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119A FORDWCH ROAD,

LONDON, NW2 3NJ

BASEMENT IMPACT ASSESSMENT

Prepared for

Daniel Deveney

CONTENTS

1.0 NON-TECHNICAL SUMMARY

1.1 Project Objectives

At the request of Daniel Deveney, a Basement Impact Assessment has been carried out at 119a Fordwych Road, London, NW2 0NS in support of a planning application for a proposed development which includes the construction of a single storey basement beneath the current property. It is understood that the proposed basement is at 1.9m below the rear garden level.

1.2 Desk Study Findings

From a review of historical maps it would appear that the site was unoccupied land until circa 1896 when the present semi-detached property is shown. It is expected that the most potentially contaminating activities at the site would be from the railways and railway land 50m north-east of the site.

1.3 Ground Conditions

The borehole revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 0.65m in thickness resting on deposits of the London Clay Formation. The Made Ground extended down to a depth of 0.65m and the material generally comprised a surface cover of brick paving slabs overlying a heterogeneous mixture of medium dense silty gravelly sand with brick and clinker fragments The London Clay Formation was encountered below the Made Ground and consisted of stiff becoming very stiff silty clay with occasional pockets and partings of silty fine sand and scattered gypsum crystals. These deposits extended down to the full depth of investigation of 8.00m below ground level in Borehole 1. Following drilling operations a groundwater monitoring piezometer was installed in Borehole 1 to approximately 7.00m depth.

The groundwater level measurements indicate that the groundwater level has stabilised after a period of about four weeks at a depth of 6.28m below ground level in the monitoring standpipe installed in Borehole 1 during the investigation in November 2013. After a return visit in May 2016, the water level was encountered at a depth of 6.72m below ground level.

1.4 Recommendations

A monitoring plan should be set out at design stage and should include a monitoring strategy, instrumentation and monitoring plans and action plans. Trigger levels on movements will need to be defined. Precise levelling or reflective survey targets should be installed at the garden walls and neighbouring buildings. It would be prudent to continue to monitor the standpipes for as long as possible in order to determine equilibrium level and the extent of any seasonal variations. The chosen contractor should also have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

2.0 INTRODUCTION

2.1 Project Objectives

At the request of Daniel Deveney, a Basement Impact Assessment has been carried out at the above site in support of a planning application.

The purpose of this assessment is to consider the effects of a proposed basement construction on the local slope stability, surface water and groundwater regime at the existing residential property.

The recommendations and comments given in this report are based on the information contained from the sources cited and may include information provided by the Client and other parties, including anecdotal information. It must be noted that there may be special conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

This report does not constitute a full environmental audit of either the site or its immediate environs.

2.2 Planning Policy Context

The information contained within this BIA has been produced to meet the requirements set out by Camden Planning Guidance – Basements and Lightwells (CPG4) including Camden Development Policies DP27 – Basements and Lightwells (Ref 1) in order to assist London Borough of Camden with their decision making process.

As recommended by the Guidance for Subterranean Development (Ref 1) the BIA comprises the following steps

1. **Initial screening** to identify where there are matters of concern

2. **Scoping** to further define the matters of concern

3. **Site Investigation and study** to establish baseline conditions

4. **Impact Assessment** to determine the impact of the basement on baseline conditions

5. **Review and Decision Making** (to be undertaken by LBC)

3.0 SITE DETAILS

(National Grid Reference: TQ 244 851)

3.1 Site Location

The site is situated on the eastern side of Fordwych Road, at approximate postcode NW2 3NJ. The site is currently occupied by an existing five storey semi-detached residential property. The site covers an approximate area of 0.04Ha and is under the authority of the London Borough of Camden.

The site is bordered by the Midland Railway to the east, Fordwych Road to the west and residential housing to the north and south. The general area is mainly residential in nature.

Figure 1. Site Location Plan

3.2 Site Layout and History

The site is accessed from Fordwych Road and comprises of a five storey residential property including a small basement area and front and rear gardens.

The front garden is currently hard landscaped with brick paving.

With reference to the Camden Geological, Hydrogeological and Hydrological Study, (Figure 2 below), the neighbouring properties also have slopes less than 7 degrees.

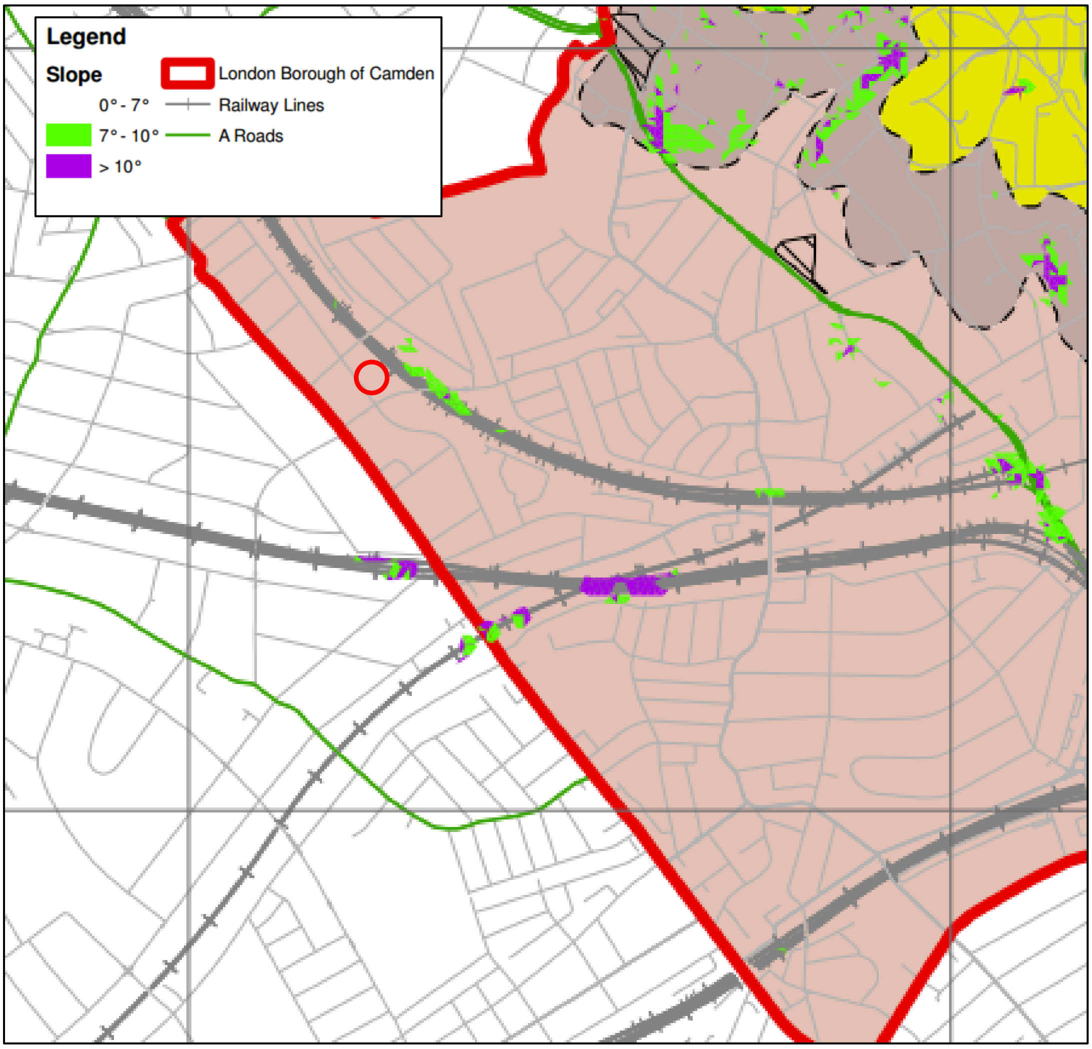

Figure 2. Exact from Figure 16 of the Camden CPG4 showing slope angles within the borough

An existing Midland Railway is located 50m east of the site, but there are no known tunnels within the vicinity of the site.

From a review of historical maps it would appear that the site was unoccupied land until circa 1896 when the present semi-detached property is shown. It is expected that the most potentially contaminating activities at the site would be from the railways and railway land 50m north-east of the site.

3.3 Previous Reports

A Phase 1 Preliminary Risk Assessment (PRA) (SAS Report Ref: 13/21182-1) and Phase 2 Site Investigation (SAS Report Ref: 13/21182) was undertaken across the site by Site Analytical Services Limited in November 2013 and the results are discussed in this BIA.

3.4 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area is detailed in Figure 3 below and indicates the site to be underlain by the London Clay Formation. Deposits of the overlying Claygate Member are indicated to be approximately 1km to the north-east of the site.

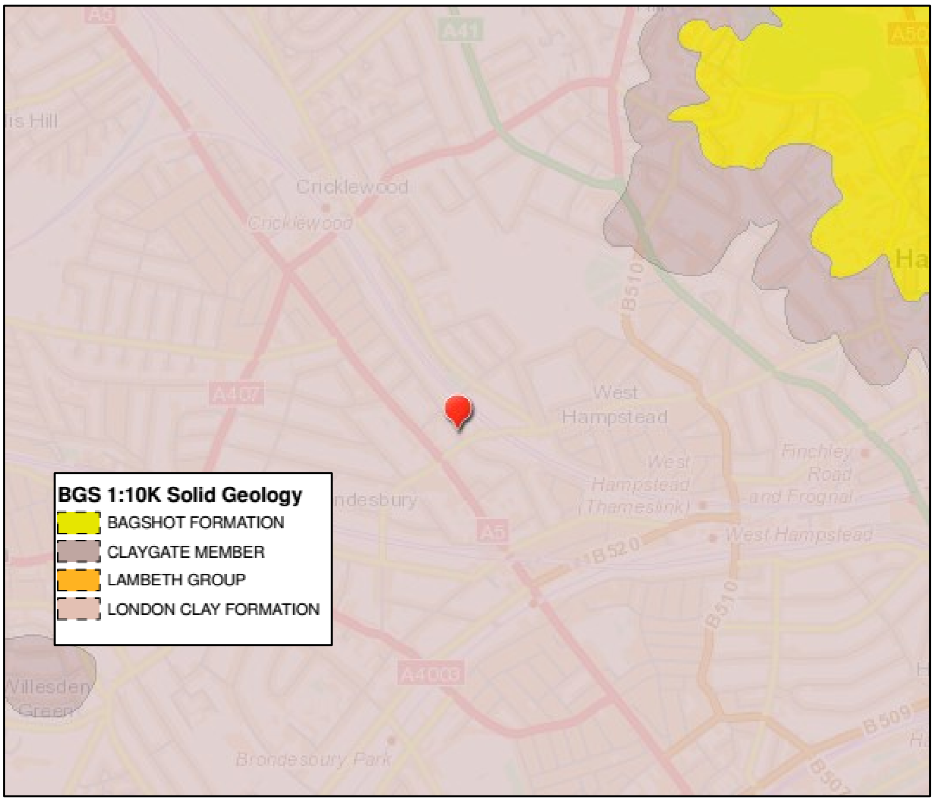

Figure 3. Geology of the Site (Ref. BGS Geoindex)

3.5 Hydrology and drainage

3.5.1 Surface Water

According to Mayes (1997) rainfall in the local area averages around 610mm and significantly less than the national average of around 900mm.

Evapotranspiration is typically 450mm/year resulting in about 160mm/year as ‘hydrologically effective’ rainfall which is available to infiltrate into the ground or run-off as surface water flow.

With reference to Camden Geological, Hydrogeological and Hydrological Study (1999), Talling (2011) and Barton (1992) according to 'lost rivers' the site is not within 100m of a lost river (Figure 4). The closest is the River Westbourne, located approximately 700m to the south east.

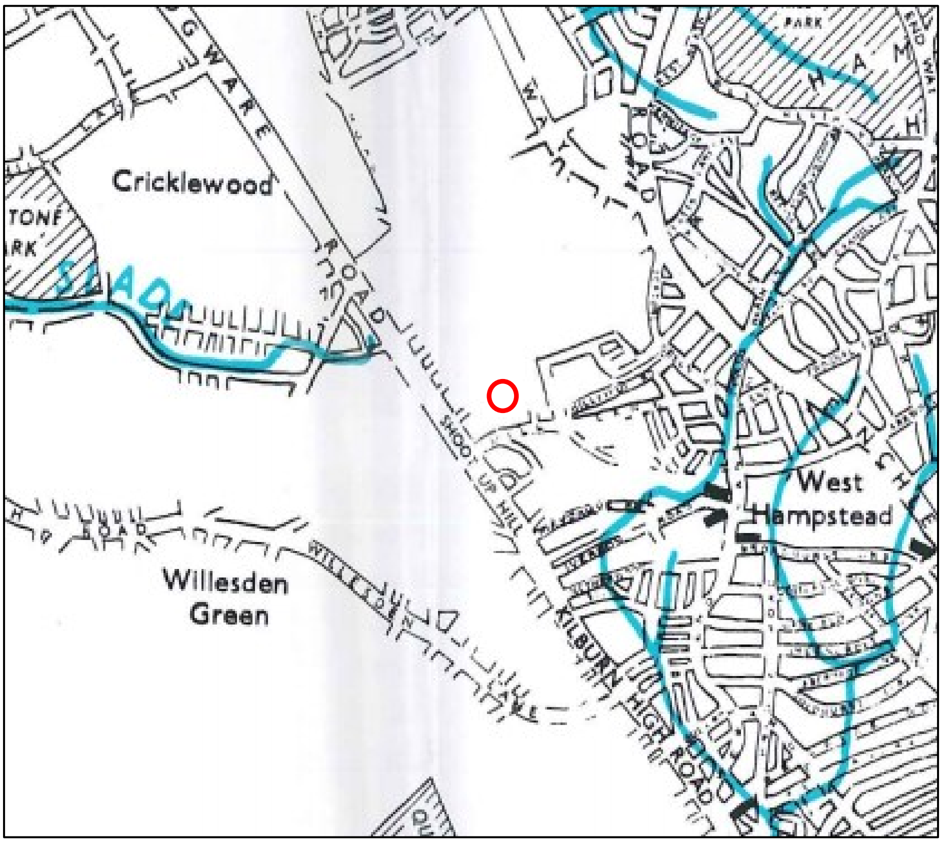

Figure 4. Location of site (circled) relative to the 'Lost Rivers' of London (Source: Barton, 1992)

The River Westbourne flowed in a southerly direction from West Hampstead. From the tributaries it flowed southwards towards Kilburn, across Bayswater Road and into Hyde Park, where it entered the Serpentine. From the Serpentine it flowed southwards under Knightsbridge before issuing into the River Thames within the grounds of Chelsea Hospital.

The watercourses have since been largely lost through a culverting system as the urban extent of the borough has grown over time.

Envirocheck indicates that the nearest surface water is recorded as a small pond 464m north of the site.

The area located immediately around the site is highly developed with more than 80% of the surface covered with hardstanding. Most of the rainfall in the area will run-off hard surface areas and be collected by the local sewer network.

Surface drainage from the site is assumed to be directed to drains flowing downhill to the south-east along Fordwych Road.

3.5.2 Flood Risk

3.5.2.1 River or Tidal flooding

According to Environment Agency Flood maps there are no flood risk zones within 1 kilometre of the site. The EA's website also shows that this area does not fall within an area at risk of flooding from reservoirs. Based on this information a flood risk assessment will not be required.

3.5.2.2 Surface water flooding

Figure 5 shows that Fordwych Road flooded during the 1975 event, but not in the 2002 flood event.

Figure 5. Exact from Figure 15 of the Camden CPG4 showing roads which flooded in 1975 (light blue), in 2002 (dark blue) and 'areas with potential to be at risk from surface water flooding' (wide light blue bands)

Further modelling of surface water flooding has been undertaken by the Environment Agency and was published on its website in January 2014; an extract from their model is presented in Figure 6. Whilst this map identifies four levels of risk (high, medium, low and very low) it is understood that it is based at least in part on depths of flooding. This modelling shows a 'Very Low' risk of flooding (the lowest category for the national background level of risk) for No.119a and the surrounding area.

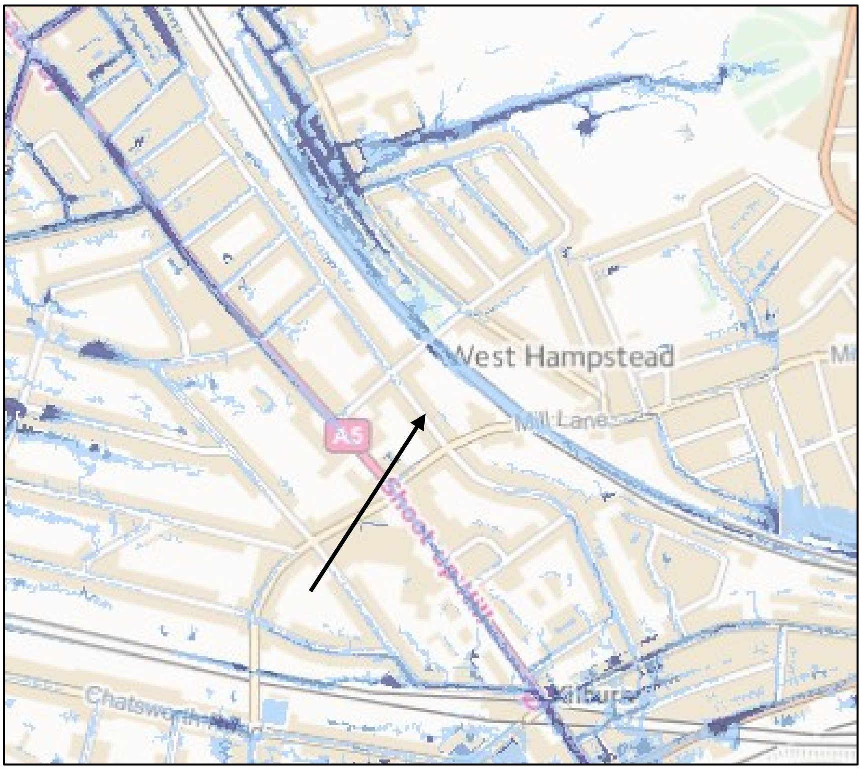

Figure 6. Extract from the Environment Agency's 'Risk of Flooding from Surface Water'. Ordnance Survey Crown copyright 2015. All rights reserved.

As detailed in Table 1 below, the scheme will result in an increase in impermeable areas by 30.0m^2.

Element	Existing (m^2)	Proposed (m^2)
Impermeable (hardstanding - building footprint, concrete areas)	87.23	117.31
Permeable (softscaping - grassed areas, (including green roof), permeable and porous paving)	271.75	241.67
Total (should be the site area and remain the same)	358.98	358.98

Table 1. Existing and Proposed Permeable Areas.

3.5.2.3 Sewer flooding

The London Regional Flood Risk Appraisal (2009) advises that foul sewer flooding is most likely to occur where properties are connected to the sewer system at a level below the hydraulic level of the sewage flow, which in general are often basement flats or premises in low lying areas. There is no record of sewer flooding having occurred at 119a Fordwych Road and therefore the risk of sewer flooding is considered low.

3.6 Hydrogeological setting

The Environment Agency Groundwater Protection Policy uses aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) and also their role in supporting surface water flows and wetland ecosystems.

The Bedrock geology underlying the site (London Clay) has been classified as Unproductive Strata; rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Other hydrogeological data obtained from the Phase 1 Preliminary Risk Assessment (PRA) (SAS Report Ref: 13/21182-1) for the site include:

- The underlying soil classification of the site is of high leaching potential.
- There are no water abstractions listed within one kilometre of the site and the site is not within one kilometre of a source protection zone.

3.7 Proposed Development

It is proposed to lower the existing ground floor and construct a 3 metre rear extension with the lower ground floor extending by an additional metre into the rear garden. It is understood that the proposed lower ground floor is at 1.9m below the rear garden level.

Sections showing the proposed developments are detailed in Figure 7 below.

Figure 7. Sections of the proposed Front and Rear Elevations of the property.

3.8 Results of Basement Impact Assessment Screening

A screening process has been undertaken for the site and the results are summarised in Table 2 below:

Table 2: Summary of screening results

Item	Description	Response	Comment
Sub-terranean (Ground water Flow)	1a. Is the site located directly above an aquifer.	No	The site has been classified as being situated above an unproductive (negligibly permeable) formation (London Clay) that is generally regarded as containing insignificant quantities of groundwater.
	1b. Will the proposed basement extend beneath the water table surface.	Unknown – to be confirmed by Ground Investigation	Given the presence of a non-aquifer below the site it is unlikely that groundwater will be encountered during any excavations for the proposed basement, however this will be confirmed by the ground investigation.
	2. Is the site within 100m of a watercourse, well (used / disused) or potential spring line.	No	The nearest surface water is recorded as a small pond 464m north of the site. According to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011), the site is not within 100m of a former river or watercourse. From the British Geological Society 'Geoindex' the nearest water well is located approximately 905m south-east of the site.
	3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas.	Yes	The amount of hardstanding on-site is expected to increase.
	4. As part of 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	Existing drainage paths are to be utilised where possible. Whether soakaways/SUDS are used on the proposed development is to be confirmed (beyond the scope of this report). An appropriately qualified engineer should be engaged to ensure mandatory requirements are met.
	5. 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 nearest surface water is recorded as a small pond 464m north of the site. According to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011), the site is not within 100m of a former river or watercourse. From the British Geological Society 'Geoindex' the nearest water well is located approximately 905m south east of the site.

Item	Description	Response	Comment
Slope Stability	1. Does the existing site include slopes, natural or man-made greater than 7 degrees (approximately 1 in 8).	No	There is a slight slope from north to south across the site, but is below 7 degrees.
	2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7 degrees (approximately 1 in 8).	No	Re-profiling of landscaping at the site is not proposed.
	3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7 degrees (approximately 1 in 8).	Yes	The surrounding area drops to the south-east, but from survey information and with reference to Figure 16 from Camden CPG 4, this is at angles of less than 7 degrees. The existing Midland Railway, located 50m east of the site is in cutting with angles estimated to be over 10 degrees.
	4. Is the site within a wider hillside setting in which the general slope is greater than 7 degrees (approximately 1 in 8).	No	There is a general slope in the area towards the south down to the south-east, but this is at an angle of less than 7 degrees.
	5. Is the London Clay the shallowest strata at the site.	Yes	With reference to available BGS records, the London Clay Formation is expected to be encountered from ground level.
	6. Will any trees be felled as part of the development and/or are any works proposed within any tree protection zones where trees are to be retained.	No	It is understood that no trees are to be felled as part of 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.	Yes	The site lies above the London Clay Formation well known as having a high tendency to shrink and swell.
	8. Is the site within 100m of a watercourse or a potential spring line.	No	The nearest surface water is recorded as a small pond 464m north of the site. According to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011), the site is not within 100m of a former river or watercourse. From the British Geological Society 'Geoindex' the nearest water well is located approximately 905m south east of the site.

Item	Description	Response	Comment
	9. Is the site within an area of previously worked ground.	No	According to records from the BGS the site is not in the vicinity of any recorded areas of worked ground.
	10. Is the site within an aquifer. If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction.	No	The site has been classified as being situated above an unproductive (negligibly permeable) formation (London Clay) that is generally regarded as containing insignificant quantities of groundwater.
	11. Is the site within 50m of the Hampstead Heath Ponds	No	With reference to the Camden Geological, Hydrogeological and Hydrological Study, the site is not within the catchment of the pond chains on Hampstead, nor the Golder's Hill Chain.
	12. Is the site within 5m of a highway or pedestrian right of way.	Yes	The site lies within 5m of Fordwych Road.
	13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties.	Yes	The development will increase the depths of foundation at the site, although the foundation depths of adjacent properties are not known.
	14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines.	No	An existing Midland Railway is located 50m east of the site. But the development is not over any tunnels.
Surface Water and Flooding	1. Is the site within the catchment of the ponds chains on Hampstead Heath	No	With reference to the Camden Geological, Hydrogeological and Hydrological Study, the site is not within the catchment of the pond chains on Hampstead, nor the Golder's Hill Chain.
	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	No – any additional surface water generated from an increased hardstanding area will be attenuated to ensure they are not increased or altered. The basement will be beneath the footprint of the new dwelling therefore the 1m distance between the roof of the basement and ground surface as recommended by Chapter 5 of the Arup report, does not apply across these areas.

Item	Description	Response	Comment
	3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.	Yes	Yes, there will be a small change in the area of hard surfacing. The surface permeability will be affected with a slight increase in the footprint of the new building and a small increase in the amount of paved surface in relation to the total site.
	4. Will the proposed basement 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	All surface water for the site will be contained within the site boundaries and collected as described above; hence there will be no change from the development on the quantity or quality of surface water being received by adjoining sites. The basement will be beneath the footprint of the dwelling therefore the 1m distance between the roof of the basement and ground surface as recommended by Chapter 5 of the Arup report does not apply across these areas.
	5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses.	No	The surface water quality will not be affected by the development, as in the permanent condition collected surface water will be generally be from roofs, domestic hard landscaping or collected from beneath the landscaping layer over the basement.
	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 King's Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature	Yes	Fordwych Road flooded during either the 1975 flood event. According to modelling by the Environment Agency, there is a 'Very Low' risk of surface water flooding (the lowest category for the national background level of risk) for No.9 and the surrounding area.

3.9 Non-Technical Summary of Chapter

The site is situated on the eastern side of Fordwych Road, at approximate postcode NW2 3NJ. The site is currently occupied by an existing five storey semi-detached residential property. The site covers an approximate area of 0.04Ha and is under the authority of the London Borough of Camden.

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area indicates the site to be underlain by the London Clay Formation. The London Clay Formation is classed as unproductive strata or a non-aquifer.

With reference to Camden Geological, Hydrogeological and Hydrological Study (1999), Talling (2011) and Barton (1992) according to 'lost rivers' the site is not within 100m of a lost river (Figure 5). The closest is the River Westbourne, located approximately 700m to the south-east.

Envirocheck indicates that the nearest surface water is recorded as a small pond 464m north of the site.

According to Environment Agency Flood maps there are no flood risk zones within 1 kilometre of the site. The EA's website also shows that this area does not fall within an area at risk of flooding from reservoirs.

Based on this information a flood risk assessment will be required. Fordwych Road flooded during the 1975 flood event. Modelling of surface water flooding by the Environment Agency shows a 'Very Low' risk of flooding (the lowest category for the national background level of risk) for No.119A and the surrounding area.

The Screening Exercise has identified the following potential issues which will be carried forward to the Scoping Phase

Subterranean Groundwater Flow

- Will the proposed basement extend beneath the water table surface?

Slope Stability

- Does the development neighbour land, including railway cuttings and the like, with a slope greater than 1 in 8?

- Does the development neighbour land, including railway cuttings and the like, with a slope greater than 1 in 8?

- Is the London Clay the shallowest strata at the site?

- Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?

- Is the site within 5m of a highway or pedestrian right of way?

- Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?

Surface Water and Flooding

- Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.

4.0 SCOPING PHASE

4.1 Introduction

This purpose of the scoping phase is to assess in more detail the factors to be investigated in the impact assessment. Potential impacts are assessed for each of the identified impact factors and recommendations are stated.

A conceptual ground model is usually complied at the scoping stage however, because the ground investigation has already been undertaken for this project, the conceptual ground model including the findings of the ground investigation is described under Chapter 4.

Subterranean (Groundwater Flow)

Potential Issue (Screening Question)		**Potential impacts and actions**
1b	Will the proposed basement extend beneath the water table surface?	**Potential impact:** Local restriction of groundwater flows (perched groundwater or below groundwater table). **Action:** Ground investigation required, then review.

Slope Stability

Potential Issue (Screening Question)		**Potential impacts and actions**
3	Does the development neighbour land, including railway cuttings and the like, with a slope greater than 1 in 8?	**Potential impact:** Landslide potential to the site and surrounding areas if the area is weakened due to excavation into the underlying geology. **Action:** Ground investigation required, then review.

Potential Issue (Screening Question)		Potential impacts and actions
5	Is the London Clay the shallowest strata at the site?	**Potential impact:** The London Clay is prone to seasonal shrink-swell (subsidence and heave). **Action:** Ground investigation required, then review.
7	Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?	**Potential Impact:** Ground movements will occur during and after the basement construction. **Action:** Ground investigation required, then review.
11	Is the site within 5m of a highway or a pedestrian right of way?	**Potential impact:** Excavation of basement causes loss of support to footway/highway and damage to the services beneath them. **Action:** Ensure adequate temporary and permanent support by use of best practice working methods.
12	Will the proposed basement substantially increase the differential depth of foundations relative to neighbouring properties?	**Potential impact:** Loss of support to the ground beneath the new foundations to neighbouring properties if basement excavations are inadequately supported. **Action:** Ensure adequate temporary and permanent support by use of best practice methods.

Surface Water and Flooding

Potential Issue (Screening Question)		Potential impacts and actions
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas?	**Potential impact:** May increase flow rates to sewer and thus increase the risk of flooding **Action:** Assess net change in hard surfaced/paved areas and, if required, recommend appropriate types of SUDS for use as site-specific mitigation.
6	Is the site in an area known to be at risk from surface water flooding?	**Potential impact**: Flooding occurs during the excavation of the basement **Action**: A groundwater exception test should be carried out prior to any construction works.

These potential impacts have been further assessed through the ground investigation, as detailed in Section 4 below.

4.2 Non-Technical Summary of Chapter

The scoping exercise has reviewed the potential impacts for each of the items carried forward from Stage 1 screening, and has identified the following actions to be undertaken:

- A ground investigation is required (which has already been undertaken).
- Review of site's hydrogeology and groundwater control requirements.

All these actions are covered in Stage 4 or Stage 3 for the ground investigation.

5.0 SITE INVESTIGATION DATA

5.1 Records of site investigation

A site-specific ground investigation was undertaken by Site Analytical Services Limited (SAS) in November 2013 and included one continuous flight auger borehole (Borehole 1) to 8.00m below ground level.

The findings from the investigation are presented in Appendix A, including a site plan, exploratory hole logs, groundwater monitoring and laboratory test results.

5.2 Ground conditions

The boreholes and trial pit revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 0.65m in thickness resting on deposits of the London Clay Formation.

5.2.1 Made Ground

The Made Ground extended down to a depth of 0.65m below ground level in Borehole 1 and comprised of a surface cover of brick paving slabs overlying a heterogeneous mixture of medium dense silty gravelly sand with brick and clinker fragments.

5.2.2 Weathered London Clay Formation

Below the Made Ground in Borehole 1 the material comprised of stiff becoming very stiff mottled silty clay with occasional partings of silty fine sand and occasional small gypsum crystals. These deposits represent weathered London Clay and extended down to a depth of 6.80m below ground level in Borehole 1.

5.2.2 London Clay Formation

Below the weathered London Clay Formation in Borehole 1 the material comprised of very stiff fissured silty clay with occasional partings of silty fine sand and scattered small gypsum crystals. These materials are typical of the more competent unweathered London Clay Formation and extended down to the full depth of investigation of 8.0m below ground level in Borehole 1.

5.3 Groundwater

Groundwater was not encountered during the drilling of Borehole 1 and the material remained essentially dry throughout.

It must be noted that the speed of excavation and boring is such that there may well be insufficient time for light seepages of groundwater to enter the borehole and hence be detected, particularly within more cohesive soils of low permeability.

Groundwater was subsequently found to have stabilised at a depth of 6.28m below existing ground level in the monitoring standpipe installed in Borehole 1 after a period of approximately four weeks.

During a return visit in May 2016, the groundwater was encountered at a depth of 6.72m below ground level.

Isolated pockets of groundwater may be present perched within any less permeable material found at shallower depth on other parts of the site especially within any Made Ground.

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (October 2013 and subsequently May 2016) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions.

5.4 In-Situ and Laboratory Testing

The results of the laboratory and in-situ tests are presented in the factual report contained in Appendix A.

5.5.1 In-Situ Shear Vane Tests

In the essentially cohesive soils encountered at depth in the borehole, in-situ shear vane tests were made in order to assess the undrained shear strength of the materials. The results indicate that the cohesive soils at depth are of a stiff becoming very stiff consistency with increasing depth below ground level.

5.5.2 Classification Tests

Atterberg Limit tests were conducted on four samples of cohesive soils taken from the London Clay present in the borehole. The results fall into Classes CH and CV according to the British Soil Classification System.

These are fine grained sandy and silty clay soils of high and very high plasticity and as such generally have medium bearing and settlement characteristics, have a low permeability and a generally high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2. The plasticity index values in the London Clay are above the 40% boundary between soils assessed as being of medium swelling and shrinkage potential and those assessed as being of high swelling and shrinkage potential.

5.5.3 Sulphate and pH Analyses

The results of the sulphate and pH analyses made on two soil samples are presented on Table 2. The results show the soil samples to have water soluble sulphate contents of up to 2.81g/litre associated with slightly acidic pH values.

5.5 Non-Technical Summary of Chapter

A site-specific ground investigation was undertaken by Site Analytical Services Limited (SAS) in November 2013 and included one continuous flight auger borehole (Borehole 1) to 8.00m below ground level.

The borehole pit revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 0.65m in thickness resting on deposits of the London Clay Formation.

Following drilling operations a groundwater monitoring piezometer was installed in Borehole 1 to approximately 8.00m depth.

Groundwater was subsequently found to have stabilised at a depth of 6.28m below existing ground level in the monitoring standpipe installed in Borehole 1 after a period of approximately four weeks.

During a return visit in May 2016, the ground water was encountered at a depth of 6.72m below ground level.

6.0 FOUNDATION DESIGN

6.1 Introduction

It is proposed to lower the existing ground floor and construct a three metre rear extension with the lower ground floor extending by an additional metre into the rear garden.

It is understood that the proposed lower ground floor is at 1.9m below the rear garden level.

6.2 Site Preparation Works

The main contractor should be informed of the site conditions and risk assessments should be undertaken to comply with the Construction Design Management (CDM) regulations. Site personnel are to be made aware of the site conditions. It is recommended that extensive searches of existing man-made services are undertaken over the site prior to final design works.

6.3 Ground Model

On the basis of the fieldwork, the ground conditions at the site can be characterised as follows:

- Made Ground extends to a depth of 0.65m depth below ground level.

- The London Clay Formation comprising stiff silty sandy clay with gypsum crystals to the full depths of investigation of 8.00m below ground.

- Groundwater was subsequently found to have stabilised at a depth of 6.28m below existing ground level in the monitoring standpipe installed in Borehole 1 after a period of approximately four weeks.

  During a return visit in May 2016, the ground water was encountered at a depth of 6.72m below ground level.

6.4 Basement Excavation

Groundwater is not expected to be encountered in the basement excavation, but it would be prudent for the chosen contractor to have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure. Trial excavations to the proposed basement depth could be carried by the main contractor to confirm the stability of the soil and to further investigate the presence of any groundwater inflows.

6.5 Conventional Spread Foundations

A result of the inherent variability of uncontrolled fill, (Made Ground) is that it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should therefore, be taken through any Made Ground and either into, or onto a suitable underlying natural strata of adequate bearing characteristics.

Based on the ground and groundwater conditions encountered in the borehole, it should be possible to support the proposed development on conventional spread or basement raft foundations taken down below the Made Ground and any weak superficial soils and placed in the stiff clay deposits encountered at depths of 2.00m below ground level in the borehole.

Using theory from Terzaghi (1943), strip foundations placed within natural soils may be designed to allowable net bearing pressures of approximately 280kN/m^2 at 3.00m depth in order to allow for a factor of safety of 2.5 against general shear failure and should be sufficiently low to ensure that overstressing of the underlying soils does not occur. The actual allowable bearing pressure applicable will depend on the form of foundation, its geometry and depth in accordance with classical analytical methods, details of which can be obtained from “Foundation Design and Construction”, Seventh Edition, 2001 by M J Tomlinson (see references) or similar texts.

Any soft or loose pockets encountered within otherwise competent formations should be removed and replaced with well compacted granular fill.

Foundations may need to be taken deeper should they be within the zones of influence of either existing or recently felled trees and any proposed tree planting. The depth of foundation required to avoid the zone likely to be affected by the root systems of trees is shown in the recommendations given in NHBC Standards, Chapter 4.2, April 2010, “Building near Trees" and it is considered that this document is relevant in this situation.

6.6 Piled Foundations

In the event that the use of conventional spread foundations proves either impracticable or uneconomical due to the size and depth of foundation required, then a piled foundation will be required. In these ground conditions, it is considered that some form of bored and in-situ cast concrete piled foundation with reinforced concrete ground beams should prove satisfactory.

The construction of a piled foundation is a specialist activity and the advice of a reputable contractor, familiar with the type of soil and groundwater conditions encountered at this site should be sought prior to finalising the foundation design. The actual pile working load will depend on the particular type of pile chosen and method of installation adopted.

To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of about 0.8 and a calculation made to check the factor of safety against block failure.

Driven piles could also be used and would develop much higher working loads approximately 2.5 to 3 times higher than bored piles of a similar diameter at the same depth. However, the close proximity of adjacent buildings will in all probability preclude their use due to noise and vibration.

6.7 Retaining Walls

Several methods of retaining wall construction could be considered. These may include retaining structures cast in an underpinning sequence, or the use of temporary or sacrificial works to facilitate the retaining structure's construction. The excavation of the basement must not compromise the integrity of adjacent structures.

The full design of temporary and permanent retaining structures is beyond the scope of this report. However, the following design parameters for each element of soil recorded in the relevant exploratory holes are provided in Table 3 below to assist the design of these structures.

Stratum	Depth to top (mbgl)	Bulk Density (Mg/m3) (ɣ)	Effective Angle of Internal Friction (Φ)
Made Ground	-	2.00	28
London Clay Formation	0.65	2.00	23

Table 3. Retaining Wall Design Parameters

The designer should use these parameters to derive the active and passive earth pressure coefficients ka and kp. The determination of appropriate earth pressure coefficients, together with factors such as the pattern of the earth pressure distribution, will depend upon the type/geometry of the wall and overall design factors.

6.8 Chemical Attack on Buried Concrete

The results show the natural soil samples to have water soluble sulphate contents of up to 2.81g/litre associated with slightly acidic pH values.

In these conditions, it is considered that deterioration of buried concrete due to sulphate attack is unlikely to occur unless precautions are taken. The final design of buried concrete according to Tables C1 and C2 of BRE Special Digest 1:2005 should be in accordance with Class DS-3 conditions.

In addition, segregations of gypsum were noted within the London Clay and scattered small gypsum crystals were also noted at depth. Consequently, it is considered that any buried concrete at depth may be attacked by such sulphates in solution and that it would be prudent to design any such deep buried concrete in accordance with full Class DS-3 conditions.

6.9 Non-Technical Summary of Chapter

On the basis of the fieldwork, the ground conditions at the site can be characterised as follows: Made Ground extends to 0.65m depth below ground level; The London Clay Formation extends to the full depth of investigation of 8.00m below ground. Groundwater was subsequently found to have stabilised at a depth of 6.28m below existing ground level in the monitoring standpipe installed in Borehole 1 after a period of approximately four weeks. During a return visit in May 2016, the ground water was encountered at a depth of 6.72m below ground level.

Groundwater is not expected to be encountered in the basement excavation, but it would be prudent for the chosen contractor to have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

Several methods of retaining wall construction could be considered. These may include retaining structures cast in an underpinning sequence, or the use of temporary or sacrificial works to facilitate the retaining structure's construction. The excavation of the basement must not compromise the integrity of adjacent structures.

Based on the water soluble sulphate tests carried out as part of these works, it is considered that deterioration of buried concrete due to sulphate or acid attack is likely to occur. The final design of buried concrete according to Tables C1 and C2 of BRE Special Digest 1:2005 should be in accordance with Class DS-3 conditions.

In addition, segregations of gypsum were noted within the London Clay and also are well known to occur within London Clay deposits. Consequently, it is considered that any buried concrete at depth may be attacked by such sulphates in solution and that it would be prudent to design any such concrete in accordance with full Class DS-3 conditions.

7.0 BASEMENT IMPACT ASSESSMENT

7.1 Summary

The screening identified a number of potential impacts. 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.

Potential Impact	Site Investigation conclusions	Impact sufficiently addressed without further justification?
The proposed basement extends beneath the water table surface.	Groundwater was encountered at a depth of 6.28 in the monitoring standpipe installed within Borehole 1. This is below the depth of the proposed basement at 1.90m below the rear garden level and therefore the influence of the development on groundwater is expected to be minimal.	Yes
There a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site.	The London Clay was proven below the site and was recorded as having a high susceptibility to shrinkage and shrinkage. However, the base of proposed basement will extend well below the potential depth of root action.	Yes
The site is within 5m of a highway or pedestrian right of way.	The proposed basement is not to be extended below Fordwych Road and therefore it is suggested that the impact on these access roads is likely to be minimal. There is nothing unusual in the proposed development that would give rise to any concerns with regard to the stability of public highways.	Yes.
The proposed basement will significantly increase the differential depth of foundations relative to neighbouring properties.	The development will result in the extension of the foundation depth of the basement relative to neighbouring properties.	No – see below for further details.
The development neighbours land, including railway cuttings and the like, with a slope greater than 1 in 8	The site and neighbouring properties are located on land which slopes towards the north- west at angles of up to 10 degrees The slope angle map produced as Figure 16 of the ARUP report indicates that slope angles in the site are less than 7° shows that the site is around 50m west from a railway cutting / embankment with slope angles in excess of 7°.	No – see below for further details.
Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.	There is an increase in impermeable area on-site following development, which equates to an increase in the rate of run-off from the site.	No – see below for further details.

Potential Impact	Site Investigation conclusions	Impact sufficiently addressed without further justification?
The site is in an area known to be at risk from surface water flooding.	There is a potential risk of surface water following the construction.	No – see below for further details.

7.2 Outstanding risks and issues

The proposed basement will significantly increase the differential depth of foundations relative to neighbouring properties.

The excavation and construction of the basement at the site has the potential to cause some movements in the surrounding ground if not properly managed. However, it is understood that ground movements and/or instability will be managed through the proper design and construction of mitigation measures during the works. This will require close collaboration with the appointed contractor's temporary works coordinator.

The Party Wall Act (1996) will apply to this development because neighbouring houses lie within a defined space around the proposed building works. The party wall process should be followed and adhered to during this development.

A monitoring plan should be set out at design stage and should include a monitoring strategy, instrumentation and monitoring plans and action plans. Trigger levels on movements will need to be defined. Precise levelling or reflective survey targets should be installed at the garden walls and neighbouring buildings. Monitoring should take place in advance of the proposed works as a base-line survey, during the works and for a period following the completion of the works, to understand the long term effects.

The development neighbours land, including railway cuttings and the like, with a slope greater than 1 in 8

The 1:50,000 scale geological map for the area indicates that the site does not lie within an 'Area of Significant Landslide Potential'. No mapped areas of landslips are present in the vicinity of the site and the natural ground stability hazards dataset supplied by the BGS (present in the desk study report for the site (SAS Report Reference 13/21182-1) gives the hazard rating for landslides in the site area as 'very low'.

Information obtained from the site walkover, site plans and ordnance survey maps indicates that the site and neighboring properties are located on land which slopes towards the north-west at angles of up to 10 degrees. There is also a general slope in the wider hillside setting from south to north, although it should be noted that the immediate site area is heavily urbanised and slopes at the site and in the close vicinity may have been altered historically or as part of developments and landscaping.

The slope angle map produced as Figure 16 of the ARUP report indicates that slope angles in the site are less than 7° shows that the site is around 50m west from a railway cutting / embankment with slope angles in excess of 7°.

As part of the development it is proposed to excavate below the site by at least 2.50m below existing ground level, although excavation may locally be to a greater depth to facilitate floor slab and foundation construction. It is anticipated that the natural London Clay Formation would be encountered at this depth and therefore 'running sand' conditions and ground instability is unlikely. Furthermore the proposed development does not include any remodeling of slopes to angles greater than 10° that could potentially result in slope stability issues. Ground retention techniques, if required, could take the form of sheet piling employed in the temporary case to maintain the stability of excavations.

All risks related to the stability of the slopes must be identified and managed in accordance with CDM legislation.

Change in paved surfacing and surface water runoff.

As identified in the initial screening and scoping stages the scheme will result in a c. 34.5% increase in impermeable areas. This is only c. 32.7% of the existing garden area, hence c. 56.4% of the garden is to remain. This meets the no greater than 67.3% of garden standard threshold.

The scheme could consider incorporating a French drain / swale area adjacent to the proposed construction to increase surface water storage on-site, but only if this landscaping does not affect the suitability of the surrounding ground. However, the predominantly clay rich nature of the soils are likely to render this solution impracticable.

Given limited scope of the scheme and minimal increase in impermeable areas, the scheme is also considered compliant with the surface water management and flood risk elements of NPPF and Camden policy.

The site is in an area known to be at risk from surface water flooding.

Fordwych Road flooded during the 1975 flood event. According to modelling by the Environment Agency, there is a 'Very Low' risk of surface water flooding (the lowest category for the national background level of risk) for No.9 and the surrounding area.

In applying the Exception Test and assessing the risk associated with surface water and sewer flooding the following is considered:

- The proposed basement construction does not change the impermeable proportion at the site (this remains essentially the same). As such, the basement will not have an adverse impact on the site's surface water run-off.

- Intrusive investigation indicated that the groundwater table is below the proposed basement level. Groundwater is therefore unlikely to adversely impact the site as a result of the development.

- At the time of writing this report, the drainage details had not been finalised; however it is our understanding that the drainage details will incorporate a pumping device to protect the property from sewer flooding.

The proposed development will not increase flood risk at the site or the surrounding area. Also since the development is on already developed land, it will not adversely impact the Council's sustainability objectives.

7.3 Advice on Further Work and Monitoring

A monitoring plan should be set out at design stage and should include a monitoring strategy, instrumentation and monitoring plans and action plans. Trigger levels on movements will need to be defined. Precise levelling or reflective survey targets should be installed at the garden walls and neighbouring buildings. Monitoring should take place in advance of the proposed works as a base-line survey, during the works and for a period following the completion of the works, to understand the long term effects.

It would be prudent to continue to monitor the standpipes for as long as possible in order to determine equilibrium level and the extent of any seasonal variations. The chosen contractor should also have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

7.4 Non-Technical Summary of Chapter

The excavation and construction of the basement at the site has the potential to cause some movements in the surrounding ground if not properly managed. However, it is understood that ground movements and/or instability will be managed through the proper design and construction of mitigation measures during the works. It is not considered that the proposed basement would result in a significant change to the groundwater flow regime in the vicinity of the proposal. Also, given limited scope of the scheme and limited increase in impermeable areas, the scheme is also considered compliant with the surface water management and flood risk elements of NPPF and Camden policy.

It would be prudent to continue to monitor the standpipes for as long as possible in order to determine equilibrium level and the extent of any seasonal variations.

8.0 REFERENCES

1. CIRIA Special Publication 69, 1989. The engineering implications of rising groundwater levels in the deep aquifer beneath London

2. Environment Agency, 2006. Groundwater levels in the Chalk-Basal Sands Aquifer in the London Basin

3. Tomlinson, M J, 2001. "Foundation Design and Construction", Seventh Edition, Prentice Hall (ISBN 0-13-031180-4).

4. British Standards Institution, 2015. Code of Practice for Site Investigations, BS5930, BSI, London

5. British Standards Institution, 1986. Code of practice for foundations, BS 8004, BSI, London.

6. British Standards Institution, 2009. Code of Practice for Protection of Below Ground Structures Against Water from the Ground. BS 8102, BSI, London

7. CIRIA, 2000. Sustainable Urban Drainage Systems: Design Manual for England and Wales. CIRIA C522, Construction Industry Research and Information Association, London

8. Environment Agency Status Report 2010. Management of the London Basin Chalk Aquifer. Environment Agency

9. NHBC Standards, Chapter 4.1, "Land Quality - managing ground conditions", September 1999.

10. NHBC Standards, Chapter 4.2, "Building near Trees", April 2010.

Appendix A. Ground Investigation Report

Site Analytical Services Ltd.

Site Investigations, Analytical & Environmental Chemists, Laboratory Testing Services.

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Your Ref:

Our Ref: **13/21182**
November 2013

119a FORDWYCH ROAD,

LONDON, NW2 3NJ

REPORT ON A GROUND INVESTIGATION

Prepared for

Mr Stelios Constantinou – Chartered Architect

Acting on behalf of

Ms Anna Swan

Ref: 13/21182
November 2013

Report on a Ground Investigation

At

119a Fordwych Road, London, NW2 3NJ

For

Ms Anna Swan

1.0 INTRODUCTION

At the request of Mr Stelios Constantinou, Chartered Architect, acting on behalf of Ms Anna Swan, a ground investigation was carried out in connection with a proposed basement development at the above site. A Phase 1 Preliminary Risk Assessment has been presented under separate cover in a Site Analytical Services Limited report (Project No. 13/21182-1) dated October 2013, together with a Basement Impact Assessment presented in a Site Analytical Services Limited report (Project No. 13/201182-2) also dated October 2013.

The information was required for the design and construction of foundations and infrastructure for the proposed development which includes lowering the existing ground floor at the front of the property to create additional living space. A study to assess whether any remediation was required for protection of the end-user from the presence of potential contamination within the soils encountered was outside the scope of the present report.

The recommendations and comments given in this report are based on the ground conditions encountered in the exploratory hole made during the investigation and the results of the tests made in the field and the laboratory. It must be noted that there may be special conditions prevailing at the site remote from the exploratory hole location which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

2.0 SITE DETAILS

(National Grid Reference: TQ 244 851)

2.1 Site Location

The site is situated on the eastern side of Fordwych Road, at approximate postcode NW2 3NJ. The site is currently occupied by an existing five storey semi-detached residential property. The site covers an approximate area of 0.04Ha and is under the authority of the London Borough of Camden.

2.2 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area (Sheet 256, 'North London', Solid and Drift Edition) indicates the site to be underlain by the London Clay Formation.

3.0 SCOPE OF WORK

3.1 General

The scope of the investigation was agreed with the Consulting Engineer and comprised:

- The drilling of one continuous flight auger borehole to a depth of 8.0m below ground level.
- The placement of a gas and groundwater monitoring standpipe to a depth of 8.0m below ground level in the borehole.
- Sampling and in-situ testing as appropriate to the ground conditions encountered in the borehole.
- Interpretative reporting on foundation options for the proposed building works and infrastructure.
- A study into the possibility of the presence of toxic substances in the soil together with comments on any remediation required was outside the scope of the present investigation.

3.2 Ground Conditions

The location of the borehole is shown on the site sketch plan (Figure 1).

The exploratory hole revealed ground conditions that were slightly inconsistent with the geological records and known history of the area and comprised up to 0.65m thickness of Made Ground followed by the London Clay Formation at depth.

For detailed information on the ground conditions encountered in the exploratory hole, reference should be made to the exploratory hole record presented in Appendix A.

3.2.1 Made Ground

The Made Ground extended down to a depth of 0.65m below ground level in Borehole 1 and comprised of a surface cover of brick paving slabs overlying a heterogeneous mixture of medium dense silty gravelly sand with brick and clinker fragments.

3.2.2 Weathered London Clay Formation

Below the Made Ground in Borehole 1 the material comprised of stiff becoming very stiff mottled silty clay with occasional partings of silty fine sand and occasional small gypsum crystals. These deposits represent weathered London Clay and extended down to a depth of 6.80m below ground level in Borehole 1.

3.2.3 London Clay Formation

Below the weathered London Clay Formation in Borehole 1 the material comprised of very stiff fissured silty clay with occasional partings of silty fine sand and scattered small gypsum crystals. These materials are typical of the more competent unweathered London Clay Formation and extended down to the full depth of investigation of 8.0m below ground level in Borehole 1.

3.3 Groundwater

Groundwater was not encountered during the drilling of Borehole 1 and the material remained essentially dry throughout.

It must be noted that the speed of excavation and boring is such that there may well be insufficient time for light seepages of groundwater to enter the borehole and hence be detected, particularly within more cohesive soils of low permeability.

Groundwater was subsequently found to have stabilised at a depth of 6.28m below existing ground level in the monitoring standpipe installed in Borehole 1 after a period of approximately four weeks.

Isolated pockets of groundwater may be present perched within any less permeable material found at shallower depth on other parts of the site especially within any Made Ground.

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (October 2013) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions.

4.0 IN-SITU AND LABORATORY TESTS

4.1 In-Situ Shear Vane Tests

In the essentially cohesive soils encountered at depth in the borehole, in-situ shear vane tests were made in order to assess the undrained shear strength of the materials. The results indicate that the cohesive soils at depth are of a stiff becoming very stiff consistency with increasing depth below ground level.

The results of the in-situ tests are shown on the appropriate exploratory hole record contained in Appendix A.

4.2 Classification Tests

Atterberg Limit tests were conducted on four samples of cohesive soils taken from the London Clay present in the borehole. The results fall into Classes CH and CV according to the British Soil Classification System.

These are fine grained sandy and silty clay soils of high and very high plasticity and as such generally have medium bearing and settlement characteristics, have a low permeability and a generally high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2. The plasticity index values in the London Clay are above the 40% boundary between soils assessed as being of medium swelling and shrinkage potential and those assessed as being of high swelling and shrinkage potential.

The test results are given in Table 1, contained in Appendix B.

4.3 Sulphate and pH Analyses

The results of the sulphate and pH analyses made on two soil samples are presented on Table 2. The results show the soil samples to have water soluble sulphate contents of up to 2.81g/litre associated with slightly acidic pH values.

4.4 In-situ Rising Head Permeability or Soakage Tests

In order to assess the soil infiltration characteristics of the natural superficial soils at the site, an in-situ falling head permeability test was carried out in Borehole 1 using a combination of the methods detailed in Building Research Establishment Digest 365:1991 and British Standard 5930:1981.

The results of the test made and the calculations of apparent permeability or soil infiltration rates are presented on Table 4, contained in Appendix B.

4.5 Gas and Groundwater Monitoring Results

The standpipe installed in Borehole 1 was monitored for gas and groundwater levels on 24th September and 2nd October 2013 and the results are presented on Tables 3 and 3a, contained in Appendix B.

The groundwater level measurements indicate that the groundwater level has stabilised after a period of about four weeks at a depth of 6.28m below ground level in the monitoring standpipe installed in Borehole 1.

4.5.1 Methane

Methane is a flammable asphyxiating gas, the flammable range being 5 to 15% by volume in air. If such a methane-air mixture is confined in some way and ignited it will explode. The 5% by volume concentration is termed the lower explosive limit (LEL). Methane is a buoyant gas having a density about two-thirds that of air.

Various guidelines have been published to help determine mitigation measures for landfill gas. `Landfill Gas' includes gas which may be generated in natural soils such as organic alluvium peat. Methane presents an explosion and asphyxiant hazard.

Building Research Establishment Report BR212 `Construction of New Buildings on Gas-Contaminated Land', states that if Methane concentrations in the ground are unlikely to exceed 1% by volume and a house or small building is constructed in accordance with its recommendations, then no further protection is required. The recommendations include installing granular under slab venting and sealing floor slabs.

CIRIA Report C665 (2007) "Assessing risks posed by hazardous ground gases to buildings" provides guidance on the monitoring and control of landfill gas. The report suggests a classification system which is summarised in Table 8.5 in the document and employs a method which uses both gas concentrations and borehole flow rates to define a characteristic situation for a site based on the Gas Screening Value (also named the limiting borehole gas volume flow) for methane and carbon dioxide.

4.5.2 Carbon Dioxide

Building Research Establishment Report BR212 `Construction of New Buildings on Gas-Contaminated Land', 1991 states that if carbon dioxide concentrations are above 1.5% by volume then protection should be considered to prevent gas ingress. If concentrations exceed 5% by volume, such protective measures are required. This has been superseded by CIRIA Report C665 (2007), states that if carbon dioxide concentrations are above 5% by volume then protection should be considered to prevent gas ingress.

Carbon Dioxide is a non-flammable toxic gas, which is about 1.5 times as heavy as air and is an asphyxiant hazard.

4.5.3 Carbon Monoxide

The occupational exposure standards for carbon monoxide are 30 ppm for long term exposure (8 hours calculated from the HSE Guidance Note EH40, 1991) and 200 ppm for short term exposure (15 minutes calculated from the HSE Guidance Note EH40, 1991) (CIRIA Report C665).

4.5.4 Hydrogen Sulphide

Hydrogen sulphide is toxic at low concentrations. The occupational exposure standard for hydrogen sulphide is 10 ppm for 8-hour time weighted average reference period and 15 ppm for short-term exposure (10 minutes reference period) (HSE Guidance Note EH40, 1991).

4.5.5 Results

The Gas Screening Value is calculated as follows:

The Gas Screening Value (litres of gas per hour) = maximum borehole flow rate (l/h) x maximum gas concentration (%)

On-site monitoring has shown emissions of methane in air of 0.0% and carbon dioxide in air of up to 3.2% recorded during the monitoring visits. The maximum borehole flow rate was 0.0 l/h.

As such the Gas Screening Value for methane at site is 0.0 l/h and the Gas Screening Value for carbon dioxide at site is also 0.0 l/h. As such the worst case value for the site would be less than 0.01 litres of gas per hour.

Carbon monoxide and hydrogen sulphide were not detected above the detection limits of the gas monitoring instrument in the borehole monitored during the monitoring programme.

These results equate to a Characteristic Situation 1, which requires no special precautions at site.

Employing the NHBC `traffic light' characterisation system, the site would be classified as Green in accordance with CIRIA Report C665. Table 8.7 using the Gas Screening Value for methane and carbon dioxide and as such gas prevention measures would not be considered necessary for the site.

For further information on design and construction details, discussions should be sought with a specialist contractor. Guidance may also be obtained from the BRE Report BR212 'Construction of New Buildings on Gas-Contaminated Land' and CIRIA Report C665 (2007). It may also be prudent to contact the local Environmental Health Officer in order to comply with the Local Authority requirements.

5.0 FOUNDATION DESIGN

5.1 General

It is proposed to lowering the existing ground floor at the front of the property by approximately 2.5m below ground level to create additional living space. Exact details of the finalised structures, layout and loadings were not available at the time of preparation of this report.

5.2 Site Preparation Works

The CDM Co-ordinator should be informed of the site conditions and risk assessment undertaken to comply with the Construction Design Management (CDM) regulations. Site personnel are to be made aware of the site conditions in particular the presence of any underground services.

5.3 Conventional Spread Foundations

A result of the inherent variability of uncontrolled fill, (Made Ground) is that it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should therefore, be taken through any Made Ground and either into, or onto a suitable underlying natural strata of adequate bearing characteristics.

Based on the ground and groundwater conditions encountered in the borehole, it should be possible to support the proposed development on conventional spread or basement raft foundations taken down below the Made Ground and any weak superficial soils and placed in the stiff clay deposits encountered at depths of 2.00m below ground level in the borehole.

Using theory from Terzaghi (1943), strip foundations placed within natural soils may be designed to allowable net bearing pressures of approximately 280kN/m^2 at 3.00m depth in order to allow for a factor of safety of 2.5 against general shear failure and should be sufficiently low to ensure that overstressing of the underlying soils does not occur. The actual allowable bearing pressure applicable will depend on the form of foundation, its geometry and depth in accordance with classical analytical methods, details of which can be obtained from "Foundation Design and Construction", Seventh Edition, 2001 by M J Tomlinson (see references) or similar texts.

Any soft or loose pockets encountered within otherwise competent formations should be removed and replaced with well compacted granular fill.

Foundations may need to be taken deeper should they be within the zones of influence of either existing or recently felled trees and any proposed tree planting. The depth of foundation required to avoid the zone likely to be affected by the root systems of trees is shown in the recommendations given in NHBC Standards, Chapter 4.2, April 2010, "Building near Trees" and it is considered that this document is relevant in this situation.

5.4 Piled Foundations

In the event that the use of conventional spread foundations proves either impracticable or uneconomical due to the size and depth of foundation required, a piled foundation will be required. In these ground conditions, it is considered that some form of bored and in-situ cast concrete piled foundation with reinforced concrete ground beams should prove satisfactory.

The construction of a piled foundation is a specialist activity and the advice of a reputable contractor, familiar with the type of soil and groundwater conditions encountered at this site should be sought prior to finalising the foundation design. The actual pile working load will depend on the particular type of pile chosen and method of installation adopted.

To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of about 0.8 and a calculation made to check the factor of safety against block failure.

Driven piles could also be used and would develop much higher working loads approximately 2.5 to 3 times higher than bored piles of a similar diameter at the same depth. However, the close proximity of adjacent buildings will in all probability preclude their use due to noise and vibration.

5.5 Retaining Walls

It is proposed to lowering the existing ground floor at the front of the property by approximately 2.0m to 3.0m to create additional living space. Exact details of the structure, layout and loadings were not available at the time of preparation of this report.

Retaining walls should generally be designed as self-supporting cantilevered retaining walls. The excavations for a basement must not affect the integrity of adjacent structures and therefore will need to be supported. Two forms of support could be considered, these being temporary works i.e. sheet piling which could be removed after the earth retaining walls have been constructed or as permanent works incorporated into the final design.

Generally, cantilevered piled walls have an open face to embedded ratio of about one to two, i.e. a supported face three metres in height would require a penetration into the ground of about six metres below the base of the excavation. Should the piled retaining wall be purely an unsupported cantilever, then it is likely that quite deep section sheet piles or large diameter bored piles would be required.

The section of the sheet or the diameter of the piles could be reduced by installing a braced waling to the wall. Piles placed as part of the permanent works would be propped by the roof to the basement and would not be acting purely as a cantilevered support in the long term.

To reduce the likelihood of loss of ground if a sheet piled wall was adopted when removing the sheets, it is considered that the sheet piles should be incorporated into the final wall design. Assuming that the earth retaining wall will be propped, i.e. have its base slab and first floor slab cast in place soon after excavation, it is unlikely that full if any earth pressures will act on the wall while it is not propped. The greatest force acting on the wall, in the short term, is likely to be from the hydrostatic head should water percolate and be retained to the rear of the earth retaining structure.

The design parameters for each element of soil recorded in the relevant exploratory holes are provided in Table A below. The depth of pile penetration can be calculated once structural details of the proposed basement are known

Founding Material	Depth to top (m)	Description	Critical Angle of Shearing Resistance (°) (Φ'_{crit})[1]	Coefficient active pressure (Ka)	Coefficient passive resistance (Kp)
London Clay	0.65	Stiff becoming very stiff silty CLAY	21	0.47	2.12

Table A. Summary of design parameters for proposed basement foundation

Notes:

1. Calculated using guidance from BS8002
2. As the depth and structural details of the proposed basement are unknown these values should be used as guidance only.

The resulting removal of overburden due to excavation and subsequent reloading from the building may potentially cause some vertical ground movement in the underlying soils, the final magnitude depending on the net unloading applied at the same time. Consideration should, therefore, be given to providing heave protection measures to the floor slab and foundations to mitigate this.

5.6 Basement Floor Slab

Due to the potential for swelling within the natural cohesive soils it is recommended that the basement floor slab should be designed as being fully suspended.

5.7 Excavations

Shallow excavations for foundations and services are likely to require nominal side support in the short term and groundwater is unlikely to be encountered in significant quantities once any accumulated surface water within the Made Ground and superficial soils has been removed.

Deeper and longer excavations below approximately 1.5m below existing ground level will require close side support and some inflows of groundwater are likely to be encountered.

5.8 Chemical Attack on Buried Concrete

The results show the natural soil samples to have water soluble sulphate contents of up to 2.81g/litre associated with slightly acidic pH values.

In these conditions, it is considered that deterioration of buried concrete due to sulphate attack is unlikely to occur unless precautions are taken. The final design of buried concrete according to Tables C1 and C2 of BRE Special Digest 1:2005 should be in accordance with Class DS-3 conditions.

In addition, segregations of gypsum were noted within the London Clay and scattered small gypsum crystals were also noted at depth. Consequently, it is considered that any buried concrete at depth may be attacked by such sulphates in solution and that it would be prudent to design any such deep buried concrete in accordance with full Class DS-3 conditions.

p.p. SITE ANALYTICAL SERVICES LIMITED

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REFERENCES

1. Beckett M.J. and Sims D.L. (1984). "The Development of Contaminated Land", Symposium on Hazardous Waste Disposal and the Re-use of Contaminated Land. Society of Chemical Industry.

2. Boscardin and Cording (1989). Building Response to Excavation-Induced Settlement. Journal of Geotechnical Engineering, ASCE.

3. British Standards Institution, 1986. Code of practice for foundations, BS 8004, BSI, London.

4. British Standards Institution, 1990. Methods for test for soils for civil engineering purposes, BS1377, BSI, London

5. British Standards Institution, 1994. Code of practice for earth retaining structures, BS8002, BSI, London

6. British Standards Institution, 2001. Investigation of Potentially Contaminated Sites - Code of Practice, BS 10175, BSI, London

7. British Standards Institution, 2007. Code of Practice for Site Investigations, BS5930, BSI, London

8. British Standards Institution, 2009. Code of practice for protection of below ground structures against water from the ground, BS 8102, BSI, London

9. Building Research Establishment Special Digest 1, 2005, "Concrete in Aggressive Ground – Third Edition."

10. Driscoll, R (1983) "The influence of vegetation on the shrinking and swelling of clay soils in Great Britain", Geo-technique 33, 93-107

11. Eurocode 1: Actions on structures – BS EN 1991-1-1:2002: General actions – Densities, self weight and imposed loads, BSI, London

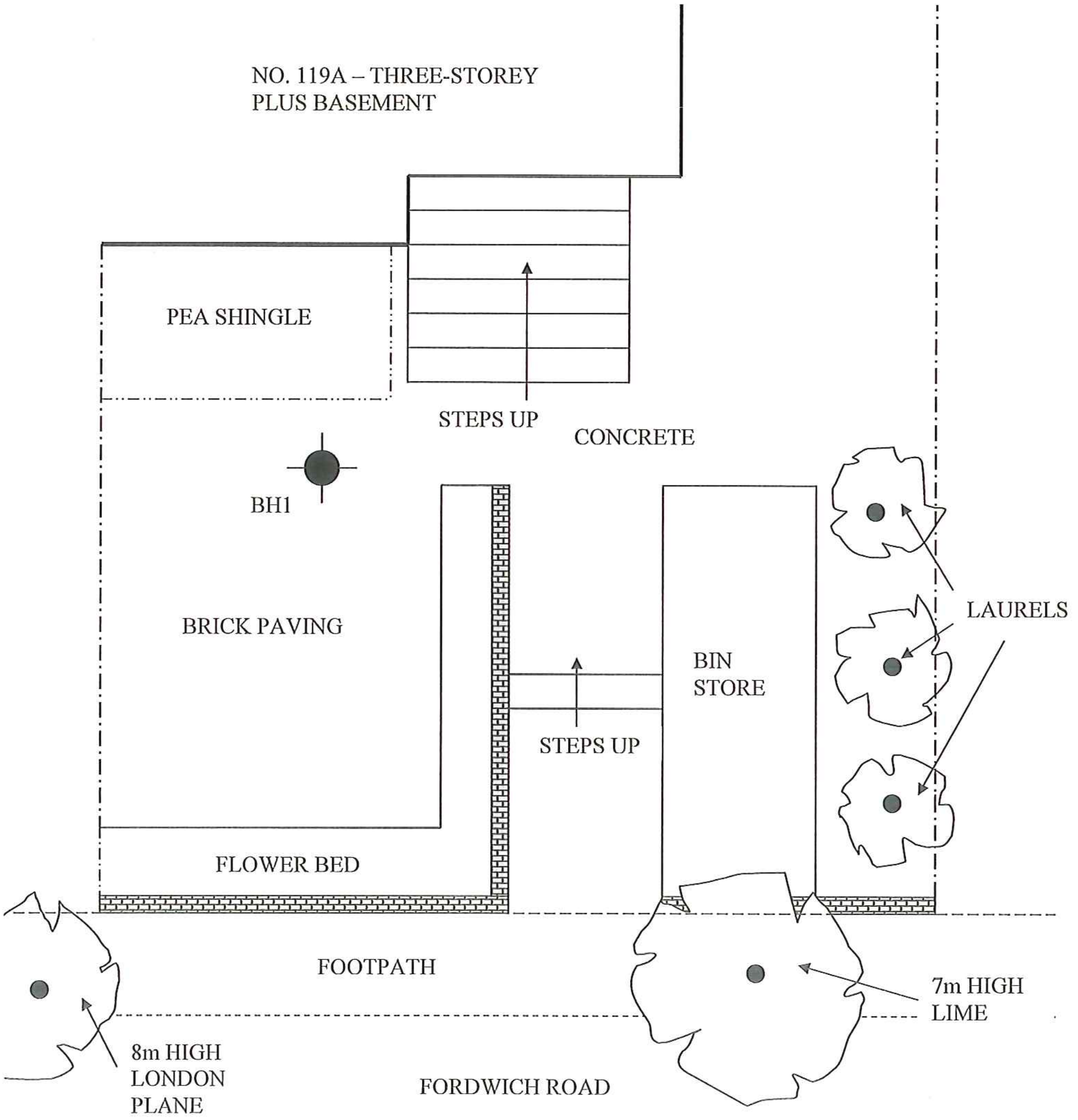
12. NHBC Standards, Chapter 4.1, "Land Quality - managing ground conditions", September 1999.

13. NHBC Standards, Chapter 4.2, "Building near Trees", April 2010.

14. Stroud M.A. and Butler F.G. (1975) Symposium on the Engineering Behaviour of Glacial Materials; the Midland Soil Mechanics and Foundation Engineering Society; pgs 124 et seq.

15. Tomlinson, M J, 2001. "Foundation Design and Construction", Seventh Edition, Prentice Hall (ISBN 0-13-031180-4).

Site Analytical Services Ltd.		REF: 13/21182
LOCATION: 119a Fordwych Road, London, NW2 3NJ		FIG: 1
TITLE: Sketch Site Plan	DATE: Sept 2013	SCALE: NTS



APPENDIX `A'

Borehole / Trial Pit Logs

Site Analytical Services Ltd.

Site	Borehole Number
119a FORDWYCH ROAD, LONDON, NW2 3NJ	BH1

Boring Method	Casing Diameter	Ground Level (mOD)	Client	Job Number
CONTINUOUS FLIGHT AUGER	100mm cased to 0.00m		MS ANNA SWAN	1321182
	Location	**Dates**	**Engineer**	**Sheet**
	TQ 244 851	06/09/2013	MR STELIOS CONSTANTUNOU	1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description
						(0.08) 0.08	MADE GROUND : Brick paving slabs
0.25	D1					(0.32) 0.40	MADE GROUND : Medium dense dark brown silty gravelly fine to coarse sand with brick and clinker fragments. Gravel is fine to coarse of sub rounded flint.
0.50	D2					(0.25) 0.65	MADE GROUND : Firm dark brown sandy silty gravelly clay with brick fragments. Gravel is fine to coarse of sub rounded flint.
0.75	D3						
1.00	D4						Stiff becoming very stiff brown and mottled orange brown, veined blue grey silty CLAY with occasional partings of light brown silty fine sand and occasional gypsum crystals.
1.00	V1 102						
1.50	D5						
1.50	V2 128						
2.00	D6						
2.00	V3 140+						
2.50	D7						
2.50	V4 140+						
3.00	V5 140+						
3.00	D8						
3.50	V6 140+					(6.15)	
3.50	D9						
4.00	D10						
4.00	V7 140+						
4.50	D11						
4.50	V8 140+						
5.00	D12						
5.00	V9 140+						
6.00	D13						
6.00	V10 140+					6.80	
7.00	D14						Very stiff dark grey brown fissured silty CLAY with occasional partings of light brown silty fine sand and scattered small gypsum crystals#
7.00	V11 140+					(1.20)	
8.00	D15					8.00	
8.00	V12 140+			06/09/2013:DRY			Complete at 8.00m

Remarks

- Groundwater was not encountered during boring
- V = Vane Test - Result in kPa
- D = Disturbed Sample

Scale (approx)	Logged By
1:50	APS

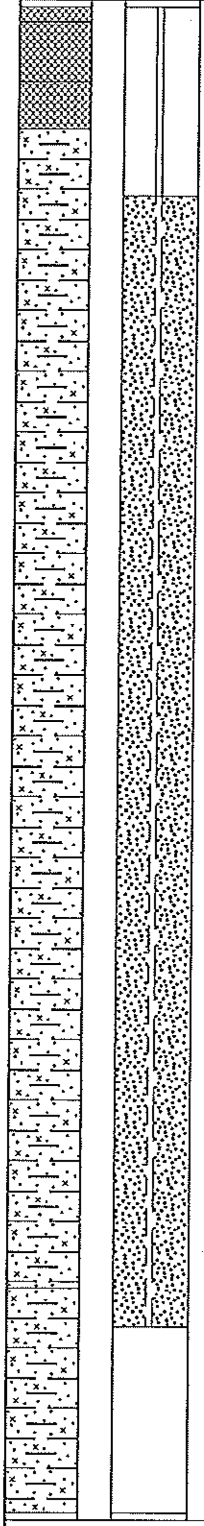
Figure No. 1321182.BH1

Site Analytical Services Ltd.

Site	Borehole Number
119a FORDWYCH ROAD, LONDON, NW2 3NJ	BH1

Installation Type	Dimensions		Client	Job Number
MONITORING STANDPIPE	Internal Diameter of Tube [A] = 50 mm Diameter of Filter Zone = 100 mm		MS ANNA SWAN	1321182
	Location	**Ground Level (mOD)**	**Engineer**	**Sheet**
	TQ 244 851		MR STELIOS CONSTANTUNOU	1/1

Legend	Water	Instr (A)	Level (mOD)	Depth (m)	Description
					Bentonite Seal
				1.00	
					Slotted Standpipe
				7.00	
					Bentonite Seal
				8.00	



Groundwater Strikes During Drilling

Date	Time	Depth Struck (m)	Casing Depth (m)	Inflow Rate	Readings 5 min	Readings 10 min	Readings 15 min	Readings 20 min	Depth Sealed (m)

Groundwater Observations During Drilling

Date	Start of Shift					End of Shift				
	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)	Time	Depth Hole (m)	Casing Depth (m)	Water Depth (m)	Water Level (mOD)
06/09/13				DRY			8.00		DRY	

Instrument Groundwater Observations

Inst. [A] Type : SINGLE STANDPIPE

Date	Instrument [A]			Remarks
	Time	Depth (m)	Level (mOD)	

Remarks

Lockable cover set in concrete
Gas valve fitted

A P P E N D I X 'B'

In-situ, Laboratory Test and gas Monitoring Data

Ref: 13/21182

PLASTICITY INDEX & MOISTURE CONTENT DETERMINATIONS

LOCATION 119a Fordwych Road, London, NW2 3NJ

BH/TP No.	Depth m	Natural Moisture %	Liquid Limit %	Plastic Limit %	Plasticity Index %	Passing 425 µm %	Class
BH1	1.00	27	67	22	45	99	CH
	2.00	28	71	22	49	100	CV
	3.00	29	71	23	48	100	CV
	4.00	31	73	25	48	100	CV

Ref: 13/21182

SULPHATE & pH DETERMINATIONS

LOCATION 119a Fordwych Road, London, NW2 3NJ

BH/TP No.	DEPTH BELOW GL m	SOIL SULPHATES AS SO_4 TOTAL %	SOIL SULPHATES AS SO_4 WATER SOL g/l	WATER SULPHATES AS SO_4 g/l	pH	CLASS	SOIL - 2mm %
BH1	2.50		2.81		5.6	DS-3	100
	7.00		2.11		5.8	DS-3	100

Classification – Tables C1 and C2 : BRE Special Digest 1 : 2005

Ref: 13/21182

GAS MONITORING

LOCATION	119a Fordwych Road, London, NW2 3NJ
MONITORING DATE	24th September 2013

BOREHOLE REF:		**BH1**
Methane	(%)	0.0
Carbon Dioxide	(%)	3.2
Oxygen	(%)	18.3
Hydrogen Sulphide	(p.p.m.)	0
Carbon Monoxide	(p.p.m.)	0
Atmospheric Pressure	(mb)	1008
Water Level	(m.bgl)	6.25
Oxygen in Air	(%)	21.0
Flow	(l/hour)	0.0

N.B. Methane Lower Explosive Limit - 5% Gas in Air

Table 3

Ref: 13/21182

GAS MONITORING

LOCATION 119a Fordwych Road, London, NW2 3NJ

MONITORING DATE 2nd October 2013

BOREHOLE REF:		**BH1**
Methane	(%)	0.0
Carbon Dioxide	(%)	1.5
Oxygen	(%)	20.3
Hydrogen Sulphide	(p.p.m.)	0.0
Carbon Monoxide	(p.p.m.)	0.0
Atmospheric Pressure	(mb)	995
Water Level	(m.bgl)	6.28
Oxygen in Air	(%)	21.0
Flow	(l/hour)	0.0

N.B. Methane Lower Explosive Limit - 5% Gas in Air

Table 3a

Ref: 13/21182

LOCATION 119a Fordwych Road, London, NW2 3NJ

RISING HEAD PERMEABILITY TEST -- BOREHOLE

Borehole Number	BH1
Initial Groundwater Depth	6.28m
Borehole Depth	8.00m
Depth to Bottom of Casing	7.46m
Length of Test Section	7.46m
Diameter of Casing	0.10m
Test Duration	30 minutes
Depth of Water at Commencement of Test	7.17m
Permeability	6.55×10^{-7} m/sec

Time Elapsed (mins)	Depth of Water Below top of Casing (m)	Time Elapsed (mins)	Depth of Water Below top of Casing (m)
0 sec	7.17	10.00	6.94
0.5	7.12	15.00	6.92
1.00	7.08	20.00	6.91
2.00	7.06	30.00	6.88
3.00	7.04		
4.00	7.00		
5.00	6.97		