OD and is sensibly level, whilst the immediate surrounding area generally slopes down gently southwards. The Slope Angle Map provided in the Arup Report (Figure 16 of the Camden Geological, Hydrogeological and Hydrological Study) shows the site to be within an area where the general slope angle is less than 7˚.

2.2 Site History

The site history has been researched by reference to historical Ordnance Survey (OS) maps sourced from the Envirocheck database.

The earliest map studied, dated 1850, shows the site to be undeveloped and within fields. The map dated 1871 shows the site to remain within an undeveloped area, with built-up residential areas present roughly 120 m to the north, west and southwest, the Eton and Middlesex Cricket Ground approximately 175 m to the northeast and Primrose Hill to the southeast of the site. Residential development was constructed over the cricket ground some time between 1874 and 1895.

The existing house was constructed some time between 1896 and 1915, together with Elsworthy Road, the neighbouring houses along Elsworthy Road, communal gardens to the north and Wadham Gardens beyond. The maps do not show any further significant changes within or adjacent to the site since that time.

2.3 Other Information

The Envirocheck report does not list any historical or current landfills or other waste management facilities within 1 km of the site.

There are no contaminated land register entries or notices and no substantiated pollution incident register entries listed within 1 km of the site and no pollution incidents to controlled waters have been recorded within 500 m of the site.

A single discharge consent is listed within 1 km of the site, relating to the discharge of trade effluent into the River Thames 550 m southeast of the site. This is downstream from the site and therefore not considered likely to impact upon the site.

The site is located in an area where less than 1% of homes are affected by radon emissions; which is the lowest classification given by the Health Protection Agency (HPA) and therefore no radon protective measures will be necessary.

The site is not within any environmentally sensitive areas, such as sites of special scientific interest (SSSI). A local nature reserve is present at St John's Wood church grounds, approximately 900 m south of the site.

No industrial land uses or fuel stations are listed within 500 m of the site.

London Underground Ltd have confirmed that they do not have any assets in the vicinity of the site.

2.4 Geology

The British Geological Survey (BGS) map of the area (Sheet 256) indicates that the site is underlain by Eocene London Clay from the surface, which overlies a downwards sequence of Lambeth Group (sandy clays) overlying Thanet Sand (fine grained sands), which in turn overlies the Cretaceous Chalk. A cross section on the geological map indicates the London Clay to be approximately 50 m thick beneath the site.

The London Clay is overlain by the clays, silts and fine grained sands of the Eocene Claygate Member approximately 1.2 km to the north of the site, which is in turn overlain by the fine sands of the Bagshot Beds.

The Envirocheck Report indicates that, according to the BGS National Geoscience Information Service, there is a moderate hazard potential for shrinking or swelling clay ground stability hazards at the site.

2.5 Hydrology and Hydrogeology

The nearest surface water feature is listed in the Envirocheck Report as 477 m northwest of the site. Regents Canal is approximately 650 m south of the site.

The site is not located within a Flood Zone as defined by the Environment Agency, and Elsworthy Road has not been identified as a street at risk of surface water flooding within the London Borough of Camden. The Camden Geological, Hydrogeological and Hydrological Study Flood Map (Figure 15 in the Arup Report) does not show the site to be within an area with the potential to be at risk of surface water flooding.

Spring lines are present at the interface of the Bagshot Beds and the Claygate Member in the area of Hampstead Heath and, to a lesser extent, near the boundary between the Claygate Member and the underlying lowly permeable London Clay. These springs have been the source of a number of London's "lost" rivers, including the Tyburn which rose roughly 1.3 km north of the site and flowed southwards, passing very close to or through the site before continuing south-southeastwards towards Regents Park. The Tyburn is entirely covered and culverted and forms part of the sewerage system, running beneath South Hampstead.

The Environment Agency classifies the London Clay as Unproductive Strata (formerly Non Aquifer), i.e. not capable of providing useable quantities of water; however this classification may not take into account local geological variations within the sandier upper unit of the London Clay Formation. The chalk is classified as a Principal (formerly Major) Aquifer, although it is highly confined beneath over 50 m of Eocene London Clay and Lambeth Group clays and is not at risk from the proposal.

The site lies within a Source Protection Zone II (Outer Protection Zone) as designated by the Environment Agency. The nearest licensed groundwater abstractions listed to the site are 467 m to the northwest and 532 m to the southeast. These abstractions are from the Chalk aquifer and are not in hydraulic continuity with the proposed development as described above.

Groundwater within the London Clay beneath the site is considered to be dominated by fissure flow. Due to the very low permeability of the London Clay, any groundwater flow will be at very low rates. Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1×10^{-10} m/s and 1×10^{-8} m/s, with an even lower vertical permeability. Without evidence to the contrary, groundwater flow beneath the site is anticipated to follow topographic contours toward the south.

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 historical usage of the site that has been established by the desk study and the site walkover indicates that the site does not have a potentially contaminative history by virtue of it having been occupied by the existing residential property for its entire developed history. There are thus no obvious likely sources of contamination on the site or in its immediate vicinity and no potential sources of soil gas have been identified in the vicinity of the site. However, as with any previously developed site, there may be areas where spillages or dumping of material have resulted in isolated contaminant sources, although it is likely that the excavation of the proposed basement would result in the removal of most shallow potential sources.

2.6.2 Receptor

Residents of the house following the proposed extension represent sensitive receptors, as is the existing situation. The London Clay beneath the site is unproductive strata and, therefore, near-surface groundwater is not considered to be a sensitive receptor, whilst groundwater at depth within the Chalk is considered to be a sensitive receptor. Site workers, who will come into contact with any contaminated soils during the ground work and plastic services, which will come into contact with any contaminants within the soil in which they are laid, are also potential sensitive receptors.

2.6.3 Pathway

The proposed extension will form a barrier between the end users and soil. Only in any remaining garden areas of planting or soft landscaping will there be a potential contaminant exposure pathway to end users of the site. The London Clay essentially forms a barrier to groundwater flow into the underlying chalk. Therefore there will be very limited potential contaminant exposure pathways to the end users of the site or groundwater in the Principal Aquifer at depth below the site. Site workers may come into direct contact with any contaminated soils during ground works and services will come into contact with any contaminants present in soils through which they are laid.

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 contaminant linkage at this site which would result in a requirement for major remediation work. Furthermore as there is no evidence of filled ground within the vicinity of the site and no landfill sites, 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 LBC guidance suggests that any development proposal that includes a subterranean basement should be screened to determine whether or not a full BIA is required. A number of screening tools are included in the Arup document and for the purposes of this report reference has been made to Appendix E.

3.1 Stability Screening Assessment

Reference has been made to Appendix E of the Arup document, which includes 14 questions within a slope stability screening flowchart. Responses to the questions are tabulated below.

Question	Response for 56 Elsworthy Road
1. Does the existing site include slopes, natural or manmade, greater than 7°?	*No.*
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. The slope angle map provided in the Arup Report (Figure 16) shows the site to be in an area where the slope is less than 7°.*
5. Is the London Clay the shallowest strata at the site?	*Yes.*
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?	*No.*
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	*Yes. The area is prone to these effects as a result of the presence of London Clay with high volume change potential.*
8. Is the site within 100 m of a watercourse or potential spring line?	*Yes. The former course of the River Tyburn flowed close to or through the site the site (now culverted), although the closest existing surface water feature is over 100 m from the site.*
9. Is the site within an area of previously worked ground?	*No.*
10. Is the site within an aquifer?	*No. The site is underlain by the London Clay which is designated as Unproductive Strata by the Environment Agency and cannot store and transmit usable amounts of water.*
11. Is the site within 50 m of Hampstead Heath ponds?	*No. The site is approximately 2 km south of Hampstead Heath.*
12. Is the site within 5 m of a highway or pedestrian right of way?	*No. Although the site fronts onto Elsworthy Road, a public road, the proposed new basement and extension are at the rear of the site, more than 5 m from the road.*
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	*Yes. It is understood that the basement will extend to a depth of about 5.5 m where the swimming pool is proposed.*
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:

Q5 The London Clay is the shallowest stratum at the site.
Q7 The site is underlain by London Clay, which is prone to shrink-swell subsidence.
Q8 The former course of the River Tyburn passed through or close to the site.
Q13 The proposed basement will significantly increase the differential depth of foundations relative to the neighbours

The potential issues that need to be assessed are discussed further in Part 2 of this report.

3.2 Subterranean (Groundwater) Flow Screening Assessment

Reference has been made to Appendix E of the Arup document, which includes 6 questions within a subterranean (groundwater) flow screening flowchart. Responses to the questions are tabulated below.

Question	Response for 56 Elsworthy Road
1a. Is the site located directly above an aquifer?	*No. The site is underlain by the London Clay which is designated as Unproductive Strata by the Environment Agency and cannot store and transmit usable amounts of water.*
1b. Will the proposed basement extend beneath the water table surface?	*Unknown. Ground investigation required to assess the presence of groundwater.*
2. Is the site within 100m of a watercourse, well (used/disused) or potential spring line?	*Yes. The River Tyburn flowed through or close to the site (now culverted), although the closest existing surface water feature is over 100 m from the site.*
3. Is the site within the catchment of the pond chains on Hampstead Heath?	*No. The site is located approximately 2 km south of Hampstead Heath.*
4. Will the proposed development result in a change in the proportion of hard surfaced / paved area?	*No. The extent of the proposed extension is across an existing hard surfaced area of the rear garden.*
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to ground (e.g. via soakaways and/or SUDS)?	*No. The low permeability of the London Clay makes it unsuitable for receiving discharge to the ground.*
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 (not just the pond chains on Hampstead Heath) or spring line?	*No. There are no ponds or spring lines in the vicinity of the site.*

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

Q1b It is unlikely that the proposed basement structure will extend below the water table, but a ground investigation is required to confirm the groundwater conditions.
Q2 The former course of the River Tyburn passed through or close to the site.

The potential issues that need to be assessed are discussed further in Part 2 of this report.

3.3 Surface Flow and Flooding Screening Assessment

This element of the BIA is provided for guidance only and should be confirmed by a suitably qualified engineer experienced in carrying out surface water assessments.

Reference has been made to Appendix E of the Arup document, which includes six questions within a surface flow and flooding screening flowchart. Responses to the questions are tabulated below and are partly based on information provided by the consulting engineers.

Question	Response for 56 Elsworthy Road
1. Is the site within the catchment of the pond chains on Hampstead Heath?	*No. The site is located approximately 2 km south of Hampstead Heath.*
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*
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	*No. The extent of the proposed extension is across an existing hard surfaced area of the rear garden.*

Question	Response for 56 Elsworthy Road
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*
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	*No*
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?	*No.*

The above assessment has not identified any potential issues that need to be assessed and this aspect of the BIA is not considered to warrant additional consideration:

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.

4.1 Potential Impacts

4.1.1 Slope Stability Scoping Assessment

The following potential impacts have been identified that may have an impact on slope stability.

Screening Issue	Potential Impact
London Clay is the shallowest strata at the site	London Clay is prone to seasonal shrink-swell (subsidence and heave)
The site is underlain by clay prone to shrink-swell	Seasonal shrink-swell can result in foundation movements and in particular if a new basement is 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
The former course of the River Tyburn passed close to or through the site	Changes in groundwater regimes within slopes can affect slope stability
The proposed basement will significantly increase the differential depth of foundations relative to the neighbouring properties	Excavation for a basement may result in structural damage to neighbouring properties if there is a significant differential depth between adjacent foundations

These potential impacts have been investigated through the site investigation, as detailed below.

4.1.2 Subterranean (Groundwater) Flow Scoping Assessment

The following potential impacts have been identified that may have an impact on subterranean flow.

Screening Issue	Potential Impact
The basement structure may extend into saturated ground	The groundwater flow regime may be altered by the proposed basement. Changes in flow regime could potentially cause the groundwater level within the zone encompassed by the new flow route to increase or decrease locally. For existing nearby

Screening Issue	Potential Impact
	structures the degree of dampness or seepage may potentially increase as a result of changes in groundwater level.
The former course of the River Tyburn passes through or close to the site	The flow from a watercourse may increase or decrease if the groundwater flow regime which supports that water feature is affected by a proposed basement. If the flow is diverted, it may result in the groundwater flow finding another location to issue from with new springs forming or old springs being reactivated. There may also be an impact on water quality.

These potential impacts have been investigated through the site investigation, as detailed below.

4.1.3 Surface Flow and Flooding Scoping Assessment

The final drainage and landscaping scheme proposals will need to be reviewed in order to determine whether there are any potential impacts on surface flow. The screening has however not indicated any potential impacts at this stage.

4.2 Exploratory Work

In order to meet the objectives described in Section 1.2, within the access constraints posed by the presence of the existing house on the site, a single borehole was advanced to a depth of 10.0 m, by means of a cable percussion rig, at the front of the house and three small diameter boreholes were advanced to depths of 5.0 m using hand-held window sampling equipment in the garden to the rear of the house.

Standard Penetration Tests (SPTs) were carried out at regular intervals in the cable percussion borehole, to provide quantitative data on the strength of the soil, and pocket penetraometer tests were carried out on samples retrieved from the window sample boreholes, to provide a preliminary indication of the presence of desiccated soil. Groundwater monitoring standpipes were installed in three boreholes and a single monitoring visit was undertaken, together with rising head tests, roughly three weeks following installation. Additionally, four trial pits were excavated by others to determine the configuration of the existing foundations.
A selection of disturbed and undisturbed samples recovered from the boreholes was submitted to a soil mechanics laboratory for a programme of geotechnical testing and an analytical laboratory for a programme of contamination testing.

The borehole records and results of the laboratory analyses are appended, together with a site plan indicating the exploratory positions.

4.2.1 Sampling Strategy

The boreholes were positioned in accessible areas of the site, to provide optimum coverage of the site with due respect to the location of the proposed extension and whilst avoiding the areas of known services.

Three samples recovered from the made ground 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 overview of the chemical conditions of the soils that are likely to be involved in a human exposure or groundwater pathway and to provide advice in respect of re-use or for waste disposal classification. The samples from Borehole Nos 2 and 3 are considered to represent the general fill material that may be encountered across the area of proposed work, whilst the sample from Borehole No 4 represents fill material that was noted to have a hydrocarbon odour. 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.

5.0 GROUND CONDITIONS

The investigation confirmed the expected ground conditions in that, beneath a moderate thickness of made ground, London Clay was encountered and proved to the full depth of the investigation of 10.0 m.

5.1 Made Ground

Made ground was found to extend to a depth of 3.0 m in Borehole No 1, at the front of the site, and to depths of between 2.0 m and 2.5 m in Borehole Nos 2 to 4, at the rear of the site. The made ground typically comprised brown clay with fragments of brick and clinker, with a thin layer of organic clay at the base, at a depth of 1.9 m, in Borehole Nos 2 and 3.

A hydrocarbon odour was noted within the base of the made ground, from a depth of 1.8 m, in Borehole No 4 only. No visual or olfactory evidence of contamination was reported within the other boreholes, with the exception of fragments of extraneous material such as tarmac and clinker which commonly contain elevated concentrations of PAH contaminants. Samples of the made ground were analysed for a range of contaminants and the results are summarised in Section 5.4.

5.2 London Clay

The London Clay typically comprised firm brown or orange-brown mottled grey silty clay, becoming fissured from a depth of around 4.0 m, and was proved to the maximum depth investigated of 10.0 m. A parting of silty fine sand was recorded within the clay at a depth of 3.7 m in Borehole No 3.

No evidence of desiccation was observed during the ground investigation and this has been confirmed by the results of laboratory classification tests. Laboratory Atterberg limit tests carried out on samples of the clay generally indicate it to be of moderate to high volume change potential.

Quick unconsolidated undrained triaxial compression tests undertaken on undisturbed samples of the clay indicated its undrained shear strength to generally increase with depth, from 53 kN/m^2 at a depth of 2.0 m to 118 kN/m^2 at a depth of 9.5 m, indicating the strength of the clay to increase from medium to high strength over this depth range.

5.3 Groundwater

Groundwater seepages were noted towards the base of the made ground in Borehole Nos 2 and 3, at depths of 2.0 m, but groundwater was not encountered during drilling of the other two boreholes. The low rates of groundwater inflow (where encountered) during drilling are reflective of low permeability strata.

Groundwater monitoring standpipes were installed to a depth of 10.0 m in Borehole No 1 and to depths of 5.0 m in Borehole Nos 2 and 4. The results from monitoring visits carried out to Borehole No 1 four days after installation and all three standpipes roughly three weeks after installation are presented in the table below.

Date	Depth To Groundwater (mbgl)		
	BH1	BH2	BH4
28 Aug 12	2.00	-	-
14 Sep 12	2.05	1.91	1.75

A rising head test was carried out in the standpipe installed in Borehole No 1 on 14 September 2012 and the results are presented in the appendix. Following bailing out the water to a depth of 4.90 m, the water level had returned to a depth of 2.22 m after two hours. Analysis of the rising head test results provides a permeability of the London Clay of c.2 x 10^{-8} m/s which is typical of low permeability clay strata. The data indicates that there is some seepage from perched water within the made ground beneath the site.

On the basis of the fieldwork and subsequent monitoring results, the groundwater encountered appears to be both present within the low permeability London Clay and perched on the London Clay towards the base of the made ground.

5.4 Soil Contamination

The table below sets out the range of values measured within three samples of made ground analysed, whilst the significance of the results is considered in more detail in Part 2. All concentrations are in mg/kg unless otherwise stated.

Determinant	BH2 0.2 m (mg/kg)	BH3 1.0 m (mg/kg)	BH4 1.9 m (mg/kg)
pH	8.0	9.0	8.0
Arsenic	18	<2.0	8.6
Cadmium	0.44	<0.10	<0.10
Chromium	29	8.2	35
Lead	**1500**	75	53
Mercury	0.54	0.12	0.39
Selenium	0.84	<0.20	0.31
Copper	100	14	17
Nickel	24	10	19
Zinc	380	29	52
Total Cyanide	<0.50	<0.50	<0.50
Total Phenols	<0.3	<0.3	<0.3

Determinant	BH2 0.2 m (mg/kg)	BH3 1.0 m (mg/kg)	BH4 1.9 m (mg/kg)
PAH	**63**	2.7	<2
Naphthalene	<0.1	<0.1	<0.1
Benzo(a)pyrene	**5.3**	0.21	<0.1
Sulphide	3.7	1.7	8.2
TPH	140	<10	**1600**
Total organic carbon %	5.7	1.3	3.2
Figure in **bold** indicates concentration in excess of risk-based soil guideline values, on the basis of a residential end use, as discussed in Part 2 of this report			

The chemical analyses measured concentrations of lead and total polyaromatic hydrocarbons (PAH), including benzo(a)pyrene, in the sample from Borehole No 2 at elevated levels in excess of their respective guideline values, indicating a potential risk to human health. With the exception of benzo(a)pyrene, no concentrations of any other individual PAH species analyses were measured in excess of their respective guideline values.

An elevated concentration of Total Petroleum Hydrocarbons (TPH) was measured in the sample from Borehole No 4, where a hydrocarbon odour had been observed during the fieldwork, although no individual hydrocarbon chain species were elevated above their respective guideline values in this sample. The TPH contamination is not, therefore, considered to pose a risk to human health.

The significance of these results is discussed in further detail below and in Part 2 of this report.

5.4.1 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[4] Soil Guideline Value where available, or is a Generic Guideline Value calculated using the CLEA UK Version 1.06 software assuming a residential end use.

The key generic assumptions for a residential end use are as follows:

- that groundwater will not be a critical risk receptor;
- that the critical receptor for human health will be young female children aged zero to six years old;
- 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

4 *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.

produce, skin contact with soils and indoor dust, and inhalation of indoor and outdoor 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 the initial generic assessment of the site. 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 concentrations of the contaminants of concern highlighted by a comparison of the measured concentrations against the generic screening values are tabulated below. This assessment is based upon the potential for risk to human health, which at this site that is underlain by unproductive strata is considered to be the critical risk receptor.

Contaminant of Concern	Maximum concentration recorded (mg/kg)	Location of maximum concentration recorded	Generic Risk-Based Screening Value
Lead	1500	BH2 0.2 m	450
PAH	63		6.7
Benzo(a)pyrene	5.3		1.00

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

5.5 Existing Foundations

The Consulting Engineer provided records of trial pits that were excavated by others.

The three trial pits excavated against the existing house at ground floor level encountered brick corbels over a concrete footing bearing on clay at depths of around 0.9 m. Groundwater was not encountered in these trial pits. A single trial pit excavated in the existing basement was abandoned due to the ingress of water.

A copy of the trial pit records is provided in the appendix.

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 foundation options and other aspects of the development.

6.0 INTRODUCTION

Consideration is being given to the construction of a new basement and two storey extension to the rear of the existing house at this site. It is understood that the proposed basement will generally extend to a depth of about 3.4 m below ground level, increasing to about 4.50 m in a proposed pool room, with the swimming pool itself extending to about 5.50 m below ground level.

7.0 GROUND MODEL

The desk study has revealed that the site has not had a potentially contaminative history, having apparently been occupied by the existing residential property for the entirety of its developed history. On the basis of the fieldwork, the ground conditions at this site can be characterised as follows.

- Beneath a moderate thickness of made ground, London Clay was proved to the maximum depth investigated of 10.0 m;
- made ground, typically comprising brown clay with fragments of brick and clinker, with a thin layer of organic clay at the base, extends to depths of between 2.0 m and 3.0 m;
- the underlying London Clay comprises firm brown or orange-brown mottled grey silty clay, becoming fissured from a depth of around 4.0 m;
- groundwater seepages were encountered towards the base of the made ground, at depths of 2.0 m, in two of the four boreholes and on subsequent monitoring visits water has been recorded at depths of beteween 1.75 m and 2.05 m in all three standpipes installed. The groundwater appears to be perched within the made ground and present within the low permeability London Clay strata.
- a hydrocarbon odour was noted towards the base of the made ground in a single borehole and the chemical analyses have measured elevated concentrations of TPH on a sample tested from this location, although not at a concentration that may pose a risk to human health, and have measured concentrations in a single sample from a different location of lead and PAH, including benzo(a)pyrene, at concentrations that may pose a risk to human health.

8.0 ADVICE AND RECOMMENDATIONS

Excavations for the proposed basement structure will require temporary support to prevent any excessive ground movements and it is unlikely to be feasible to construct the new basement without the requirement for some level of groundwater control. It would be prudent to carry out further investigation to assess the volume of water likely to flow into the basement excavation.

Formation level for the proposed basement is likely to be within the firm clay of the London Clay, which should provide an eminently suitable bearing stratum for spread foundations although consideration should be given to the likely presence of both perched groundwater within the made ground and groundwater within the London Clay. Piled foundations would provide a suitable alternative solution for providing both support for the basement excavation and for the new structure.

8.1 Basement Excavation

The investigation has indicated that groundwater is likely to be encountered within the approximately 3.0 m deep basement excavation. Water was encountered in two of the four boreholes during drilling, at depths of 2.0 m, and has subsequently been measured in all three standpipes at depths of between 1.75 m and 2.05 m. The water appears to be predominantly perched within the made ground, above the London Clay. Although no groundwater was encountered within the London Clay during drilling, analysis of the rising head test indicates that the London Clay is saturated beneath the made ground and is very slowly permeable. The made ground, which was found to comprise clay, is also of a low permeability. The rising head test carried out in the standpipe in Borehole No 1 indicates the rate of inflow into an excavation is likely to be relatively low. It is not possible to draw wholly meaningful conclusions from the measurements made in the standpipes, as the level of the water table is not as significant as the volume of water that may flow into the excavation. For example, a high level of water measured in a standpipe may not be significant if this represents only a small volume of water. It would therefore be prudent to carry out a number of trial excavations, to depths as close to the full basement depth as possible, to provide an indication of the likely ground water conditions.

The design of basement support in the temporary and permanent conditions needs to take account of the need to maintain the stability of the excavation and surrounding structures and to protect against groundwater inflows.

A bored pile wall may be the most reliable method of 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 monitoring observations to date a contiguous piled wall is likely to be appropriate, with sump pumping required to deal with groundwater inflows between the piles. Alternatively, a sheet piled wall could be used as a temporary measure, prior to the construction of a permanent structure following the completion of the basement excavations. It is recommended that the advice of a specialist piling contractor should be sought in this respect and consideration should also be given to the noise and vibrations associated with the installation of sheet piles, unless a “silent” installation method is adopted. Care would need to be taken if water jetting of sheet piles is adopted, in view of the risk of causing settlement of the adjacent buildings and structures.

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. Consideration will need to be given to a retention system that maintains the stability at all times of the existing and neighbouring properties. Excavation of an approximately 3.0 m deep basement will result in settlement and lateral displacement behind the basement wall; the stability of the adjacent buildings will need to be ensured at all times and the retaining walls will need to be designed to accommodate the loads from these foundations unless they are underpinned.

8.1.1 Basement Retaining Walls

The following parameters are suggested for the design of the permanent basement retaining walls.

Stratum	Bulk Density (kg/m^3)	Effective Cohesion (c' – kN/m^2)	Effective Friction Angle (φ' – degrees)
Made Ground	1700	Zero	25
London Clay	1900	Zero	25

The investigation has indicated that groundwater is likely to be encountered within the basement excavation and the advice in BS8102:2009[5] should be followed with respect to waterproofing.

8.1.2 Basement Heave

The excavation of a maximum of around 5.5 m of soil for the proposed basement will result in an unloading of up to approximately 180 kN/m^2, which will result in heave of the underlying London Clay. This will comprise an "immediate" elastic component that may be expected to occur within the construction period, together with long term swelling movement that would theoretically occur over a period of many years. The effects are likely to be mitigated to some extent by the loads applied by the proposed structures. However, a detailed analysis of the likely movements should be carried out once the basement design has been finalised.

8.2 Spread Foundations

Moderate width strip or pad foundations bearing on the firm clay of the London Clay at a minimum depth of 1.5 m may be designed to apply a net allowable bearing pressure of 120 kN/m^2. This recommended bearing pressure includes an adequate factor of safety to protect against bearing capacity failure and should ensure that settlement remains within normal tolerable limits.

Foundations will need to be deepened in the vicinity of existing and proposed trees and National House Building Council (NHBC) guidelines should be followed in this respect. High shrinkability clay should be assumed. 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 any desiccation, and 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. The requirement for compressible material alongside foundations should be determined by reference to the NHBC guidelines.

On the basis of the groundwater monitoring carried out, groundwater is likely to be encountered within the approximately 4.0 m to 5.5 m deep basement excavation and there may be difficulties in controlling groundwater to allow such foundations to be excavated. Any inflows into foundation excavations may be controllable by sump pumping, although it would be prudent to carry out trial excavations as noted in Section 8.1 above.

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

8.3 Piled Foundations

For the ground conditions at this site, driven or bored piles could be adopted. Driven piles would have the advantage of minimising the spoil that is generated, but the effects of noise and vibrations on neighbouring sites may not be acceptable. Some form of bored pile may therefore be more appropriate.

The following table 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.

Ultimate Skin Friction		***kN/m²***
Basement excavation	GL to 4.0 m (varies)	Ignore
London Clay (α = 0.5)	4.0 m to 10.0 m	Increasing linearly from 25 to 60
Ultimate End Bearing		**kN/m²**
London Clay	6.0 m to 10.0 m	Increasing linearly from 720 to 1080

In the absence of pile tests, guidance from the London District Surveyors Association[6] (LDSA) suggests that a factor of safety of 2.6 should be applied to the above coefficients in the computation of safe theoretical working loads. On the basis of the above coefficients, applying a factor of safety of 2.6, it has been estimated that a 450 mm diameter pile extending 7 m below the proposed 3.0 m deep basement, to a depth of 10.0 m, should provide a safe working load of about 230 kN.

The above example is 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 the presence of groundwater within the London Clay.

8.4 Shallow Excavations

On the basis of the boreholes, it is considered likely that it will be feasible to form relatively shallow excavations that extend into the made ground without the requirement for lateral support, although localised instabilities may occur from within the made ground. Where personnel are required to enter excavations, a risk assessment should be carried out and temporary lateral support or battering of the excavation sides will be required in order to comply with normal safety requirements.

Inflows of groundwater into shallow excavations, less than around 2.0 m deep, are not generally anticipated, although seepages may be encountered from perched water tables within the made ground, particularly within the vicinity of existing foundations. Such inflows should be suitably controlled by sump pumping.

6 LDSA (2009) *Foundations No 1 – Guidance notes for the design of straight shafted bored piles in London Clay*. LDSA Publications

8.5 Basement 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.

8.6 Effect of Sulphates

Chemical analyses of three samples of the London Clay have revealed low concentrations of soluble sulphate and near neutral pH, corresponding to Class DS-1 and AC-1s of Table C2 of BRE Special Digest 1:2005, assuming static groundwater conditions. The guidelines contained in the above digest should be followed in the design of any new foundation concrete.

8.7 Site Specific Risk Assessment

Consideration is being given to the construction of an extension to the existing house at this site, including a basement. Following the proposed work, the site will remain in use as a residential property, as the existing situation, with a reduced garden area. On the basis of the desk study findings, which indicate the site to have been occupied by the existing house since first being developed, the site is considered to have a low risk of contamination.

Chemical analyses carried out on samples of the made ground have identified the presence of concentrations of lead and the PAH benzo(a)pyrene which are in excess of their respective adopted generic screening values and could thus pose a potentially unacceptable risk to human health through direct contact, accidental ingestion or inhalation of soil or soil derived dust, in a single sample of the made ground. These elevated concentrations are likely to results from the presence of clinker within the sample tested. Benzo(a)pyrene is considered to be non-volatile or of a low volatility and to be of a generally low solubility and does not thus present a significant vapour risk or a significant risk of leaching and migration within any perched groundwater.

In addition, an elevated concentration of Total Petroleum Hydrocarbon (TPH) was measured in a single sample of made ground, where a hydrocarbon odour was noted during the fieldwork. However, a review of the results from the chemical analyses has not identified any individual TPH species to be at concentrations in excess of their respective guideline values and a risk to human health is not, therefore, envisaged.

No elevated concentrations of any other contaminants were measured.

The following table provides a summary of the risk assessment and indicates where a pollution linkage has been established for which remedial action or further investigation will be required. This assessment is based upon the existing situation environmental situation, with a view to carrying out remediation prior to redevelopment for residential purposes.

SOURCE	RECEPTOR	PATHWAY	COMMENTS
PAH (benzo(a)pyrene), lead and hydrocarbon contamination within near surface soils	end users	direct contact	end users will be effectively isolated from contaminants by buildings and hardstanding, as is the existing situation, although precautions may be necessary in any areas of soft landscaping
		vapours	the contaminants identified are of low volatility and as such do not present a significant vapour risk
	groundwater	percolation	the contaminants identified are considered to be of low solubility and thus do not present a significant risk of leaching and migration within groundwater. Additionally, the site is predominantly covered by impermeable surfacing, and underlain by lowly permeable London Clay, significantly limiting infiltration of surface water thereby preventing percolation of water through any contaminated near-surface soil to the underlying Principal Aquifer or adjacent sites.
	adjacent sites	groundwater migration	
	site workers during construction	ingestion of contaminated soil or dust, skin contact, inhalation	appropriate protective equipment and working practices will be required during demolition and groundwork
	plastic services	direct contact	protection from hydrocarbon contaminants may be necessary
	foundation concrete	direct contact	protection from hydrocarbon contaminants may be required if the retardation of setting cannot be tolerated
	vegetation	uptake via soil, ground water or vapour	remediation or protection from contaminants may be required in order to ensure successful plant growth in affected areas

Each of the potential pollution linkages is considered in more detail below.

8.7.1 End Users and Vegetation: Direct Contact

The affected soils will largely be removed by excavation of the proposed basement and end users will be effectively isolated from direct contact with any remaining contaminants by the buildings and areas of external hardstanding. Only in areas of soft landscaping in the garden could end users conceivably come into direct contact with the contaminated soils.

The investigation to date has identified elevated concentrations of benzo(a)pyrene and lead in a single sample of made ground, attributed to the presence of clinker within the sample. Therefore, contact through dust, inhalation or ingestion are unlikely due to the particle size of the affected material. It would, however, be prudent to carry out additional contamination investigation within any areas of the garden that will remain as soft landscaping following the proposed redevelopment, to determine the extent of contamination and whether remediation is required, or to follow the recommendation below as a precautionary measure.

At this stage it is recommended that, within any affected areas, a cover thickness of imported subsoil and topsoil of 600 mm in thickness should be specified to ensure successful plant growth, in accordance with recommendations from BRE[7]. It may be possible to reduce the final thickness of cover required, but this will need to be determined once final levels have been established and the concentrations of potential contaminants within the imported material are known.

[7] BRE (2004) *Cover systems for land regeneration. Thickness of cover systems for contaminated land.* BRE pub 465

8.7.2 Site Workers

Concentrations of potentially carcinogenic contaminants have been measured in the made ground. 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[8] and CIRIA[9] and the requirements of the Local Authority Environmental Health Officer.

87.3 Services

Consideration may need to be given to the protection of buried plastic services laid within the made ground. Details of the proposed protection measures for buried plastic services will in any case need to be approved by the EHO and the relevant service authority prior to the adoption of any scheme. It is possible that barrier pipe will be required or additional testing will need to be carried out.

8.8 Waste Disposal

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE guidance[10], will need to be disposed of to a licensed tip. 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 going to landfill is subject to landfill tax at either the standard rate of £64 per tonne (about £120 per m^3) or at the lower rate of £2.50 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 rocks and soils, which are accurately described as such in terms of the 2011 Order[11], would qualify for the 'lower rate' of landfill tax.

Based upon on the technical guidance provided by the Environment Agency[12] it is considered likely that the made ground from this site, as represented by the three chemical analyses carried out, would generally be classified as NON-HAZARDOUS waste under the waste code 17 05 04 (soils and stones not containing dangerous substances) and would be taxable at the standard rate, although the hydrocarbon impacted soil may be classified as HAZARDOUS waste. It is likely that the natural soils, if separated out, could be classified as an INERT waste also under the waste code 17 05 04. This material would be taxable at the lower rate, if accurately described as naturally occurring clay in terms of the 2011 Order on the waste transfer note. As the site has never been developed or used for the storage of potentially hazardous materials, it is likely that WAC leaching tests would not be required for such inert waste going to landfill. This would however need to be confirmed by the receiving landfill site.

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.

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

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

10 CL:AIRE (2011) *The Definition of Waste: Development Industry Code of Practice* Version 2, March 2011

11 *Landfill Tax (Qualifying Material) Order 2011*

12 Environment Agency (2008) *Hazardous Waste: Interpretation of the definition and classification of hazardous waste. Technical Guidance* WM2 Second Edition Version 2.2, May 2008

The Environment Agency has issued a position paper[13] 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" on site by sufficiently characterising the soils insitu prior to excavation.

The above opinion with regard to the classification of the excavated soils and its likely landfill taxable rate 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.

If consideration were to be given to the re-use of the soil as a structural fill on this or another site, in accordance with the Code of Practice for the definition of waste, it would be necessary to confirm its suitability for use, its certainty of use and to confirm that only as much material is to be used as is required for the specific purpose for which it was being used. A materials management plan could then be formulated and a tracking system put in place such that once placed the material would no longer be regarded as being a waste and thus waste management licensing and landfill tax would not apply.

9.0 BASEMENT IMPACT ASSESSMENT

The current development proposal includes the construction of a new basement, including a swimming pool. It is anticipated that the basement will extend to a depth of 5.5 m below ground level and formation level will, therefore, be within the London Clay.

The slope stability screening identified four potential impacts and the subterranean flow screening identified two potential impacts. The desk study and ground investigation information has been used below to review the potential impacts identified by the slope stability screening and subterranean flow screening, to assess the likelihood of them occurring and the scope for reasonable engineering mitigation.

9.1 Slope Stability Impact Assessment

Potential Impact	Site Investigation Conclusions
London Clay is the shallowest strata at the site – *London Clay is prone to seasonal shrink-swell (subsidence and heave)*	Foundations must be extended to sufficient depth to be below the zone affected by volume changes of the clay, taking into account the presence of trees at the site in accordance with NHBC guidelines, and inspected to ensure they are below the depth of any desiccation.
The site is underlain by clay prone to shrink-swell – *seasonal shrink-swell can result in foundation movements and in particular if a new basement is 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*	The proposed development will not be structurally linked to neighbouring properties. The stability of the existing house should be ensured at all times, with underpinning carried out if necessary.
The proposed basement will significantly increase the differential depth of foundations relative to the neighbouring properties	A suitably designed and maintained retention scheme will serve to minimise damage to neighbouring properties

13 Regulatory Position Statement (2007) *Treating non-hazardous waste for landfill - Enforcing the new requirement* Environment Agency 23 Oct 2007

Potential Impact	Site Investigation Conclusions
The proposed basement will significantly increase the differential depth of foundations relative to the neighbouring properties	A suitably designed and maintained retention scheme will serve to minimise damage to neighbouring properties
The former course of the River Tyburn passed close to or through the site – *changes in groundwater regimes within slopes can affect slope stability*	The River Tyburn no longer exists as a surface watercourse and is not considered likely to be affected, or have any effect on, the proposed development.

The screening and scoping stages have identified potential adverse impacts relating to land stability associated with the proposed development. However, the proposed development is unlikely to result in any specific land or slope stability issues; the design of the foundations and of basement support in the temporary and permanent conditions for the proposed development must take into account the need to maintain the stability of the excavation and the surrounding structures, and to protect against groundwater inflows.

9.2 Subterranean (Groundwater) Flow Impact Assessment

Potential Impact	Site Investigation Conclusions
The basement structure may extend into saturated ground - *the groundwater flow regime may be altered by the proposed basement. Changes in flow regime could potentially cause the groundwater level within the zone encompassed by the new flow route to increase or decrease locally. For existing nearby structures the degree of dampness or seepage may potentially increase as a result of changes in groundwater level.*	The ground investigation has confirmed the presence of groundwater both in the made ground and the London Clay, within the depth of the proposed basement excavation. Consideration will need to be given to the control of groundwater during excavation of the basement and construction of the foundations. However, further investigation is required to determine the volumes of water likely to be encountered in the excavation. Since the made ground predominantly comprises clay it is likely to be of low permeability and as with the London Clay it will not store and transmit significant quantities of groundwater. The proposed basement will therefore not result in a significant change to the groundwater regime in the vicinity. The basement will not form a barrier to groundwater flow, since it is relatively shallow and water, where present, will flow around it.
The course of the River Tyburn passed close to or through the site – *the flow from a watercourse may increase or decrease if the groundwater flow regime which supports that water feature is affected by a proposed basement. If the flow is diverted, it may result in the groundwater flow finding another location to issue from with new springs forming or old springs being reactivated. There may also be an impact on water quality.*	The site is underlain by low permeability London Clay, which cannot store and transmit significant quantities of groundwater and does not support flow to water courses. Any water flows associated with the former course of the River Tyburn are, therefore, unlikely to be affected by the proposed development.

The screening and scoping stages have identified potential adverse impacts relating to subterranean flow associated with the proposed development. However, site specific information on the geology and hydrogeology beneath the site has established that the site is underlain by Non Productive strata (London Clay) which is not capable of storing and transmitting water in usable amounts and receives very low levels of annual recharge due to its lowly permeable nature. Groundwater beneath the site is both perched within the made ground and in the underlying London Clay strata. However the made ground is predominantly cohesive and therefore of low permeability as is the London Clay. The proposal is therefore not likely to have a significant impact on either the groundwater flow regime beneath the site or on the amount of annual recharge into the London Clay. The proposed basement will not effectively close a gap between underground structures and as such will not form a barrier to groundwater flow. It would be prudent to carry out trial excavations in order to determine the likely inflows of groundwater into the basement excavation, in order to ensure that appropriate groundwater control measures are included in the design of the temporary works.

10.0 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 may 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.

An issue that requires careful consideration at this site is the extent to which groundwater will affect the basement excavation in the temporary condition and the level of the water table to be adopted in the permanent design. It would be prudent to carry out ongoing groundwater monitoring of the existing standpipes and to carry out trial excavations to investigate the likely volumes of inflow that should be anticipated in the proposed basement excavation.

Consideration will need to be given to measures to guard against heave as a result of the basement excavation. It is likely that the floor slab for the proposed basement will need to be suspended over a void to accommodate the anticipated heave unless the slab can be suitably reinforced to cope with these movements.

Elevated concentrations of hydrocarbon contaminants and lead have been identified in the made ground. Further investigation, or precautionary protective measures, are likely to be required in areas remaining as garden following the proposed redevelopment of the site. In addition, any suspect soils encountered during groundworks should be inspected by a suitably qualified engineer.

APPENDIX