Card Geotechnics Limited
Providing Ground Solutions

Ironside & Malone Design & Build

9 Arkwright Road, Hampstead, London

Geoenvironmental and Flood Risk Interpretive Report – Revision 1

May, 2012

Card Geotechnics Limited
4 Godalming Business Centre, Woolsack Way,
Godalming, Surrey, GU7 1XW
Telephone: 01483 310 600
www.cardgeotechnics.co.uk

Author	Adam Cadman, Engineer *MSc BSc (Hons) FGS*				
Checked	Andy O'Dea, Business Director *MSc BAI BA DIC MIES FGS*				
Approved	Ian Marychurch, Director *MSc BSc CEng MICE CGeol FGS*				
Reference	CG/5595	Revision	0 1	Issue Date	September 2011 May 2012

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EXECUTIVE SUMMARY

Ironside & Malone Design and Build Limited (Ironside) is proposing the redevelopment of 9 Arkwright Road, Camden, London. It is understood that the proposed development will comprise the part-demolition and extension of the existing building with the provision of a new basement under the south-eastern corner of the proposed building footprint and in the south-eastern quadrant of the site, under the existing car parking area.

The site is roughly square in shape and covers an area of approximately 0.17 hectares. A 19th century building is located in the north-western half of the site with a garden to the rear (south). An access way extends along the north-eastern site boundary terminating at a small car park in the south-eastern corner of the site. The site is bound by Arkwright Road to the north-west and residential properties to the north-east, south-west and south-east.

The site remained relatively undeveloped until around 1894 when the current site boundary was established and the western half of the existing building was constructed. Mapping from 1915 shows the completion of the current building on the site.

The ground conditions encountered during the investigation were in general agreement with the published geology. These comprised Made Ground to depths of between 1.6mbgl and 3.7mbgl, over the Claygate Beds and the London Clay Formation. The top of the London Clay was encountered at depths of between 7.1mbgl and 9.4mbgl. Groundwater was recorded at levels of between 86mAOD and 89mAOD. The Claygate Beds are classified as a Secondary A aquifer, although the site is not within a source protection zone. The London Clay Formation is a non-productive stratum.

Based on the ground and groundwater conditions at the site, the proposed basement will have no discernable impact on the local hydrology or hydrogeology and is therefore unlikely to impact or influence neighbouring properties. A rail tunnel is present approximately 60m to 70m to the south of the site, however the proposed works are not considered to pose a risk to this feature.

The results of chemical soil analyses indicate that concentrations of potential contaminants in the Made Ground are generally below the assessment criteria for the chosen site end-use. A single, isolated elevated concentration of lead was recorded in foundation inspection pit FIP08 at a depth of 0.58mbgl and may be considered a localised 'hotspot'. It is likely that this area will be removed during the construction of the extension to the

southern façade. However, should this not be the case, it is recommended that an area of 2m x 2m around the lead hotspot is removed to a depth of 1.0mbgl. Validation testing, including sampling of each side and the base of the excavation and subsequent chemical analysis, will be required to confirm the successful removal of the hotspot. Alternatively, additional surface soil sampling and analysis could be carried out in the affected area to provide a larger body of data for statistical analysis, which may eliminate the risk.

The risks to controlled waters as a result of leaching of contaminants from residual soil contamination is considered to be negligible given the lack of contaminative sources identified on the site. Furthermore, the site is not situated within a Groundwater Source Protection Zone.

The results of the total soils analysis undertaken on the Made Ground and natural soils indicate that the material may be classified as 'not-hazardous', including the material in the area of the lead hotspot. If not required for reuse on site, the Made Ground material is likely to be suitable for disposal at an inert landfill facility. Waste Acceptance Criteria (WAC) analysis will be required during construction to confirm waste disposal requirements. The natural material (Claygate Beds and London Clay) is likely to be classified as inert and suitable (in chemical terms) for reuse on-site or off-site subject to compliance with appropriate waste management and controls.

The results of ground gas monitoring indicate that the site conforms to Characteristic Situation 1 and NHBC Green. On this basis no specific gas protection measures are considered necessary.

1. INTRODUCTION

Ironside & Malone Design and Build Limited (Ironside) is proposing the redevelopment of 9 Arkwright Road, Camden, London. It is understood that the proposed development will comprise the part-demolition and extension of the existing building with the provision of a new basement under the south-eastern corner of the proposed building footprint in the south-eastern quadrant of the site, under the existing car parking area.

Card Geotechnics Limited (CGL) has been commissioned by Adair Associates on behalf of Ironside to undertake a desk based study and Phase 2 geoenvironmental intrusive investigation.

The objectives of the investigation are to;

- Provide information on the ground conditions;
- Confirm the presence/absence of land contamination;
- Undertake a contamination risk assessment;
- Produce a conceptual site model;
- Provide recommendations on remediation works and preliminary waste disposal requirements; and
- Undertake a flood risk/hydrogeological impact assessment.

This report does not address the geotechnical aspects of the project, such as building foundations, basement wall, concrete, pavements and groundwater management provisions, which will be discussed in a later report.

2. SITE CONTEXT

2.1 Site location

The site is located on 9 Arkwright Road, Camden, London, and is currently occupied by a large 19th century house, previously converted into offices. The approximate National Grid Reference for the centre of the site is 526421, 185320. A Site location plan is presented in Figure 1.

2.2 Site description

The site is roughly square in shape and covers an area of approximately 0.17 hectares. The 19th century building is located in the north-western half of the site. A small grassed slope extends across much of the northern site boundary, between Arkwright Road and the front façade of the existing building. The area between this soft landscaping and the façade is covered with paving stones with light wells, which extend to the level of the ground floor (at approximately 93mAOD). Additional light wells are located on the eastern façade of the property. A boiler room basement is located in the northern corner of the existing building and is accessible via a stairwell in the northern corner of the site.

An access road adjoining Arkwright Road (at an elevation of around 96mAOD) slopes down towards the south-east on the eastern site boundary. This access road terminates at a relatively flat area of hardstanding, currently used as a small car park, at an elevation of approximately 94mAOD, which occupies around half of the south-eastern quadrant of the site.

The rear garden of the property is situated in the remaining area of the south-eastern and south-western quadrants. This area comprises soft landscaping with turf and several trees, including young to mature cypress, sycamore and birch species. Full details of vegetation and trees on the site are provided separately in a Arboriculture Impact Assessment Report produced by Landmark Trees. The area between the garden and the rear of the existing building is currently covered with slab paving and tarmac hardstanding.

The site is bound by Arkwright Road to the north-west and residential properties to the north-east, south-west and south-east.

The current site layout is presented in Figure 2.

2.3 Proposed development

It is understood that the proposed development consists of the part demolition and reconfiguration of the rear façade of the current building. The ground floor level is to be extended to the south to occupy the patio area of the existing rear garden. A new basement is proposed under the south-eastern corner of the proposed footprint and will extend under the current parking area. The proposed basement level is approximately 89.35mAOD. The existing access road will remain relatively unchanged.

The proposed development plans are included in Appendix A.

3. DESK STUDY

3.1 General

This section provides the summarised findings of the desk study and a site walkover survey of the site to allow the development of a qualitative environmental risk assessment based upon the 'source-pathway-receptor' approach.

3.2 Historical development

3.2.1 Sources of information

The development history of the site has been traced using historical Ordnance Survey maps dating from 1865. Selected extracts of the relevant maps are presented in Appendix B.

3.2.2 Summary of development

The historic map dated 1865 indicates the site and immediate surrounding area was occupied by *Rosslyn Park* and agricultural land. Between 250m and 500m to the north of the site, is the small town of Hampstead. Houses, roads and amenities, including schools, churches and public houses, associated with the town, extend south to the east and south-east of the site. The *Midland Railway* is situated approximately 500m to the south-west of the site, including two *Finchley Road Stations*. Two *railway lines* are present, one of which runs in a south-west to north-east direction and the other east to west. A tunnel portal for the former line is situated approximately 350m to 400m to the south-east of the site. The line of the *tunnel* trends parallel to the southern site boundary, at a distance of around 60m to 70m from the site, extending from *Finchley Road Station* in the south-west to *Hampstead Heath Station* to the north-east. A *ventilation shaft* for the tunnel is located some 150m to the east of the site. Several farms are located around the site; *Mount Farm* lies approximately 250m to the north, and *Belsize Farm* to the south-east. The *Hampstead Ponds*, a collection of waterworks reservoirs operated by the *Newriver Company*, is located approximately 1km to the north-east of the site. Approximately 650m to the north-east of the site is a *Militia Barracks*.

The Ordnance Survey mapping dated 1894 shows considerable expansion of the town of *Hampstead*. The site and surrounding area have undergone development, with the

construction of roads and residential properties. This includes the establishment of the current site boundary and construction of the western half of the building that remains on site at the time of reporting. The *N.W. Fever Hospital* is noted approximately 750m to the east of the site and a Workhouse is located around 500m to the north. The *Midland Railway* to the south-west of the site undergoes expansion with the construction of a new *railway line* which runs in a south-east direction from *Finchley Road Station*. A *works* and several buildings associated with the railway are noted in the areas around the *Midland Railway* from 1911-1914.

Mapping from 1915 shows the completion of the current building on the site. The surrounding area sees progressive residential expansion and the construction of the *University College School* approximately 50m to the north-west of the site.

Continued expansion is noted in the surrounding area between 1915 and the current day, however the site remains relatively unchanged.

3.3 Bomb damage assessment

World War II bomb damage maps[1] show the site to be unaffected by blast or more serious structural damage, however the local area suffered some damage. Two properties along the southern section of Ellerdale Road, approximately 50m to the north-west of the site, were damaged beyond repair and the properties in the immediate vicinity of these properties were subjected to minor blast damage. This includes the property immediately opposite the site on Arkwright Road. This was also the case on Netherhall Gardens approximately 50-100m to the south/south-east of the site. Nearer to the aiming point of the Hampstead Junction Line, to the south-west of the site, several properties suffered total destruction.

Given the locality of the site to bomb damaged properties, the likelihood of unreported ordnance on the site is considered unlikely and as such the risk posed by UXO on the site is considered low.

[1] London Topographic Society and London Metropolitan Archives. 2005. *The London County Council Bomb Damage Maps 1939-1945*.

3.4 Ground and groundwater conditions

3.4.1 Published geology

According to British Geological Map Sheet 256[2], the site lies on the Claygate Member over London Clay Formation. Nominal Made Ground is anticipated across the site, given the lack of historic development.

The Claygate Member[3] is the top part of the London Clay Formation and generally consists of a repetitive sequence of low to very high plasticity, overconsolidated, fissured, firm to very stiff, silty clays, silts and medium dense to dense fine sands. The clay beds are subject to shrinkability and this is further compounded by the more permeable sandy beds, which act as conduits for the movement of moisture in and out of the clay units. The response of moisture content to seasonal changes may therefore be more pronounced and occur more rapidly. In its weathered state, the clays are brown in colour, but in general show little difference in behaviour compared to the unweathered material. According to the BGS geological map[2], the Claygate Member can be up to 10m to 20m thick in the area of the site. However, given the location of the site with relation to the lateral extent of these deposits, the Claygate Member is more likely to be in the region of 5m thick over the site.

The London Clay Formation[3] is an overconsolidated, firm to very stiff, fissured, silty clay of low to very high plasticity. The clay is susceptible to shrinkage and swelling under the effects of seasonal change in moisture content and tree growth or removal. In its weathered state the clay becomes brown in colour and is accompanied by an increase in moisture content. In dry periods, a superficial desiccation zone may form, reversing the moisture content and strength profile. Weathering may be present to a depth of up to 5m to 10m below the surface of the formation. The BGS geology map indicates the base is at approximately -10mOD to -20mOD, with a thickness of about 80m to 90m[2].

3.4.2 Unpublished geology

British Geological Survey (BGS) borehole records were obtained to confirm the published geology in the area of the site. The records are located at either end of Arkwright Road, approximately 180m to the north-east (BH reference TQ28NE44) and around 500m the south-west (TQ28NE129 & TQ28NE130) of the site. The ground conditions encountered

[2] British Geological Survey. (1993). *North London.* England and Wales Sheet 258. 1:50,000 Series. Solid and Drift Geology, Sheet 258.

generally confirmed the published geology, with the Claygate Beds overlying the London Clay Formation.

The BGS borehole records are presented in Appendix C.

3.5 Hydrology and hydrogeology

The Environment Agency has produced an aquifer designation system consistent with the requirements of the Water Framework Directive. The designations have been set for superficial and bedrock geology, and are based on the importance of aquifers for potable water supply and their role in supporting surface water bodies and wetland ecosystems.

With reference to the Environment Agency website[4], the bedrock geology (Claygate Beds) has been classified as a Secondary A aquifer. These are permeable layers capable of supporting water supplies at a local rather than strategic scale and in some cases forming an important source of base flow for rivers. The underlying London Clay Formation is classified as an unproductive stratum. These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow. No superficial deposits are located on the site.

The site does not lie within a Groundwater Source Protection Zone. The nearest surface water body to the site has been identified between 51-250m of the site boundary, although this is not evident from the mapping within the environmental disclosure report, it is understood to relate to a tributary of the Westbourne at a level of approximately 70mAOD. The River Thames is located some 6km to the south-east of the site.

The site is not located within 250m any Environment Agency indicative Zone 2 or 3 floodplains. With reference to the Environment Agency website[5], the site is significantly outside the area susceptible to flooding from rivers or sea without defences and the extent of extreme flooding.

[3] British Geological Survey. (1997. *The Engineering Geology of the London Area*. Technical Report: WN/97/27.
[4] http://maps.environment-agency.gov.uk

3.6 Environmental setting

3.6.1 General

An environmental disclosure report for the area was obtained to provide information on the environmental setting of the site and possible sources of ground and groundwater contamination. A summary of the key points is set out below and the fill report is presented in Appendix D.

3.6.2 Source protection zones and sensitive land uses

The site is not located within a source protection zone or within 500m of any designated environmentally sensitive sites. The closest outer source protection zone is located approximately 1km to the south-east of the site.

There are no groundwater or surface water abstraction licenses issued within 1km of the site, and no potable water abstraction licenses within 2km of the site. The closest water abstraction point is approximately 1.8km to the south-east.

There are no discharge consents within 500m of the site and no pollution incidents to controlled waters have been reported within 250m of the site.

3.6.3 Local authority pollution prevention and control

There are no recorded active or historic landfill sites within 500m of the site. One historic landfill site is recorded with 1km of the site, located at Canfield Place, London (NGR 526000, 184800), approximately 592m to the south-west of the site.

There are no operational or non-operational waste treatment, transfer or disposal sites within 500m of the site. No Environment Agency licensed waste sites are identified within 1km of the site.

There are no records of Category 3 or 4 radioactive substances authorisations or records of planning hazardous substance consents and enforcements within 500m of the site.

There are no recorded mineral workings within 75m of the site. The risk of subsidence relating to shallow mining within 150m of the site is considered negligible.

3.6.4 Contemporary trade directory entries

There are six recorded current trade directory entries within 250m of the site. The closest is located on the site and concerns Tribune Publication Limited. It is understood that the entry relates to published goods and that no manufacturing takes place on site.

The other entries relate to a recording studio 39m to the north-west of the site and several electricity substations between 82m and 223m from the site.

Three records of Part A(2) and Part B activities and enforcements are located within 500m of the site, all of which relate to Perkins Dry Cleaners located at 40 Heath Street, approximately 378m to the north of the site.

There are no fuel station entries within 500m of the site.

3.6.5 Radon gas

A radon risk report was obtained from UKradon for the site in order to assess the risks posed by radon gas on existing properties and new buildings. Based on this report, and with reference to BRE and HPA guidance on radon protection, the site is situated in an area where less than 1% of homes are at or above the action level for radon. On this basis, no radon protection measures are considered necessary. The radon risk report is included in Appendix D.

3.7 Local Authority enquiries

Liaison with the Local Authority Contaminated Land Officer did not identify any relevant additional information. The environmental disclosure report obtained for the site confirms that there are no sites determined as contaminated land under Part IIA of the Environmental Protection Act 1990 within 500m of the site.

3.7.1 Environment agency enquiries

With reference to the Environment Agency Website[5], there are no recent pollution incidents recorded within 1km of the site.

4. PRELIMINARY RISK ASSESSMENT

4.1 Introduction

Historical contamination of land may present harm to human health and the environment. Current UK legislation stipulates that the risk associated with any potential land contamination is assessed and remediated, if necessary. Under the Town and Country Planning Act 1947 (as amended), potential land contamination is a "material planning consideration" which means that a planning authority must consider contamination when it prepares development plans or considers individual applications for planning permission. It is the responsibility of the developer to carry out the remediation where it is required and satisfy the Local Authority that the remediation has been carried out as agreed.

Additionally, Part 2A of the Environmental Protection Act 1990 requires that a significant source-pathway-receptor linkage exists to determine a site as contaminated land. This means that there has to be a contaminant present, a receptor that could be harmed by this contaminant, and a pathway linking the two. Part 2A deals with the contamination risk from a site in its current use, however the planning system requires that the proposed use is considered. Where remediation is carried out under the planning system, it should be ensured that the site is in such a condition that it would not still meet the definition of contaminated land under Part 2A.

4.2 Preliminary conceptual site model

A preliminary conceptual site model has been compiled for the site to determine the potential sources of contamination and the significance of potential pollutant linkages. A pictorial representation of the conceptual site model is presented in Figure 3.

4.2.1 Potential sources

Potential contamination sources can include current and historical activities both on the site and from neighbouring land. The following potential sources have been identified at the site:

Made Ground – it is possible that there is a thin layer of Made Ground beneath the Topsoil and the hardstanding across the site. The Made Ground may be variable in thickness and chemical nature. Should a significant thickness of Made Ground be locally present, there is

a potential for contaminants associated with building and construction debris associated with the construction of the building and localised spillages associated with the car parking area which may include heavy metals, petroleum hydrocarbons and polyaromatic hydrocarbons (PAH) etc. There may also be a potential for some very limited soil gases and isolated fragments of asbestos may be present given the age and nature of the development.

Surrounding area – the dry cleaners, railway infrastructure and associated works, may be potential sources of contaminants including lubricating oils, anti-freeze, brake fluids, solvents, paints, petroleum hydrocarbons and polyaromatic hydrocarbons (PAH). However, there is a considerable distant between these potential sources and the site.

4.2.2 Potential pathways

The potential migration pathways that may be present at the site include:

Ingestion & inhalation – contamination within Made Ground, if present and exposed during construction or in the final development, may result in ingestion or inhalation of contaminated dust, including asbestos fibres, and soil gases/vapour;

Direct contact – direct contact with contaminated soils or surface water can result in uptake of contaminants through the skin;

Vapour/soil gas migration – if there is significant Made Ground, with an appreciable organic content, there may be a potential for soil gases. These gases could migrate through the soil matrix into proposed buildings.

4.2.3 Potential receptors

Based on the proposed site use as a residential dwelling, the main potential receptors at the site are considered to be:

Future site occupiers – considered to be primarily at risk from possible shallow contamination and soil gas/vapour accumulation within buildings, arising from possible Made Ground;

Construction workers – could be affected by contamination and asbestos within possible Made Ground during the site works. Such persons are likely to be in close contact with contaminated materials, especially during site clearance;

Buildings & structures – buried concrete and services, such as plastic water supply pipes, can be at risk from chemically aggressive ground and hydrocarbon contamination. Soil gases and vapours may also accumulate in buildings and structures presenting an explosive or asphyxiation risk;

Vegetation & plants – primarily at risk from phototoxic contaminants such as copper and zinc.

Controlled waters, including groundwater – possibly at risk from the migration of contaminants such as hydrocarbons and heavy metals from the site.

4.3 Preliminary quantitative risk assessment

A qualitative risk assessment has been undertaken based on the findings of the Conceptual Site Model and the potential pollutant linkages that may exist at the site in accordance with Contaminated Land Report (CLR) 11[6]. The risks identified are in accordance with the DEFRA and Contaminated Land Report (CLR) 6[7], site prioritisation and categorisation rating system which is summarised in Table 1 below.

[6] The Environment Agency. 2004. Model Procedures for the Management of Land Contamination, CLR 11
[7] M.J. Carter Associates. 1995. *Prioritisation and Categorisation Procedure for Sites which may be Contaminated*, Department of the Environment, CLR 6

Table 1: Risk rating terminology.

Risk Rating	Description
High Risk	Contaminants very likely to represent an unacceptable risk to identified targets; Site probably not suitable for proposed use; Enforcement action possible; and Urgent action required.
Medium Risk	Contaminants likely to represent an unacceptable risk to identified targets; Site probably not suitable for proposed use; and Action required in the medium term.
Low Risk	Contaminants may be present but unlikely to create unacceptable risk to identified targets; Site probably suitable for proposed use; and Action unlikely to be needed whilst site remains in current use.
Negligible Risk	If contamination sources are present they are considered to be minor in nature and extent; Site suitable for proposed use; and No further action required.

Based on the above terminology an assessment of the risks posed by the potential pollutant linkages at the site is outlined in Table 2.

Table 2: Preliminary qualitative risk assessment.

Source/Medium	Receptor	Potential Exposure Route	Risk Rating
Explosive / asphyxiating gases from within Made Ground and natural soils.	Internal building spaces & future occupiers	Migration of gases through the surface and via permeable soils	Low
Asbestos within Made Ground.	Construction workers	Direct ingestion of soil & dust, inhalation of particulates & vapours and dermal contact	Low
Organic/inorganic contaminants (e.g. hydrocarbons, metals etc.) within Made Ground and natural soils.	Construction workers	Direct ingestion of soil & dust, inhalation of particulates & vapours and dermal contact	Low
	Future site occupiers	Direct ingestion of soil & dust, inhalation of particulates & vapours, indirect ingestion by means of dermal contact	Low
	Vegetation and plants	Root uptake	Low
	Buildings & structures	Direct contact and migration & accumulation within building spaces	Low
	Controlled waters	Migration of contaminants.	Low

4.4 Conclusions

The available information and past land uses identified in and around the site and the anticipated ground conditions would suggest a low potential for contamination. The table indicates that there is a low risk to construction workers, in relation to the possibly presence of asbestos.

If contaminated Made Ground is not found at the site the risk could be reduced to negligible.

5. PRESENT GROUND INVESTIGATION

5.1 Fieldwork

An intrusive investigation was undertaken between 25th July 2011 and 2nd August 2011. The investigation comprised the excavation of 2 No. machine dug trial pits (TP01 to TP02), 4 No. cable percussion boreholes (BH01 to BH04) and 16 No foundation inspection pits (FIP01 to FIP15).

Rising head tests were undertaken within the standpipes in each borehole position on 7th September 2011. The results are included in Section 6.5, however the implications of these will be discussed in a separate report.

In order to obtain samples for laboratory chemical testing and to fully characterise the near surface ground conditions across the site, the trial pit and borehole arisings were recorded and representatively sampled by an suitably qualified engineer from CGL.

Service drawings were provided prior to the intrusive investigation and each exploratory hole location was scanned with a cable avoidance tool (CAT) prior to the works commencing.

The locations of all the exploratory holes are indicated in Figure 2 and copies of the borehole and trial pit records are provided in Appendix E. Foundation inspection pit logs will be included in the geotechnical report.

The investigation was undertaken generally in accordance with the requirements of current UK guidance including BS5930[8] and BS10175[9].

5.2 Laboratory testing

5.2.1 Chemical

Representative soil and groundwater samples were sent to i2 Analytical Limited (a UKAS and MCERTS accredited laboratory) for chemical testing. The analysis included the following contaminants and the full results are presented in Appendix F

[8] British Standards Institution. (1999). *Code of practice for site investigations*. BS5930:1999.
[9] British Standards Institution. (2001). *Investigation of potentially contaminated sites: Code of practice.* BS10175:2001.

- Soil Organic Matter (SOM);
- Heavy metals including; arsenic, barium, beryllium, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium and zinc;
- Benzene, Toluene, Ethylbenzene, Xylenes (BTEX) compounds;
- Total Petroleum Hydrocarbons (TPH) and Polycyclic Aromatic Hydrocarbons (PAH);
- Total Monohydric Phenols;
- Total cyanide,
- Sulphate; and
- pH determination.

5.3 Monitoring

Groundwater level and soil gas monitoring visits were undertaken on three separate occasions between 1st September and 15th September 2011. Groundwater sampling was undertaken on 7th September 2011. Copies of the monitoring records are presented in Appendix G.

6. GROUND AND GROUNDWATER CONDITIONS

6.1 Summary

The ground conditions encountered during the intrusive investigation generally confirmed those expected from the desk study and are summarised in Table 3 below.

Table 3. Summary of ground conditions.

Strata	Depth encountered (mbgl)	Thickness (m)
[MADE GROUND] Medium dense light brown gravelly sand and soft to firm brownish grey gravelly very sandy clay and silt.	0.0	1.6 to 3.7
Loose to medium dense ochreous brown slightly clayey very silty fine sand & firm light ochreous brown clayey very sandy silt and clay. [CLAYGATE BEDS]	1.6 to 3.7	3.4 to 7.8
Firm, becoming stiff with depth, dark grey sandy silty clay with occasional sand partings. [LONDON CLAY]	7.1 to 9.4	Proven to 25m bgl

6.2 Made Ground

Made Ground was encountered within each exploratory hole below hardstanding or topsoil, with thicknesses ranging between 1.6m to 3.7m. The Made Ground was encountered at its maximum thickness in BH02 (2.6m) and BH03 (3.7m) within the rear garden area of the site. Given the site and surrounding topography slopes towards the south-east, it is likely that this Made Ground is associated with site level make up.

The Made Ground generally comprised sands, clays and silts with variable proportions of minor constituents including sand, clay and gravel. The gravel was typically fine to coarse, rounded to angular of brick and flint.

No visual or olfactory evidence of contamination was noted in the boreholes or trial pits. However, ashy material was noted in the shallow Made Ground within foundation inspection pits.

6.3 Claygate Beds

The Claygate Beds were encountered at depths of between 1.6mbgl and 3.7mbgl. As previously discussed, the Made Ground/Claygate Beds interface was found to be at greater depths within the soft landscaped area in the south-west quadrant of the site, increasing in depth towards the centre and south of the site (boreholes BH02 and BH03). This is considered to be representative of the erosional surface at the top of the Claygate Beds (i.e. natural ground level before reprofiling of the site), given the topography of the surrounding area.

The Claygate Beds generally comprised a combination of granular and cohesive horizons. For ease, they will be discussed separately below.

6.3.1 Granular horizons

The granular horizons of the Claygate Beds generally comprised loose to medium dense, ochreous, brown, slightly clayey, very silty, fine sand. These horizons were encountered in BH01 between 3.4mbgl and 9.3mbgl, in BH02 between 3.4mbgl and 5.3mbgl and in BH04 between 4.4mbgl and 9.4mbgl, but were generally absent in BH03. The material was noted to occasionally grade into very clayey, sandy silt. A relatively thin horizon of slightly silty, slightly sandy gravel was noted between 3.7mbgl and 4.8mbgl in BH03.

6.3.2 Cohesive horizons

The cohesive horizons of the Claygate Beds generally comprised firm, light ochreous brown, clayey, very sandy silt and clay and was mottled grey where encountered at greater depths. This material was encountered in BH01 at between 2.9mbgl and 3.4mbgl, in BH02 at 2.6mbgl to 3.4mbgl and 5.3mbgl to 7.8mbgl, in BH03 between 4.8mbgl and 7.1mbgl and BH04 between 3.0mbgl and 4.4mbgl.

Given the proportion of coarse material noted in these deposits, these soils are likely to have a low to medium potential for volume change, subject to confirmatory laboratory testing.

6.4 London Clay Formation

The top of the London Clay Formation was encountered at depths of between 7.1mbgl and 9.4mbgl and was proven to a depth of 25mbgl in BH01. The material generally comprised firm, becoming stiff with depth, dark grey sandy, silty clay with occasional sand partings.

6.5 Groundwater

Groundwater levels were recorded in the monitoring standpipes in the boreholes between 1st and 15th September 2011. Groundwater strikes were encountered during the investigation at depths of between 9.2mbgl (84.8mAOD) and 13.7mbgl (81mAOD). Groundwater seepage and slightly wet to wet material was recorded at depths of between 3.4mbgl (89.4mAOD) and 9.6mbgl (83.2mAOD).

Table 4. Summary of groundwater monitoring.

Exploratory hole number	Groundwater level (approx. mAOD)		
	1st September 2011	7th September 2011	15th September 2011
BH01	89.19 (4.82mbgl)	89.22 (4.78mbgl)	89.17 (4.83mbgl)
BH02	89.07 (3.73mbgl)	89.41 (3.39mbgl)	89.09 (3.71mbgl)
BH03	86.74 (5.56mbgl)	86.70 (5.60mbgl)	86.70 (5.60mbgl)
BH04	89.34 (5.36mbgl)	89.36 (5.34mbgl)	89.20 (5.50mbgl)

Standing groundwater levels were recorded within the Claygate Beds at elevations of between 89.07mAOD to 89.36mAOD across much of the site (BH01, BH02 and BH04) and at 86.70mAOD (BH03) in the southern corner of the site. Given the topography of the site and surrounding area, which dips towards the south, the lower groundwater level recorded in BH03 is likely to represent the generally southerly slope of the phreatic surface.

Rising head tests were undertaken in each borehole on 7th September 2011 and recorded infiltration rates of the order of 10^{-6} to 10^{-8} m/s, with the lower infiltration rates recorded in BH02 and BH03. The implication of these results will be discussed in a separate report.

6.6 Soil gas

Soil gas concentrations and flow rates were recorded from the monitoring standpipes in the boreholes between 1st and 15th September 2011. The results indicate that there are negligible concentrations of methane and concentrations of carbon dioxide that are consistent with natural soils with low organic content or 'typical' made ground. Oxygen

levels are generally normal, or slightly depressed where measureable concentrations of carbon dioxide were present. A maximum flow rate of 0.5 l/h was recorded. A summary of the soil gas monitoring is presented in Table 5.

Table 5. Summary of soil borne gas monitoring.

	Ranges of Recorded Values from All Boreholes			
Date	**CH_4 (% Vol.)**	**CO_2 (% Vol.)**	**Oxygen (min % by vol)**	**Flow (l/hr)**
1st September 2011	0.0	0.0 to 3.3	14.7	-0.1 to 0.1
7th September 2011	0.0	0.1 to 4.2	13.4	-0.4 to 0.5
15th September 2011	0.0	0.0 to 2.4	16.8	-0.4 to 0.0

The results of the monitoring from across the site have been converted into Gas Screening Values (GSV) in accordance with CIRIA Report C665[10]. The calculated GSV for carbon dioxide of 0.021 l/hr indicates that the site conforms to Characteristic Situation 1 and NHBC Green.

[10] Wilson, S. et al. (2007). *Assessing the risks posed by hazardous ground gases to buildings.* C665. CIRIA.

7. FLOOD RISK AND HYDROGEOLOGICAL IMPACT ASSESSMENT

7.1 Current hydrogeological regime

The ground and groundwater conditions indicate that precipitation falling on the site, where not already collected by gullies from the roof and hardstanding, will only slowly infiltrate through the relatively impermeable clays and silts passing to the relatively permeable sands of the Claygate Beds. In this horizon it will pass downwards until it reaches the top of the relatively low permeability London Clay Formation where the direction of flow will become lateral. The direction of flows in the Claygate Beds is most likely to be generally towards the south in line with the local topography.

Contribution to local groundwater from vertical infiltration of rainwater is likely to be very limited at this site and the development will not significantly alter this.

7.2 Impact of proposed basement construction

The site investigation data broadly confirms the anticipated shallow depth geology suggested by desk study information. The deeper Made Ground at the rear of the house is likely the result of the making up of levels behind the retaining structure on the southern site boundary.

The proposed basement works will be at a depth of approximately 89.35mAOD and is therefore likely to be formed into the top of the Claygate Beds. Although the Claygate Beds are classified as a Secondary A Aquifer, the site investigation information suggests that the basement will generally rest at or above site groundwater level and will not form an obstruction to regional flow. Control of groundwater migration into basement excavations is likely to be required during the construction phase of the works, although this will be subject to seasonal variation in groundwater levels. This will be discussed further in the geotechnical interpretive report.

A tributary for the Westbourne has been identified approximately 200m to the west of the site. However, the level of this surface water feature is approximately 70mAOD, which is considerably lower than the levels recorded on the site.

The London Clay Formation is susceptible to volume change with seasonal variation in moisture content. However, the basement is likely to be formed within the Claygate Beds,

which are likely to have a low to medium potential for volume change, subject to confirmatory laboratory testing. Measures to mitigate against the effects of shrink-swell in this material will be discussed further in a separate report upon receipt of the laboratory analyses.

A tunnel portal for a railway line is situated approximately 350m to 400m to the south-east of the site. The line of the tunnel trends parallel to the southern site boundary, at a distance of around 60m to 70m from the site, extending from Finchley Road Station in the south-west to Hampstead Heath Station to the north-east. The proposed works are not considered to pose a risk to this feature.

Based on the ground and groundwater conditions at the site, the proposed basement will have no discernable impact on the local hydrology or hydrogeology and is unlikely therefore, to impact or influence neighbouring properties.

8. CONTAMINATION

8.1 Risks to human health (long-term chronic risks)

The laboratory test results have been compared against the published *Soil Guideline Values* (SGVs) for the "*Residential (with home-grown produce)*" land-use category to assess the risk to human health from chemical contamination in the soils. Currently, SGVs have only been issued by the Environment Agency for a limited number of contaminants, namely selenium, mercury, arsenic, nickel, the BTEX compounds, phenol, polychlorinated biphenyls and cadmium. The SGVs have all been issued for a sandy loam soil with a Soil Organic Matter of 6% as standard.

Where SGVs are not available, the soil results have been compared to *Generic Assessment Criteria* (GACs) that have been derived in-house by CGL using the *Contaminated Land Exposure Assessment (CLEA)* model[11] and version 1.06 of the CLEA software. The GACs represent conservative screening criteria and have been calculated using the default parameters for the standard land use scenario set out in the CLEA technical report and toxicological inputs in line with the requirements of *Science Report SC050021/SR2*[12] and, in the case of petroleum hydrocarbons, Science *Report P5-080/TR3*[13]. The GACs have been generated assuming a sandy loam soil type and a Soil Organic Matter of 1.0%, which are suitable assumptions for the site in question. More detailed information on the derivation of the CGL GACs can be provided upon request.

Seven samples of the Made Ground and one sample of the natural soil (Claygate Beds) were scheduled for chemical analysis. The results of the assessment are set out below in Table 6 for the Made Ground and Table 7 for natural soils. Assessment against the SGVs and GACs is carried out at the 95th percentile on the sample mean (designated US_{95}), which is considered to represent a reasonable worst-case scenario. Statistical assessment of the results has been completed in accordance with the recommendations set out in the recently published CL:AIRE guidance[14]. In this regard, an assessment of the normality of

[11] Environment Agency. (January 2009). *Updated technical background to the CLEA model*. Science Report SC050021/SR3.
[12] Environment Agency. (January 2009). *Human health toxicological assessment of contaminants in soil*. Science Report SC050021/SR2.
[13] Environment Agency. (February 2005). *The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soils*. Science Report P5-080/TR3.
[14] J. Lowe et al. (May 2008). *Guidance on comparing soil contamination data with a critical concentration*. CL:AIRE, CIEH & SAGTA.

the data has been undertaken. Where datasets are normally distributed the *one sample t-test* has been applied to calculate the US_{95}. In the case of non-parametric datasets, the Chebychev Theorem has been applied. The Grubbs Test has also been used to identify potential outliers within datasets. Copies of the relevant statistical analysis are available on request.

Table 6a. Summary of soil contamination Made Ground (risks to human health)

Contaminant	SGV or GAC @ 1% SOM for Residential (with home-grown produce) land-use (mg/kg)	Notes on soil saturation limits (SSL)[1]	Measured range (mg/kg)	US_{95} (mg/kg)	US95 > Assessment Criteria? (Y/N) #- outlier detected
SOM (%)	*[2]		0.3 – 5.1	*	*
Arsenic	32[3]	-	4.3 – 25	16.17	N
Cadmium	10[3]	-	< 0.2 – 0.6	0.52	N #
Chromium (total)	37	-	15 – 32	28.98	N
Lead	290	-	18 – 1700	1334.75	Y #
Mercury (inorganic)	170[3]	-	< 0.3	n/a	N
Selenium	350[3]	-	< 1.0 – 1.1	1.08	N #
Boron	*		< 0.2 – 0.6	0.52	N #
Copper	3,700	-	10 – 53	36.3	N
Nickel	130[3]	-	6.8 – 18	14.03	N
Zinc	18,000	-	30 – 400	340.72	N
Barium	*		45 – 290	244.15	N #
Beryllium	23	-	0.3 – 1.2	1.0	N
Vanadium	130	-	20 – 60	51.71	N
Phenols[4]	180[3]	-	< 2.0	n/a	N
Cyanide	*		< 1.0	n/a	N

Notes:
1. - = green; (a) = amber i.e. GAC set to model output, [SSL provided in square brackets] ; (b) = red i.e. SSL exceeded & considered to affect interpretation. GAC calculated in accordance with the CLEA Software Handbook ; (c) = based on direct contact; (d) GAC limited to SSL.
2. * = no value currently defined
3. Based on published Soil Guideline Value (Environment Agency, 2009), adjusted for 1% SOM
4. GAC relates to Phenol (C_6H_5OH) only.

Table 6b Summary of soil contamination Made Ground (risks to human health) cont.

Contaminant	SGV or GAC @ 1% SOM for Residential (with home-grown produce) land-use (mg/kg)	Notes on soil saturation limits (SSL)[1]	Measured range (mg/kg)	US_{95} (mg/kg)	US95 > Assessment Criteria? (Y/N) #- outlier detected
Total Petroleum Hydrocarbons (TPH)					
TPH aliphatic EC5-6	24	-	< 0.1	n/a	N
TPH aliphatic EC>6-8	49	-	< 0.1	n/a	N
TPH aliphatic EC>8-10	10	-	< 0.1	n/a	N
TPH aliphatic EC>10-12	430	(b)	< 1.0	n/a	N
TPH aliphatic EC>12-16	4,200	(b)	< 2.0	n/a	N
TPH aliphatic EC>16-35	88,000	(b)	< 8.0 – 22	n/a	N
TPH aromatic EC5-7	0.080	-	< 0.1	n/a	N
TPH aromatic EC>7-8	120	-	< 0.1	n/a	N
TPH aromatic EC>8-10	15	-	< 0.1	n/a	N
TPH aromatic EC>10-12	56	-	< 1.0	n/a	N
TPH aromatic EC>12-16	130	-	< 2.0	n/a	N
TPH aromatic EC>16-21	250 [60]	(a)	< 10 – 36	30.13	N #
TPH aromatic EC>21-35	890 [4.8]	(a)	< 10 – 99	85.93	N
Polycyclic Aromatic Hydrocarbons (PAH)					
Acenaphthene	570	(b)	< 0.1 – 0.42	0.35	N #
Anthracene	8,000 [7.7]	(a)	< 0.1 – 0.82	0.68	N #
Benzo(a)anthracene	7.5 [1.7]	(a)	< 0.2 – 2.5	2.41	N
Benzo(a)pyrene	2.2 [0.9]	(a)	< 0.1 – 2.1	2.0	N
Benzo(b)fluoranthene	21 [1.2]	(a)	< 0.1 – 3.4	3.18	N
Benzo(g,h,i)perylene	240 [0.02]	(a)	< 0.05 – 1.7	1.53	N
Benzo(k)fluoranthene	22 [0.7]	(a)	< 0.2 – 1.1	1.09	N
Chrysene	160 [0.4]	(a)	< 0.05 – 2.5	2.34	N
Dibenzo(a,h)anthracene	2.0 [0.004]	(a)	< 0.2 – 0.22	0.22	N #
Fluoranthene	820 [19]	(a)	< 0.2 – 4.4	4.52	N
Fluorene	650	(b)	< 0.2 – 0.32	0.29	N #
Indeno(1,2,3-cd)pyrene	20 [0.06]	(a)	< 0.2 – 1.7	1.55	N
Naphthalene	1.5	-	< 0.05	n/a	N
Pyrene	560 [2.2]	(a)	< 0.2 – 3.5	3.75	N

Notes:

1. - = green; (a) = amber i.e. GAC set to model output, [SSL provided in square brackets] ; (b) = red i.e. SSL exceeded & considered to affect interpretation. GAC calculated in accordance with the CLEA Software Handbook ; (c) = based on direct contact; (d) GAC limited to SSL.

Table 7a Summary of soil contamination natural soil (risks to human health)

Contaminant	SGV or GAC @ 1% SOM for Residential (with home-grown produce) land-use (mg/kg)	Notes on soil saturation limits (SSL)[1]	Measured range (mg/kg)	US_{95} (mg/kg)	US95 > Assessment Criteria? (Y/N) #- outlier detected
SOM (%)	*[2]		< 0.1	*	*
Arsenic	32[3]	-	6.3	n/a	N
Cadmium	10[3]	-	< 0.2	n/a	N
Chromium (total)	37	-	37	n/a	N
Lead	290	-	9.6	n/a	N
Mercury (inorganic)	170[3]	-	< 0.3	n/a	N
Selenium	350[3]	-	< 1.0	n/a	N
Boron	*		< 0.2	n/a	N
Copper	3,700	-	12	n/a	N
Nickel	130[3]	-	12	n/a	N
Zinc	18,000	-	30	n/a	N
Barium	*		21	n/a	N
Beryllium	23	-	0.8	n/a	N
Vanadium	130	-	49	n/a	N
Phenols[4]	180[3]	-	< 2.0	n/a	N
Cyanide	*		< 1.0	n/a	N

Notes:

1. - = green; (a) = amber i.e. GAC set to model output, [SSL provided in square brackets] ; (b) = red i.e. SSL exceeded & considered to affect interpretation. GAC calculated in accordance with the CLEA Software Handbook ; (c) = based on direct contact; (d) GAC limited to SSL.
2. * = no value currently defined
3. Based on published Soil Guideline Value (Environment Agency, 2009), adjusted for 1% SOM
4. GAC relates to Phenol (C_6H_5OH) only.

Table 7b Summary of soil contamination natural soil (risks to human health) cont.

Contaminant	SGV or GAC @ 1% SOM for Residential (with home-grown produce) land-use (mg/kg)	Notes on soil saturation limits (SSL)[1]	Measured range (mg/kg)	US_{95} (mg/kg)	US95 > Assessment Criteria? (Y/N) #- outlier detected
Total Petroleum Hydrocarbons (TPH)					
TPH aliphatic EC5-6	24	-	< 0.1	n/a	N
TPH aliphatic EC>6-8	49	-	< 0.1	n/a	N
TPH aliphatic EC>8-10	10	-	< 0.1	n/a	N
TPH aliphatic EC>10-12	430	(b)	< 1.0	n/a	N
TPH aliphatic EC>12-16	4,200	(b)	< 2.0	n/a	N
TPH aliphatic EC>16-35	88,000	(b)	< 8.0	n/a	N
TPH aromatic EC5-7	0.080	-	< 0.1	n/a	N
TPH aromatic EC>7-8	120	-	< 0.1	n/a	N
TPH aromatic EC>8-10	15	-	< 0.1	n/a	N
TPH aromatic EC>10-12	56	-	< 1.0	n/a	N
TPH aromatic EC>12-16	130	-	< 2.0	n/a	N
TPH aromatic EC>16-21	250 [60]	(a)	< 10	n/a	N
TPH aromatic EC>21-35	890 [4.8]	(a)	< 10	n/a	N
Polycyclic Aromatic Hydrocarbons (PAH)					
Acenaphthene	570	(b)	< 0.1	n/a	N
Anthracene	8,000 [7.7]	(a)	< 0.1	n/a	N
Benzo(a)anthracene	7.5 [1.7]	(a)	< 0.2	n/a	N
Benzo(a)pyrene	2.2 [0.9]	(a)	< 0.1	n/a	N
Benzo(b)fluoranthene	21 [1.2]	(a)	< 0.1	n/a	N
Benzo(g,h,i)perylene	240 [0.02]	(a)	< 0.05	n/a	N
Benzo(k)fluoranthene	22 [0.7]	(a)	< 0.2	n/a	N
Chrysene	160 [0.4]	(a)	< 0.05	n/a	N
Dibenzo(a,h)anthracene	2.0 [0.004]	(a)	< 0.2	n/a	N
Fluoranthene	820 [19]	(a)	< 0.2	n/a	N
Fluorene	650	(b)	< 0.2	n/a	N
Indeno(1,2,3-cd)pyrene	20 [0.06]	(a)	< 0.2	n/a	N
Naphthalene	1.5	-	< 0.05	n/a	N
Pyrene	560 [2.2]	(a)	< 0.2	n/a	N

Notes:

2. - = green; (a) = amber i.e. GAC set to model output, [SSL provided in square brackets] ; (b) = red i.e. SSL exceeded & considered to affect interpretation. GAC calculated in accordance with the CLEA Software Handbook ; (c) = based on direct contact; (d) GAC limited to SSL.

A review of Table 6 indicates that contaminant concentrations in the Made Ground are generally below the assessment criteria for the chosen site end-use with the exception of lead. The US_{95} for lead is 1334.75mg/kg compared to the generic assessment criteria of 290mg/kg. A review of the data indicates the presence of an outlier in the data set corresponding to the sample from foundation inspection pit FIP08 at 0.59mbgl, which has a concentration of 1700mg/kg. Removal of this sample from the statistical analysis gives a revised US_{95} of 174.53mg/kg, which is below the assessment criteria. On this basis, concentrations of lead across the site are not considered to pose a risk to human health and the elevated lead concentration recorded in FIP08 may be considered to be a localised lead hotspot.

A review of Table 7 indicates that contaminant concentrations in the natural soil are below the assessment criteria.

8.2 Risks to controlled waters

The risks to controlled waters as a result of leaching of contaminants from residual soil contamination are considered to be negligible given the lack of contaminative sources identified on the site. Furthermore, the site is not situated within a Groundwater Source Protection Zone.

8.3 Risks to plant growth (i.e. phytotoxicity)

Given the negligible to low levels of contamination encountered across the site, the risks posed to plant growth are considered to be low. However full assessment of the risks should be undertaken by a suitably qualified person (e.g. landscape architect) as part of the design of the landscaping scheme for the development.

8.4 Risks to construction workers

Given the negligible levels of contamination concentrations within the Made Ground across the site, the risks pose to construction workers is considered to be low and may be mitigated with nominal safety precautions should be acceptable including the adoption of good hygiene practices and the use of appropriate Personal Protective Equipment (PPE).

8.5 Waste classification

The results of the total soils analysis undertaken on the Made Ground, including the soils in the area of the lead hotspot, and natural soils indicate that the material may be classified as 'not-hazardous'. If reuse on site is not possible, the Made Ground material is likely to be suitable for disposal at an inert landfill facility, subject to additional Waste Acceptability Criteria (WAC) testing. The natural material (Claygate Beds and London Clay) is likely to be classified as inert and may be reused on-site or off-site subject to appropriate waste management controls.

9. CONCEPTUAL SITE MODEL

The preliminary conceptual site model (CSM) has been revised and refined based on observations made during the intrusive ground investigation and the results of the chemical analyses undertaken on soil and water samples. The CSM is presented diagrammatically in Figure 3.

An assessment of the risks posed by the potential pollutant linkages at the site is outlined in Table 8.

Table 8. Qualitative risk assessment.

Source/Medium	Receptor	Potential Exposure Route	Risk Rating
Explosive / asphyxiating gases from within Made Ground and natural soils.	Internal building spaces & future occupiers	Migration of gases through the surface and via permeable soils	Negligible to low
Asbestos within Made Ground.	Construction workers	Direct ingestion of soil & dust, inhalation of particulates & vapours and dermal contact	Low
Organic/inorganic contaminants (e.g. hydrocarbons, metals etc.) within Made Ground and natural soils.	Construction workers	Direct ingestion of soil & dust, inhalation of particulates & vapours and dermal contact	Negligible to low
	Future site occupiers	Direct ingestion of soil & dust, inhalation of particulates & vapours, indirect ingestion by means of dermal contact	Negligible
	Vegetation and plants	Root uptake	Negligible
	Buildings & structures	Direct contact and migration & accumulation within building spaces	Negligible
	Controlled waters	Migration of contaminants.	Negligible

The available information and past land uses identified in and around the site and the findings of the intrusive investigation would suggest a negligible potential for contamination risk to buildings, future users and controlled waters. There is considered to be a negligible to low risk to construction workers in relation to the presence of a lead hotspot in the area of foundation inspection pit, FIP08, and the potential for fragments of asbestos within the made ground.

10. CONCLUSIONS AND RECOMMENDATIONS

10.1 General

It is understood that the proposed development will comprise the part-demolition and extension of the existing building with the provision of a new basement under the south-eastern corner of the proposed building footprint and in the south-eastern quadrant of the site, under the existing car parking area.

10.2 Flood risk and hydrogeological impact assessment

Based on the ground and groundwater conditions at the site, the proposed basement will have no discernable impact on the local hydrology or hydrogeology and is unlikely therefore, to impact or influence neighbouring properties. A rail tunnel is present approximately 60m to 70m to the south of the site, however the proposed works are not considered to pose a risk to this feature.

Geotechnical considerations relating to the construction of the basement will be discussed in detail in the geotechnical interpretive report.

10.3 Contamination and remediation

The results of chemical soil analysis indicate that concentrations of potential contaminants in the Made Ground are generally below the assessment criteria for the chosen site end-use. A single, isolated elevated concentration of lead was recorded in foundation inspection pit FIP08 at a depth of 0.58mbgl and may be considered a localised 'hotspot'. On this basis it is recommended that an area of 2m x 2m around the lead hotspot is removed to a depth of 1.0mbgl and disposed of off-site. Total soils analysis indicates that this material is classified as 'not-hazardous'. However additional WAC analysis will be required to confirm waste disposal classification. Validation testing, including sampling of each side and the base of the excavation and subsequent chemical analysis, will be required to confirm the successful removal of the hotspot. Alternatively, additional surface soil sampling and analysis could be carried out in the affected area to provide a larger body of data for statistical analysis, which may eliminate the risk.

The risks to controlled waters as a result of leaching of contaminants from residual soil contamination are considered to be negligible given the lack of contaminative sources

identified on the site. Furthermore, the site is not situated within a Groundwater Source Protection Zone.

10.4 Waste classification

The results of the total soils analysis undertaken on the Made Ground, including the soils in the area of the lead hotspot, and natural soils indicate that the material may be classified as 'not-hazardous' and may be disposed at a suitably license 'inert' or 'non-hazardous' waste facility subject to Waste Acceptance Criteria (WAC) testing.

If the option for reuse on site is not available, the Made Ground material is likely to be suitable for disposal at an inert landfill facility. However WAC analysis will be required during construction to confirm waste disposal requirements. The natural material (Claygate Beds and London Clay) is likely to be classified as inert and may be reused on-site or off-site subject to appropriate waste management controls.

All material intended for off-site removal should be transported and disposed in accordance with the Environmental Protection (Duty of Care) Regulations, 1991 and the Landfill (England and Wales) Regulations, 2002 (as amended). Waste legislation stipulates that all waste be pre-treated prior to disposal. Pre-treatment can be undertaken either at the site of origin or may be carried out at a license off-site facility. Carefully selected excavation and segregation of Made Ground and natural ground is recommended for any material required for off-site removal.

10.5 Gas protection measures

The results of ground gas monitoring indicate that the site generally conforms to Characteristic Situation 1 and NHBC Green, with a GSV for CO_2 of 0.021l/hr. On this basis no specific gas protection measures are considered necessary.

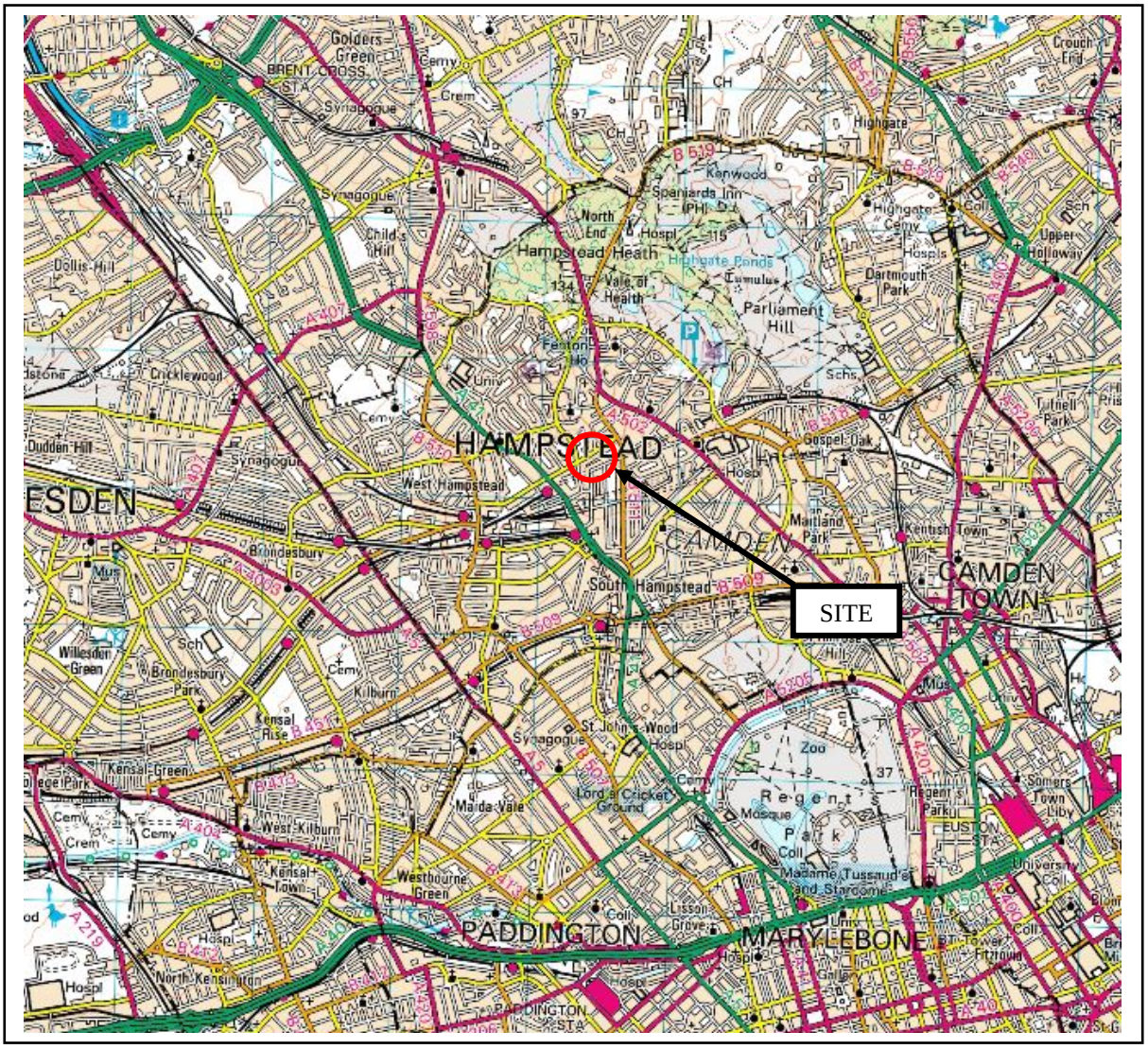
10.6 Health and safety

All site works should be undertaken in accordance with the guidelines prepared by the Health and Safety Executive (HSE, 1991). In this context, the risks should be negligible to low and nominal safety precautions should be acceptable (the adoption of good hygiene practices and the use of overalls, gloves and dust masks if necessary).

During the redevelopment, precautions should be taken to minimise exposure of workers and the general public to potentially harmful substances. Attention should also be paid to restricting possible off-site nuisance such as dust and odour emissions. Such precautions should include, but not be limited to:

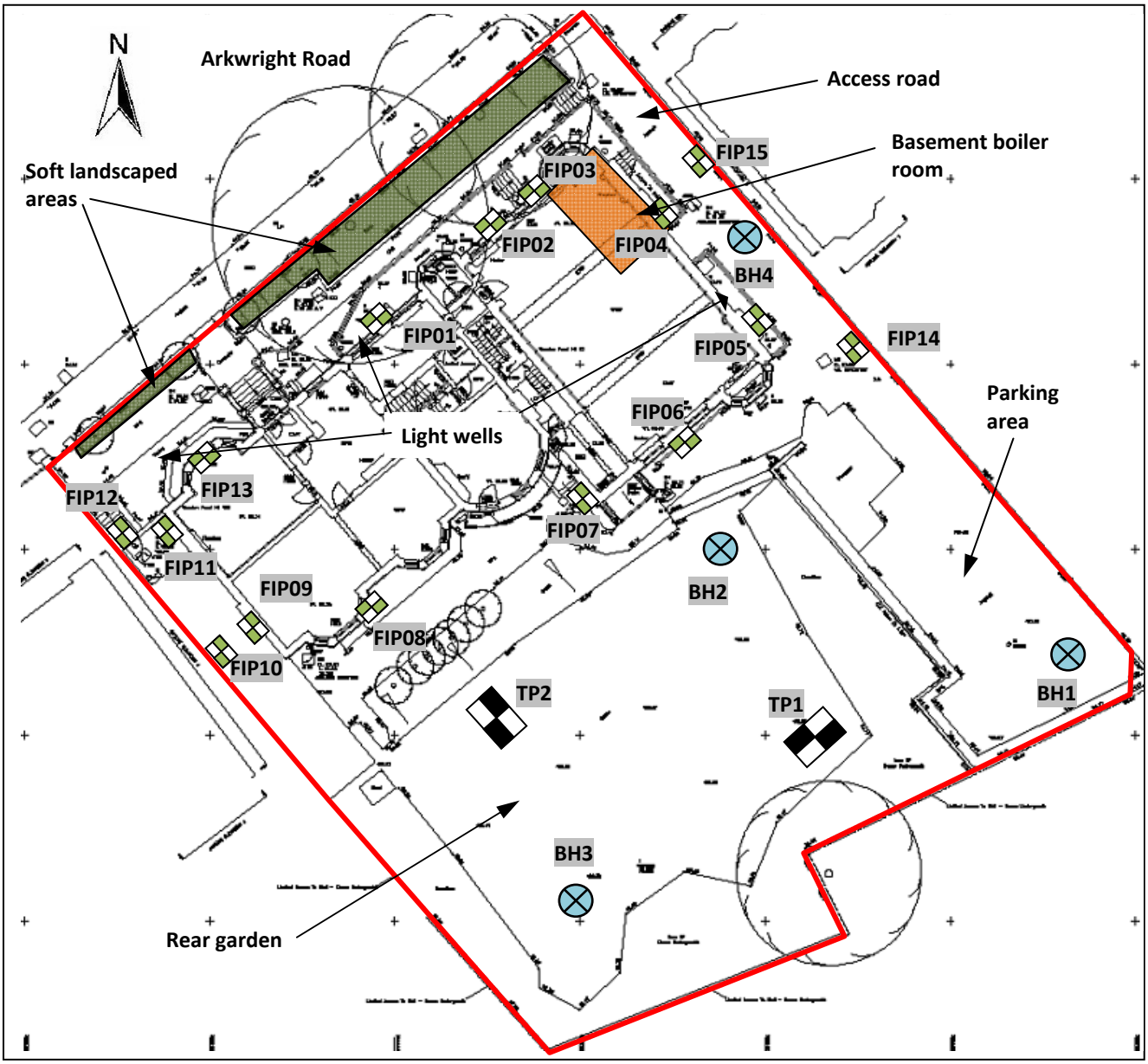
- Personal hygiene, washing and changing procedures.
- Personal protective equipment, including disposable overalls, gloves etc.
- Measures to avoid surface water ponding and positive collection and disposal of all on-site run-off.
- Regular cleaning of all site roads, access roads and the public highway including dust suppressions methods (e.g. water spraying), if necessary.

FIGURES



N

Client	Project	Job No
Ironside & Malone Design & Build Ltd	**9 Arkwright Road, Hampstead, London**	**CG/5595**
CGL	Title: **Site location**	**Figure 1**



Key;

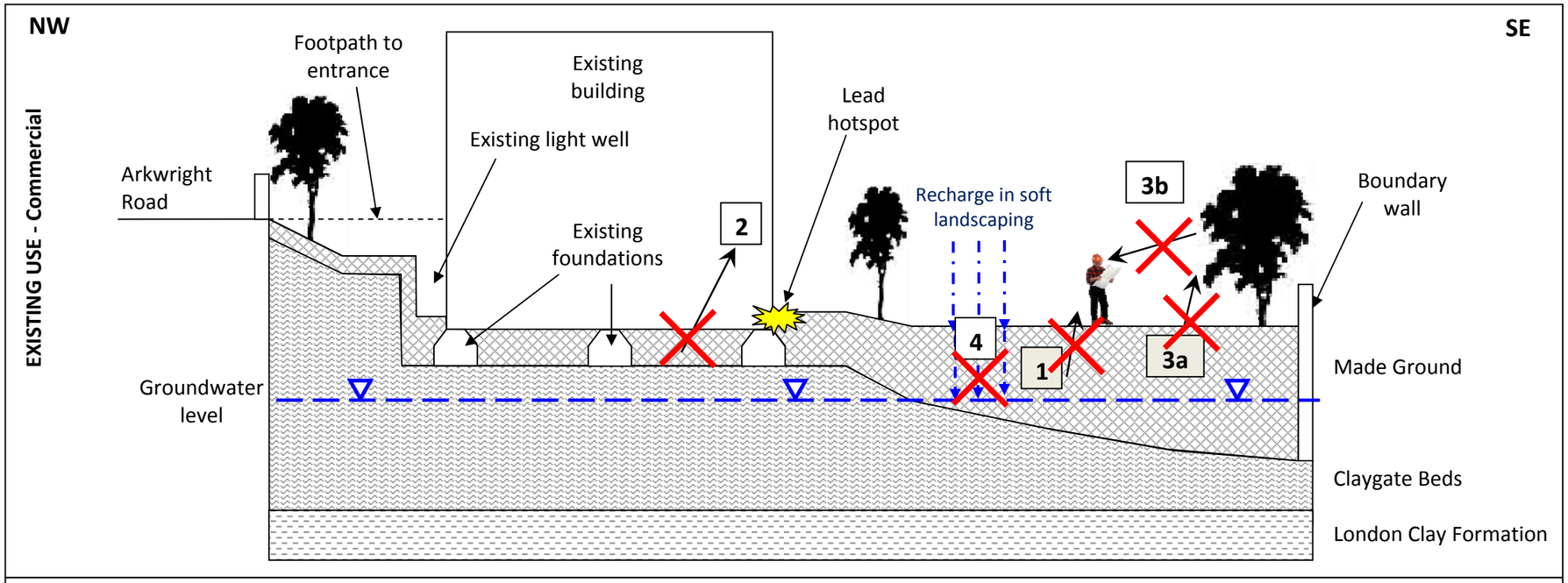
FIP01 – Foundation inspection pit

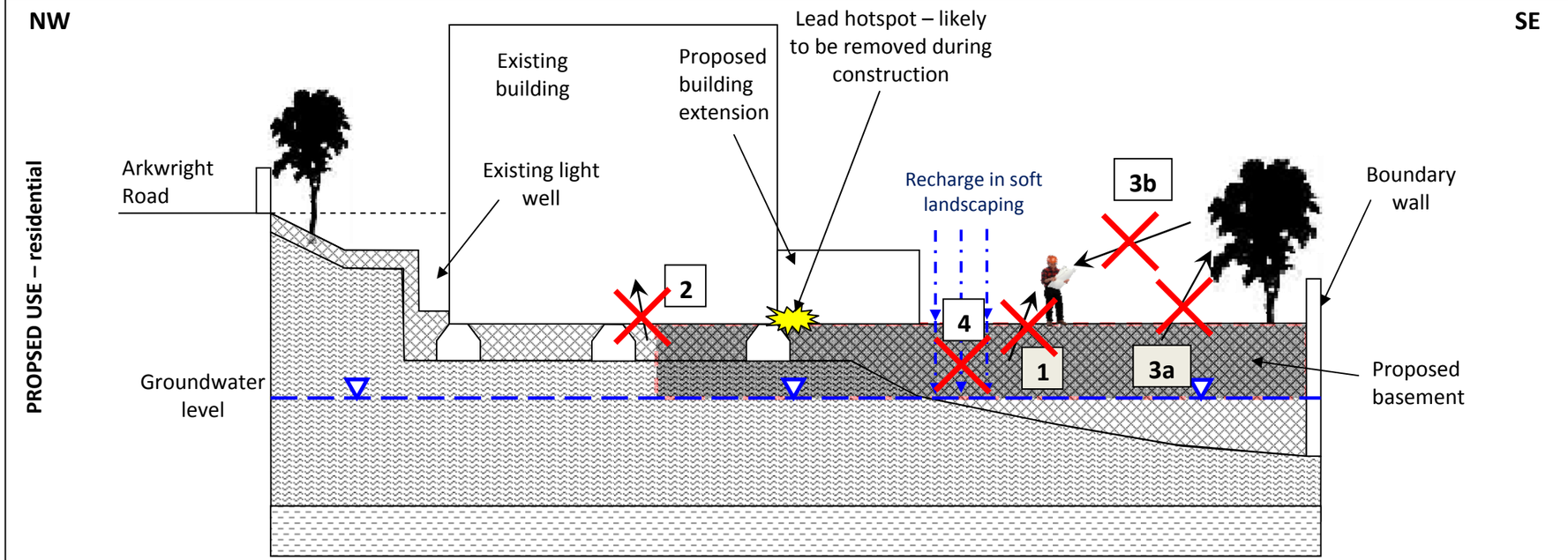
TP01 – Trial pit location

BH01 – Cable percussion borehole

NOT TO SCALE

Client	Project	Job No
Ironside & Malone Design and Build Ltd	**9 Arkwright Road, Hampstead, London**	**CG/5595**
CGL	Title: **Site layout and exploratory hole location pan**	**Figure 2**





Possible Pollution linkages:

1. Outdoor ingestion/skin contact/inhalation of soil, dust and/or vapours – No significant contaminant concentrations recorded apart from a localised lead hotspot, which is likely to be removed during construction or investigated further.

2. Soil gas/vapour ingress and inhalation – No significant gas concentrations recorded – precautionary measures not required.

3a. Plant uptake and 3b. Subsequent ingestion of vegetables/fruit – Pathway 3a – No significant contaminant concentrations recorded apart from a localised lead hotspot, which is likely to be removed during construction or investigated further.

4. Migration of contamination into controlled waters; groundwater (Secondary A aquifer); e.g. elevated contaminant concentrations in soils leaching to groundwater – No significant contaminant concentrations recorded apart from a localised lead hotspot, which is likely to be removed during construction or investigated further.

NOT TO SCALE

Client	Project	Job No
Ironside & Malone Design & Build Ltd	**9 Arkwright Road, Hampstead, London**	**CG/5595**
CGL	Title: **Conceptual site model**	**Figure 3**