118 Malden Road
London
NW5 4BY

Site Investigation &
Basement Impact Assessment

William Carter Limited

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Rev 0

Ground investigation | Geotechnical consultancy | Contaminated land assessment

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Contents

Executive summary

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

Brief

This report describes the findings of a site investigation carried out by Geotechnical and Environmental Associates Limited (GEA) on the instructions of William Carter Limited, with respect to the extension of the existing basement beneath the rear part of the site.

The purpose of the investigation has been to determine the ground conditions and hydrogeology, to carry out an assessment of ground movements resulting from excavation of the proposed basement, to assess the extent of any contamination and to provide information to assist with the design of the basement structure and suitable foundations.

The report also includes information required to comply with London Borough of Camden Planning Guidance (CPG) Basements, relating to the requirement for a Basement Impact Assessment (BIA).

Site history

Reference to the earliest available OS map, dated 1875, indicates that the site had already been developed with the existing terraced property by this time, and that the majority of the existing road network, including Malden Road, had already been established. Much of the surrounding area had also been developed, primarily with terraced housing. Between 1896 and 1916, a group of properties located just to the east of the site appear to have been extended and combined into one large building, fronting onto Queens Close. With the exception of minor additions to the adjacent properties, no significant changes can be seen within the near vicinity of the site until the 1974 map, which shows that extensive demolition works had taken place to the north of the site, including the adjacent properties located to the north of 120 Malden Road. Between 1974 and 1980, these vacant plots were then redeveloped with the existing properties, including Gilden Crescent, although a car park was established at the current location of 120 Malden Street, which was then redeveloped with the existing property some time between 2003 and 2006. No significant changes have subsequently been made within the site and the immediate surrounding area.

Ground conditions

The investigation broadly confirmed the expected ground conditions in that, below a nominal thickness of made ground, London Clay was encountered to the maximum depth investigated. The made ground generally comprised mid brown to dark grey gravelly sandy silty clay, with the gravel comprising fine to coarse fragments of brick and occasional glass, charcoal, ash and wire, and extended to a maximum depth of 0.60 m. The underlying London Clay generally comprised stiff becoming very stiff with depth fissured brown silty clay with rare pockets of orange brown clayey sand and occasional to rare blue grey veining with root traces, and was recorded to the maximum depth investigated of 2.00 m. Borehole Nos 1 and 2 were aborted at depths of 2.00 m and 1.80 m respectively, due to the very stiff ground conditions. The London Clay was found to be desiccated, and it is understood that the north flank wall of the rear extension has been underpinned due to desiccation issues associated with the mature London plane trees located just to the north of the site.

Groundwater was not encountered within any of the boreholes or trial pits during the fieldwork. However, water has been recorded at a depth of 1.22 m below existing basement level within the standpipe installed into Borehole No 2.

Contamination testing has indicated a single sample of the three tested to contain an elevated concentration of lead.

Recommendations

Formation level of the proposed basement extension will be within the stiff silty clay of the London Clay. Desiccation was recorded during the investigation, and roots were observed in both boreholes, including Borehole No 2 drilled from the existing basement level, although the maximum depth to which the desiccation extends to has not been confirmed. In this respect, it is recommended that all foundation excavations are inspected by a suitably experienced engineer. Notwithstanding NHBC guidelines, all foundations should extend beyond the zone of desiccation.

Excavations for the proposed basement extension will require temporary support to maintain stability and to prevent any excessive ground movements. The proposed use of reinforced concrete underpinning to form the proposed lower ground floor and support the existing building should be suitable. Significant groundwater flows are not anticipated within the excavation, although localised inflows may be encountered within the made ground, as well as from partings of silt and sand in the London Clay.

Basement Impact Assessment

The BIA has not indicated any concerns with regard to the effects of the proposed basement on the site and surrounding area. It has been concluded that the impacts identified can be mitigated by appropriate design and standard construction practice.

Ground Movement Analysis Conclusions

The analysis has concluded that the predicted damage to the neighbouring properties from the construction of the proposed basement extension would be ‘Negligible’ to ‘Very Slight’. On this basis, the damage that has been predicted to occur as a result of the construction and the proposed basement extension falls within the limits acceptable to the London Borough of Camden.

Part 1: Investigation Report

This section of the report details the objectives of the investigation, the work that has been carried out to meet these objectives and the results of the investigation. Interpretation of the findings is presented in Part 2.

1.0 Introduction

Geotechnical and Environmental Associates Limited (GEA) has been commissioned by Martin Redston Associates, on behalf of William Carter Limited, to carry out a desk study, ground investigation and ground movement assessment at 118 Malden Road, London NW5 4BY.

This report also forms part of a Basement Impact Assessment (BIA), which has been carried out in accordance with guidelines from the London Borough of Camden (LBC) in support of a planning application.

The site has been the subject of several previous reports, including a Factual Report of Investigation by CET Safehouse (report ref 130902, dated September 2012), an Insurance Claim by the previous owners of 118 Malden Road, Concerning Suspected Subsidence at the rear of the property (report ref 54252838, dated October 2012), an Arboricultural Assessment Report by OAC UK Ltd (report ref 53164, dated November 2012), and a Report on Movement by Hammer Consulting Ltd (report ref 2938, dated September 2021). Copies of these report were provided to GEA and are referred to where appropriate.

1.1 Proposed Development

It is understood that it is proposed to extend the existing basement beneath the rear part of the site, with re-modelling and partial demolition of the existing rear extension to create a basement level courtyard at the rear of the site.

The existing basement extends to a depth of 2.80 m below the existing ground floor level of the property, and the extended basement section will be formed at the same level.

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

1.2 Purpose of Work

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

- to check the history of the site with respect to previous contaminative uses;
- to provide an assessment of the risk of encountering unexploded ordnance (UXO);
- to determine the ground conditions and their engineering properties;
- to use the above information to provide recommendations with respect to the design of suitable foundations and retaining walls;
- to assess the impact of the proposed basement on the local hydrogeology, hydrology and stability of the surrounding natural and build environment;
- to provide an indication of the degree of soil contamination present; and
- to assess the risk that any such contamination may pose to the proposed development, its users or the wider environment.

1.3 Scope of Work

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

- a review of historical Ordnance Survey (OS) maps and environmental searches sourced from the Envirocheck database;
- a review of readily available geology maps;
- a preliminary UXO risk assessment completed by 1st Line Defence (report ref PA18116-00, dated June 2023); and
- a walkover survey of the site carried out in conjunction with the fieldwork.

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

- two boreholes advanced to depths of 1.80 m and 2.00 m by hand held window sampling techniques;
- two hand-dug trial pits to expose the existing foundations and provide information on the boundary wall conditions;
- the installation of groundwater monitoring standpipes into each borehole and a single monitoring visit;
- testing of selected soil samples for contamination and geotechnical purposes; and
- provision of a report presenting and interpreting the above data, together with our advice and recommendations with respect to the proposed development.

This report includes a contaminated land assessment which has been undertaken by a suitably qualified and competent professional in accordance with the methodology presented by the Environment Agency (EA) in their Land contamination risk assessment (LCRM)[1] published 8 October 2020. This involves identifying, making decisions on, and taking appropriate action to deal with, land contamination in a way that is consistent with government policies and legislation within the United Kingdom. Risk management is divided into three stages; Risk Assessment, Options Appraisal and Remediation, and each stage comprises three tiers. The Risk Assessment stage includes preliminary risk assessment (PRA), generic quantitative risk assessment (GQRA) and detailed quantitative risk assessment (DQRA)and this report includes the PRA and GQRA.

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

1.3.1 Basement Impact Assessment

The work carried out includes a Hydrological and Hydrogeological Assessment and Land Stability Assessment (also referred to as Slope Stability Assessment). These assessments form part of the BIA procedure specified in the London Borough of Camden (LBC) Planning Guidance CPG[2] and their Guidance for Subterranean Development[3] prepared by Arup (the "Arup report") in accordance with Policy A5 of the Camden Local Plan 2017. The aim of the work is to provide information on surface water, groundwater and land stability and in particular to assess whether the development will affect neighbouring properties or groundwater movements and whether any identified impacts can be appropriately mitigated by the design of the development.

1.3.2 Qualifications

The land stability element of the Basement Impact Assessment (BIA) has been carried out by Martin Cooper, a BEng in Civil Engineering, a chartered engineer (CEng), member of the Institution of Civil Engineers (MICE), and Fellow of the Geological Society (FGS) who has over 20 years' specialist experience in ground engineering. The subterranean (groundwater) flow assessment has been carried out by Nick Mannix, MSc in Hydrogeology, Chartered Geologist (CGeol) and Fellow of the Geological Society of London (FGS). The surface water and flooding assessment has been carried out by Rupert Evans, a hydrologist with more than ten years consultancy experience in flood risk assessment, surface water drainage schemes and hydrology / hydraulic modelling. Rupert Evans is a Chartered Environmentalist, Chartered Water and Environmental Manager and a Member of CIWEM.

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

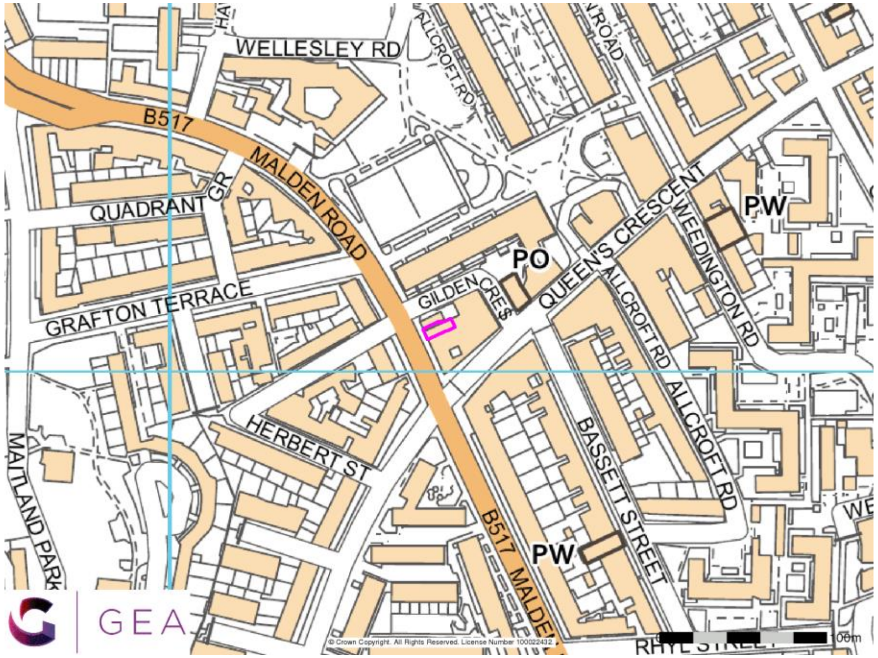
All assessors meet the qualification requirements of the Council guidance.

1 https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm
2 London Borough of Camden Planning Guidance CPG (January 2021) *Basements*
3 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

2.0 The Site

2.1 Site Description

The site is located in London Borough of Camden, approximately 500 m northwest of Kentish Town West London Overground station. It may be additionally located by National Grid Reference 528160, 185030 and is shown on the map extract below.



The site is roughly rectangular in shape, measuring approximately 7 m by 18 m in maximum extent. It fronts onto Malden Road to the west and is bounded by Nos 120 and 116 Malden Road to the north and south, respectively, and by the rear extension of No 131 Queens Crescent to the east.

The site is occupied by 118 Malden Road, a three-storey end of terrace property with a basement beneath the front, or western, part of the building, and a single-storey rear extension, which is understood to have been constructed circa 1992.

The site is essentially level, whist the area around the site slope down towards the south.

With the exception of a narrow passageway along the northern elevation of the building, the site is entirely occupied by the existing buildings and does not include any areas of soft landscaping. However, a number of mature London plane trees are present to the north of the site, within the pavement of Gilden Crescent.

The property is previously understood to have been occupied by a Doctors Surgery, and was the subject to a previous site investigation, an arboricultural assessment and structural assessments to establish the cause of cracking to the rear extension, first observed in 2011. The investigation established the presence of potentially desiccated clay soils and that the foundations along the northern elevation of the existing extension, extended to a depth of about 2.0 m. The subsequent insurance claim and arboricultural assessment identified the nearby trees as the likely cause of the observed movement and recommended their removal, although it is understood that a programme of pollarding was instead adopted by the local authority to manage the growth of these trees. A later report by Hamer Consulting Ltd, which included reference to a programme of movement monitoring carried out in 2012 and 2013 by CET Safehouse, concluded that no significant movement and little damage had taken place following the implementation by Camden of measures to restrict the growth of the nearby trees, and that provided these works continued, there should not be any requirement for structural mitigation works.

2.1.1 Nearby Basements

A search of planning applications on Camden Council's website revealed an application pertaining to a change of use at Nos 114 and 116 Malden Road, across the basement, ground floor and part of the first floor. Drawings included with this planning application confirm that the footprint of the basement beneath Nos 116 and 114 is very similar to No 118, extending beneath the main part of the building, and a short distance beyond the main rear wall, with front vaults beneath the footway.

No relevant information was found pertaining to No 131 Queens Crescent to the rear of the site, thus it has been conservatively assumed that this property does not have a basement. Additionally, it has been assumed that No 120 Malden Road, which is of a different construction to No 118 having been built between 2003 and 2006, also does not have a basement level.

2.2 Site History

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

Reference to the earliest available OS map, dated 1875, indicates that the site had already been developed with the existing terraced property by this time, and that the majority of the existing road network, including Malden Road, had already been established. Much of the surrounding area had also been developed, primarily with terraced housing.

Between 1896 and 1916, a group of properties located just to the east of the site appear to have been extended and combined into one large building, fronting onto Queens Close. With the exception of minor additions to the adjacent properties, no significant changes can be seen within the near vicinity of the site until the 1974 map, which shows that extensive demolition works had taken place to the north of the site, including the adjacent properties located to the north of 120 Malden Road.

Between 1974 and 1980, these vacant plots were then redeveloped with the existing properties, including Gilden Crescent, though a carpark was established at the current location of 120 Malden Street, which was then redeveloped with the existing property sometime between 2003 and 2006. No significant changes have subsequently been made within the site and the immediate surrounding area.

2.3 Other Information

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

There are no recorded historical landfill sites or Local Authority recorded or registered landfill sites within 1 km of the site. Additionally, there are no waste management, transfer or treatment sites within 500 m, and no recorded areas of infilled land within 250 m of the site.

There have been no pollution incidents to controlled waters within 1 km of the site and there are no pollution prevention and controls, enforcements or contaminated land register entries close to the site, or that are otherwise likely to have had an adverse impact.

The site is not located within a nitrate vulnerable zone or any other sensitive land use.

Information on Urban Soil Chemistry provided by the BGS indicates that background concentrations for lead in the vicinity of the site are likely to range between 600 mg/kg and 900 mg/kg. Therefore, whilst relatively high concentrations of lead may be encountered within any near surface soils present on the site, a significant proportion of the measured concentration is likely to be the result of residual airborne sources, and this will need to be taken into account in any subsequent risk assessment.

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

There are no contemporary trade directory entries listed on site and there only three entries within 100 m, comprising a former and two active dry cleaners, located 46 m to the east, 60 m to the southeast and 74 m to the east, respectively.

There are no fuel station entries within 200 m, with the nearest comprising an obsolete Service Station, located 211 m to the northwest of the site.

2.4 Preliminary UXO Risk Assessment

A Preliminary UXO Risk Assessment has been completed by 1st Line Defence (report ref PA18116-00, dated 14th June 2023), and the report is included in the appendix. The risk assessment has been carried out in accordance with the guidelines provided by CIRIA[4], which state that the likelihood of encountering and detonating UXO below a site should be assessed along with establishing the consequences that may arise. The first phase comprises a preliminary risk assessment, which should be undertaken at an early stage of the development planning. If such an assessment identifies a high level of risk then a detailed risk assessment should be carried out by a UXO specialist, which will identify an appropriate course of action with regard to risk mitigation.

The report indicates that, during World War II (WWII), the site was located within the Metropolitan Borough of St Pancras, which sustained an overall very high density of bombing. No bomb strikes are recorded to have fallen within the site boundary on the London bomb census mapping records, with the closest strike recorded around 35 m to the

4 CIRIA C681 (2009) *Unexploded ordnance (UXO) A guide for the construction industry*

northeast of the site. The London County Council damage mapping indicates that 118 Malden Road did not sustain any damage. It is considered likely that the site would have been subject to regular access during the war, such that a low / minimal risk of encountering unexploded ordnance has been identified for the site and no further action is recommended in this respect.

2.5 Geology

The British Geological Survey map of the area (BGS sheet 256 North London 2006) indicates the site to be underlain by the London Clay Formation, which typically comprises slightly calcareous, silty to very silty clay, clayey silt and sometimes silt, with some layers of sandy clay. Given the developed history of the site, a thickness of made ground is likely to be present above the London Clay.

The previous investigation of the site by CET Safehouse (report ref; 130902, dated September 2012), comprised a single borehole and trial pit completed against the northern elevation of the existing rear extension from the garden of No 120 Malden Road, encountered the expected ground conditions, in that beneath a 0.45 m thickness of made ground, firm becoming stiff silty clay of the London Clay was encountered and proved to the full depth of the investigation, of 5.00 m.

A review of deep borehole records for the area held on the British Geological Society (BGS) database, indicates that the London Clay is likely to extend to a depth of more than 60 m beneath the site, and below which essentially incompressible soils of the Lambeth Group, Thanet Sand and Upper Chalk are expected to be present.

The Arup report contains a map showing the slope angles within the borough (Fig No 16) and the site is not shown to include any slopes with an angle greater than 7° so is not deemed on that basis to be at risk of general slope failure.

2.6 Hydrology and Hydrogeology

The London Clay Formation is classified as an Unproductive Stratum, referring to rock layers or drift deposits with low permeability and that have negligible significance for water supply or river base flow. Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1×10^{-10} m/s and 1×10^{-8} m/s, with an even lower vertical permeability.

As the London Clay comprises low permeability clay soils, it cannot support groundwater flow over any significant distance, nor can it be considered to support a “water table” or continuous piezometric surface. Boreholes constructed within clays do fill with water, due to the often high water content of shallow clays draining into the standpipe or by the collection of surface water drainage, which is unable to drain through the clay. However, this is not reflective of the type of groundwater flow that would occur in a porous and permeable saturated stratum.

Perched groundwater may be present within any made ground encountered on site, particularly in the vicinity of existing foundations. However, these are unlikely to be a source of any significant inflows, as they will be both laterally and vertically impersistent.

No groundwater inflows were encountered during the aforementioned investigation, with the borehole remaining ‘dry and open on completion’.

The site is not located within an EA designated Source Protection Zone (SPZs) and there are no listed water abstraction points within 500 m of the site.

The site lies outside the catchment of the Hampstead Heath chain of ponds, with the nearest surface water feature identified as the Parliament Hill Fields Lido, located 736 m to the north of the site. However, Figure 11 of the Arup report and reference to the Lost Rivers of London[5] indicates that a former tributary of the River Fleet, flowed in a southerly direction immediately to the west of the site, along the present line of Malden Road and Bassett Street. This former water course is not shown on any of the historical maps, and like many of London’s Lost Rivers is likely to have been culverted or otherwise incorporated into the local sewer system beneath the existing road network during the early to mid-1800s, such that it is unlikely to be impacted by, or impact upon, the proposed development.

The site is not within an area shown by the EA to be at risk from flooding from rivers or the sea, nor is it located within an area with a potential risk for groundwater flooding.

The site is not listed within the London Borough of Camden report[6] as having suffered from surface water flooding in the 1975 or 2002 flooding events and is not shown on Figure 15

5 Barton, N, & Meyers, S (2016) *The Lost Rivers of London (revised and extended edition with colour maps).* Historical Publications Ltd.

6 London Borough of Camden (2003) *Floods in Camden, Report of the Floods Scrutiny Panel*

of the Arup report or the EA surface water flood maps as being at risk from surface water flooding.

The site is entirely covered by the existing buildings and areas of external hardstanding, such that infiltration of rainwater is therefore restricted to surface water drains, and as such the majority of surface runoff currently drains into combined sewers in the road. In addition, as the site is underlain by impermeable clay the development is unlikely to result in any significant change to runoff rate or volume into the existing sewer system. There should not, therefore, be any requirement for any mitigation measures.

2.7 Preliminary Risk Assessment

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

2.7.1 Source

The desk study research has indicated that the site has most likely only had residential and commercial end uses for its entire developed history, having most recently been occupied by a small doctor's surgery, and is therefore not considered to have had a particularly contaminative history.

There are no historical or existing landfill sites within 1 km, and no areas of potentially infilled land within 250 m of the site; on this basis no potential sources of soil gas have been identified.

2.7.2 Receptor

The exact end use is not known at this stage, but the building is expected to retain a mixed commercial and residential end use, such that future occupants would represent relatively high sensitivity receptors.

Buried services are likely to come into contact with any contaminants present within the soils through which they pass, and site workers are likely to come into contact with any contaminants present during construction works.

Perched water may be present in the made ground or head deposits, particularly in the vicinity of existing foundations, although such pockets of water are likely to be localised and unlikely to form part of a general water table.

2.7.3 Pathway

Within the site, end users will be isolated from direct contact with any contaminants present within the made ground by the extent of the existing and proposed structures, sun that no potential contaminant exposure pathways will exist with respect to end users.

There will be a potential for contaminants to move onto or off the site horizontally within the made ground, although these pathways are already in existence. A pathway for ground workers to come into contact with any contamination will exist during construction work and services will come into contact with any contamination within the soils in which they are laid.

There is thus considered to be a low potential for a contaminant pathway to be present between any potential contaminant source and a target for the particular contaminant.

2.7.4 Preliminary Risk Appraisal

On the basis of the above it is considered that there is a LOW risk of there being a significant contaminant linkage at this site which would result in a requirement for major remediation work.

Furthermore, as the site is underlain by low permeability soils of the London Clay and there is no landfill sites or areas of filled ground within the vicinity of the site, there is not considered to be a significant potential for hazardous soil gas to be present on or migrating towards the site.

3.0 Screening

The Camden planning guidance suggests that any development proposal that includes a basement should be screened to determine whether or not a full BIA is required.

3.1 Screening Assessment

A number of screening tools are included in the Arup document and for the purposes of this report reference has been made to Appendices E1, E2 and E3 which include a series of questions within screening flowcharts for surface flow and flooding, subterranean (groundwater) flow and land stability. The flowchart questions and responses to these questions are tabulated below.

3.1.1 Subterranean (groundwater) Screening Assessment

Question	Response for 118 Malden Road
1a. Is the site located directly above an aquifer?	No. The site is underlain by the London Clay Formation which is designated as Unproductive Strata by the Environment Agency, which refers to rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow. Aquifer designation maps acquired from the Environment Agency as part of the desk study and Figures 3, 4 and 8 of the Arup report confirm this.
1b. Will the proposed basement extend beneath the water table surface?	No. As Unproductive Strata, the London Clay cannot behave as an aquifer or consequently support a continuous groundwater table. The proposed basement extension will not extend below the existing basement structure and previous investigation works did not encounter any perched or groundwater inflows, with the borehole remaining dry to a depth of 5.0 m.
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	*Yes. The site is located immediately to the east of a former tributary of the River Fleet. However, this feature is no longer present at surface, having been diverted and / incorporated into the local surface water sewer system beneath Malden Road.*
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No. Figure 14 of the Arup report confirms this.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No. There will be no change in the proportion of hard surfaced / paved areas, as the site will remain entirely covered by the extent of the existing / proposed building.
5. As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No. Given that the site is underlain by clay soils and is unlikely to be suitable for a soakaway or similar SUDS based system, the site drainage will therefore be directed to public sewers. Site drainage will therefore be designed to generally maintain the existing situation.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	No. There are no local ponds or spring lines. Figures 11 and 12 of the Arup report confirm this.

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

Q2. The site is within 100 m of the former course of the culverted Fleet River.

3.1.2 Stability Screening Assessment

Question	Response for 118 Malden Road
1. Does the existing site include slopes, natural or manmade, greater than 7°?	No. As indicated on the Slope Angle Map Fig 16 of the Arup report.
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No. The site is not to be significantly re-profiled as part of the development.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No. Not according to Figure 16 of the Arup report.
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	No. Not according to Figure 16 of the Arup report.
5. Is the London Clay the shallowest strata at the site?	*Yes, according to the BGS map of the area and previous investigation of the site.*
6. Will any trees be felled as part of the proposed development and / or are any works proposed within	No trees are to be felled.

Question	Response for 118 Malden Road
any tree protection zones where trees are to be retained?	
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	*Yes. The area is prone to these effects as a result of the presence of shrinkable London Clay.*
8. Is the site within 100 m of a watercourse or potential spring line?	*Yes. The site is located immediately to the east of a former tributary of the River Fleet. However, this feature is no longer present at surface, having been diverted and / incorporated into the local surface water sewer system beneath Malden Road.*
9. Is the site within an area of previously worked ground?	No. The geological map of the area and Figures 3, 4 and 8 of the Arup report do not indicate any worked ground in close proximity to the site.
10a. Is the site within an aquifer?	No. The site is underlain by the London Clay which is designated as Unproductive Strata by the Environment Agency and cannot store and transmit usable amounts of water.
10b. Will the proposed basement extend beneath the water table such that dewatering may be required during construction?	No. The London Clay cannot support a water table and is classified as an unproductive stratum.
11. Is the site within 50 m of Hampstead Heath ponds?	No. Not according to Figure 14 of the Arup report.
12. Is the site within 5 m of a highway or pedestrian right of way?	No. Whilst the site fronts onto Malden Road, the basement extension will be over 5 m from the existing footway.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	*Yes. The adjoining No 116 has a similar single level basement, but since it does not extend across the full footprint of the site, the development will locally result in a significant increase in differential founding depths. Additionally, it is understood that No 120 Malden Road and 131 Queens Crescent do not have existing basement levels, thus there will also be an increase in differential founding depths relative to these properties.*
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No. Not according to Figure 18 of the Arup report.

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

Q5 London Clay is the shallowest stratum at the site.

Q7 The site is moderately susceptible to ground shrink swell stability hazards due to being underlain by the London Clay Formation.

Q13 The proposed basement will increase the differential depth of foundations relative to neighbouring properties.

3.1.3 Surface Flow and Flooding Screening Assessment

Question	Response for 118 Malden Road
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No. Figure 14 of the Arup report indicates that the site is not located within this catchment area.
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. There will not be an increase in impermeable area across the site, so the surface water flow regime will be unchanged. The basement will be beneath the footprint of the building and the 1m distance between the roof of the basement and ground surface as recommended by section 3.2 of the CPG Basements 2021 does not apply across these areas.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No. There will not be an increase in impermeable area across the ground surface above the basement.
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	No. There will not be an increase in impermeable area across the site, so the surface water flow regime will be unchanged. The basement will be beneath the footprint of the building and the 1m distance between the roof of the basement and ground surface as recommended by section 3.2 of the CPG Basements 2021 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 proposed basement extension is very unlikely to result in any changes to the quality of surface water being received by adjacent properties or downstream watercourses as the surface water drainage regime will be unchanged and the land uses will remain the same.
6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk of flooding, for example because the proposed basement is below the static water level of nearby surface water feature?	No. The Camden Flood Risk Management Strategy dated 2013, together with Figures 3ii, 3vii, 4e, 5a and 5b of the SFRA dated 2014, and Environment Agency online flood maps show that the site has a very low flooding risk from surface water, sewers, reservoirs (and other artificial sources), groundwater and fluvial/tidal watercourses. In accordance with paragraph 6.16 of the CPG a positive pumped device

Question	Response for 118 Malden Road
	and non-return valve will be installed in the basement in order to further protect the site from sewer flooding. The site is not in a Local Flood Risk Zone, as identified in the Camden SWMP and Updated SFRA Figure 6/Rev 2.

The above assessment has not identified any potential issues that need further assessment.

4.0 Scoping and Site Investigation

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

4.1 Potential Impacts

The following potential impacts have been identified by the screening process.

Potential Impact	Consequence
The site is within 100 m of a former watercourse.	The basement may alter the groundwater flow regime to former watercourse.
London Clay is the shallowest stratum at the site.	The London Clay is prone to seasonal shrink-swell (subsidence and heave).
The site is underlain by the London Clay Formation, and is susceptible to ground shrink swell stability hazards of moderate hazard potential.	In terraced properties, the implications of a deepened basement/foundation system on neighbouring properties should be considered.
The proposed development may result in an increase in differential depth relative to neighbouring properties.	The stability of all surrounding structures will need to be ensured at all times. An analysis of the predicted ground movements will be completed once the scheme is finalised, to assess the impact on neighbouring buildings.

These potential impacts have been investigated through the site investigation, as detailed in Section 13.0.

4.2 Exploratory Work

In view of the access restrictions and in order to meet the objectives described in Section 1.2. a single hand-held window sampler borehole was advanced to a depth of 2.00 m from ground floor level within the existing rear extension, whilst the second borehole was advanced to a depth of 1.80 m below existing basement level. During boring, disturbed samples were obtained from the boreholes for subsequent laboratory examination and testing.

Additionally, two trial pits were hand excavated to depths of 0.40 m and 0.60 m below the existing lower ground floor / basement level to investigate the foundations of the existing structures on the site and confirm the boundary wall conditions.

Groundwater monitoring standpipes were installed to the base of each borehole to facilitate groundwater monitoring, which has been carried out on a single occasion to date.

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

All of the above work was carried out under the supervision of a geotechnical engineer from GEA. The borehole records are appended, together with a site plan indicating the exploratory positions.

4.3 Sampling Strategy

The boreholes and trial pits were positioned on site by a geotechnical engineer from GEA in accessible areas, with due regard to the proposed development and the locations of known buried services.

Three samples of the made ground have been tested for the presence of contamination. The analytical suite of testing was selected to identify a range of typical industrial contaminants for the purposes of general coverage. For this investigation the analytical suite for the soil included a range of metals, speciation of total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH), total cyanide and monohydric phenols. The samples were also screened for the presence of asbestos. The contamination analyses were carried out at an MCERTs accredited laboratory with the majority of the testing suite accredited to MCERTS standards. A summary of the MCERTs accreditation and test methods are included with the attached results and further details are available upon request.

5.0 Ground Conditions

The investigation has generally confirmed the expected ground conditions in that, beneath a moderate thickness of made ground, the London Clay Formation was encountered and extended to the full depth of the investigation, of 2.00 m.

5.1 Made Ground

The made ground generally comprised mid brown to dark grey gravelly sandy silty clay, with the gravel comprising fine to coarse fragments of brick and occasional glass, charcoal, ash and wire, and extended to depths of 0.30 m and 0.60 m.

Apart from the presence of fragments of extraneous material noted above, no visual or olfactory evidence of contamination was observed during the fieldwork. However, three samples of the made ground have been analysed for a range of contaminants as a precautionary measure and the results are detailed within Section 5.4.

5.2 London Clay

The underlying London Clay generally comprised stiff becoming very stiff with depth fissured brown silty clay with rare pockets of orange brown clayey sand and occasional to rare blue grey veining with root traces, and was recorded to the maximum depth investigated of 2.00 m.

Borehole Nos 1 and 2 were aborted at depths of 2.00 m and 1.80 m respectively, due to the very stiff ground conditions. The London Clay was found to be desiccated, and it is understood that the north flank wall of the rear extension has been underpinned due to desiccation issues associated with the mature London Plane Trees located just to the north of the site.

The results of plasticity index tests indicate the clay to be of very high plasticity and high volume change potential.

5.3 Groundwater

Groundwater was not encountered within any of the boreholes or trial pits during the fieldwork. However, water has been recorded at a depth of 1.22 m below the existing basement level within the standpipe installed into Borehole No 2.

5.4 Soil Contamination

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

Determinant	BH1 0.50 m	TP1 0.20 m	TP2 0.30 m
pH	8	8	10.1
Arsenic	15	23	14
Cadmium	<0.2	<0.2	<0.2
Chromium	38	22	27
Lead	270	290	**540**
Mercury	1.1	0.7	0.7
Selenium	<1.0	<1.0	<1.0
Copper	41	130	110
Nickel	22	18	20
Zinc	120	76	130
Total Cyanide	<1.0	<1.0	<1.0
Total Phenols	<1.0	<1.0	<1.0
Total PAH	6.76	1.23	1.62
Sulphide	<1.0	<1.0	1.9
Benzo(a)pyrene	0.51	0.1	0.17
Naphthalene	<0.05	<0.05	<0.05
TPH	<10	<10	<10
Total Organic Carbon %	1.2	0.6	0.6

Note: Figure in bold indicates concentration in excess of risk-based soil guideline values, as discussed in Part 2 of this report

In addition, all three of the samples were screened for the presence of asbestos and none was detected.

5.4.1 Generic Quantitative Risk Assessment

The use of a risk-based approach has been adopted to provide an initial screening of the test results to assess the need for subsequent site-specific risk assessments. Contaminants of concern are those that have values in excess of generic human health risk-based guideline values, which are either the CLEA[7] Soil Guideline Values where available, the Suitable 4 Use Values[8] (S4UL) produced by LQM/CIEH calculated using the CLEA UK Version 1.07[9] software, or the DEFRA Category 4 Screening values[10], assuming a residential end use with plant uptake. The key generic assumptions for this end use are as follows:

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

It is considered that these assumptions are acceptable for this generic assessment of this site. The tables of generic screening values derived by GEA and an explanation of how each value has been derived are included in the Appendix.

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

7 *Updated Technical Background to the CLEA Model (Science Report SC050021/SR3) Jan 2009* and Soil Guideline Value reports for specific contaminants; all DEFRA and Environment Agency.
8 *The LQM/CIEH S4Uls for Human Health Risk Assessment* S4UL3065 November 2014
9 Contaminated Land Exposure Assessment (CL|EA) Software Version 1.071 Environment Agency 2015
10 CL:AIRE (2013) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Final Project Report SP1010 and DEFRA (2014) *Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination* Policy Companion Document SP1010

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

The results of the chemical analyses have indicated a single sample of the made ground tested to contain an elevated concentration of lead, but all of the other contaminants tested were found to be below their respective generic guideline values for a residential with plant uptake end use, and none of the samples were found to contain asbestos.

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

5.5 Existing Foundations

The findings of the trial pits are summarised in the table below. Sketches and photographs of each pit are included in the Appendix.

Trial Pit No	Structure	Foundation detail	Bearing Stratum
1	Covered courtyard within basement	Brick footing Top 0.04 m Base 0.21 m. Lateral projection 150mm	Made Ground (brick rubble)
2	Party wall with No 116	Brick footing Top 0.28 m Base 0.44 m. Lateral projection 100mm	Made Ground (brick rubble)

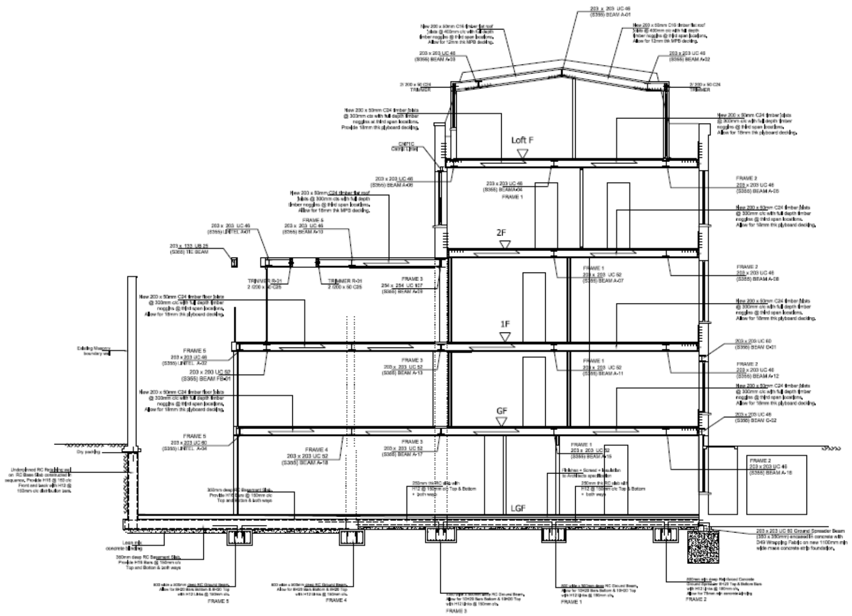
Part 2: Design Basis Report

This section of the report provides an interpretation of the findings detailed in Part 1, in the form of a ground model, and then provides advice and recommendations with respect to the proposed development.

6.0 Ground Model

It is understood that it is proposed to extend the existing basement beneath the rear part of the site, with re-modelling and partial demolition of the existing rear extension to create a basement level courtyard at the rear of the site. The proposals also involve significant internal alterations, including raising the height of the ground floor, and remodelling the roof.

The existing basement extends to a depth of 2.80 m below the existing ground floor level of the property, and the extended basement section will be formed at the same level.



Extract from Martin Redston Associates 'Section 1-1' (Drg No 23.206 07 Rev A, dated August 2023)

The desk study research has indicated that the site has most likely only had residential and commercial end uses for its entire developed history, having most recently been occupied by a small doctor's surgery, and is therefore not considered to have had a particularly contaminative history. On the basis of the fieldwork, the ground conditions at this site can be characterised as follows:

- below a moderate thickness of made ground, the London Clay Formation was encountered and extended to the full depth of the investigation, of 2.00 m;
- the made ground comprises mid brown to dark grey gravelly sandy silty clay, with the gravel consisting of fine to coarse fragments of brick and occasional glass, charcoal, ash and wire, and extends to a maximum depth of 0.60 m;
- the underlying London Clay comprises stiff becoming very stiff with depth fissured brown silty clay with rare pockets of orange brown clayey sand and occasional to rare blue grey veining with root traces, and is present to the maximum depth investigated of 2.00 m;
- the London Clay was found to be desiccated, and the boreholes were aborted at depths of 2.00 m and 1.80 m, due to the very stiff ground conditions;
- groundwater was not encountered within any of the boreholes or trial pits during the fieldwork, but water has been recorded at a depth of 1.22 m below existing basement level within the standpipe installed into Borehole No 2; and
- contamination testing has revealed the presence of locally elevated concentrations of lead within the made ground.

7.0 Advice & Recommendations

Excavations for the proposed basement structure will require temporary support to maintain stability and to prevent any excessive ground movements.

Formation level for the basement will be within the London Clay at a depth of about 2.80 m below existing ground level.

On the basis of the investigation observations and the underlying ground conditions, significant groundwater inflows are not expected to be encountered within the basement excavation.

7.1 Basement Construction

Formation level for the basement is expected to be within the stiff clay of the London Clay at a depth of about 2.80 m.

Inflows of perched water should be anticipated from within the made ground. However, any such inflows are likely to be relatively minor in nature and should be adequately dealt with through sump pumping, although it would be prudent for the chosen contractor to have a contingency plan in place to deal with more significant or prolonged inflows as a precautionary measure.

The design of basement support in the temporary and permanent conditions needs to take account of the need to maintain the stability of the excavation and surrounding structures, and to protect against potential shallow groundwater inflows. There are a number of methods by which the sides of the basement excavation could be supported in the temporary and permanent conditions. The choice of wall may be governed to a large extent by whether it is to be incorporated into the permanent works and have a load bearing function.

The final choice will depend, to a large extent, on the need to protect nearby structures from movements, the required overall stiffness of the support system, and the need to control groundwater movement through the wall in the temporary condition. In this respect the stability of the existing and adjacent buildings, will be paramount.

In the absence of significant groundwater inflows and the presence of clay soils, the use of underpinning in a traditional hit and miss approach is to be utilised along with cast in-situ reinforced concrete retaining walls constructed using a similar methodology. Careful workmanship will be required to ensure that movement of the surrounding structures does not occur and the contractor should be required to provide details of how they intend to control groundwater and instability of excavations, should it arise.

The ground movements associated with the basement excavation will depend on the method of excavation and support and the overall stiffness of the basement structure in the temporary condition. Thus, a suitable amount of propping will be required to provide the necessary rigidity. In this respect the timing of the provision of support to the wall will have an important effect on movements. An assessment of the movements has been carried out and is discussed in Part 3.

7.1.1 Basement Retaining Walls

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

Stratum	Bulk Density (kg/m^3)	Effective Cohesion (c' – kN/m^2)	Effective Friction Angle (ϕ' – degrees)
Made ground	1700	Zero	27
London Clay	1950	Zero	23

Significant groundwater inflows are not anticipated within the basement, although monitoring of the standpipes should be continued to confirm this view, along with trial excavations.

Provided that a fully effective drainage system can be ensured in order to prevent the build-up of groundwater behind the retaining walls, it should be possible to design the basement on the basis that water will not collect behind the walls. If an effective drainage system cannot be ensured, then a water level of two-thirds of the basement depth, subject to a minimum depth of 1.00 m, should be assumed. The advice in BS8102:2009[11] should be followed in this respect and with regard to the provision of suitable waterproofing.

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

7.1.2 Basement Heave

The 2.80 m deep excavation of the basement will result in a net unloading of around 55 kN/m^2, which will result in heave of the underlying London Clay. This will comprise immediate elastic movement, which will account for approximately 40 % of the total movement and be expected to be complete during the construction period, and long term movements, which will theoretically take many years to complete. These movements will, to some extent, be mitigated by the loads applied by the proposed development, however the ground movements associated with the proposed basement excavation and construction have been considered in more detail in Part 3 of this report.

7.2 Spread Foundations

New strip or pad foundations bearing beneath basement formation level in the stiff London Clay, may be designed to apply a net allowable bearing pressure of 150 kN/m². This value incorporates an adequate factor of safety against bearing capacity failure and should ensure that settlement remains within normal tolerable limits.

The depth of the basement excavation is expected to be such that foundations should be placed below the depth of actual or potential desiccation, but this should be checked once the proposals have been finalised. Additional ground investigation should be carried out under the supervision of a qualified geotechnical engineer once access becomes available.

Notwithstanding NHBC guidelines, all foundations should extend beyond the zone of desiccation. Desiccation was recorded during the investigation, and roots were observed in both boreholes, including Borehole No 2 drilled from the existing basement level, although the maximum depth to which the desiccation extends has not been confirmed. In this respect, it would be prudent to have all foundation excavations inspected by a suitably experienced engineer. Due allowance should be made for future growth of existing / proposed trees.

The requirement for compressible material alongside foundations should be determined by reference to the NHBC guidelines.

7.3 Shallow Excavations

On the basis of the borehole findings, it is considered that it will be generally feasible to form relatively shallow excavations terminating within the London Clay without the requirement for lateral support, although localised instabilities may occur where more granular material or groundwater is encountered.

Significant inflows of groundwater into shallow excavations are not generally anticipated, although seepages may be encountered from perched water tables within the made ground, particularly within the vicinity of existing foundations, although such inflows should be suitably controlled by sump pumping.

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

7.4 Basement Floor Slab

Following excavation of the basement extension, it is likely that the floor slab for the proposed basement extension will need to be suspended over a void or a layer of compressible material to accommodate the anticipated heave and any potential uplift forces from groundwater pressures, unless the slab can be suitably reinforced to cope with these movements.

Further consideration is given to ground movements in Part 3 of this report.

7.5 Effect of Sulphates

Chemical analyses have generally revealed relatively low concentrations of soluble sulphate and near-neutral pH in the samples of natural soil tested, in accordance with Class DS-1 conditions of Table C2 of BRE Special Digest 1:SD Third Edition (2005), but moderate concentrations of soluble sulphate were locally recorded in the samples of the made ground, in accordance with Classes DS-1 to DS-3.

The measured pH values of the samples show that an ACEC class of up to AC-1s would be appropriate for the site, for concrete placed within the natural soils, assuming a static water condition. For concrete placed entirely within the made ground, an ACEC class of AC-2s would be appropriate, also assuming a static groundwater condition.

7.6 Contamination Risk Assessment

The desk study research has indicated that the site has most likely only had residential and commercial end uses for its entire developed history, having most recently been occupied by a small doctor's surgery, and is therefore not considered to have a particularly contaminative history. Furthermore, no there are no potential offsite sources of contamination that are considered to pose a risk to the site.

The results of the contamination testing have identified an elevated concentration of lead within one of the three samples of made ground tested. The source of the lead contamination is unknown. However, the made ground was noted as containing variable amounts of extraneous material, including ash and charcoal, and it is therefore likely that a fragment of such material was present within the samples tested, accounting for the elevated concentrations. Information on Urban Soil Chemistry provided by the BGS also indicates that background concentrations for lead in the vicinity of the site are between 600 mg/kg and 900 mg/kg, such that a proportion of the measured concentrations could be the result of residual airborne sources.

Lead compounds are relatively immobile, unlikely to be in a soluble form and are considered to be non-volatile or of a low volatility. The contamination does not therefore present a significant vapour risk or a significant risk of leaching and migration within any perched groundwater within the made ground. As the site is underlain by the London Clay, which cannot support a continuous groundwater table, a risk to groundwater is also not identified.

It is proposed to excavate a basement extension beneath the rear part of the site, and as a result, much of the made ground will be removed. In addition, end users will be effectively isolated from any potential contamination by the building and associated areas of hardstanding. No pathway and no risk to end users is therefore considered to exist, but the contamination could pose a risk to site workers during the ground works. These risks are further assessed below.

7.6.1 Site Workers

Site workers should be made aware of the contamination and a programme of working should be identified to protect workers handling any soil. The method of site working should be in accordance with guidelines set out by HSE[12] and CIRIA[13] and the requirements of the Local Authority Environmental Health Officer.

It is recommended that a watching brief be maintained during ground works by the contractor and any suspected contamination, especially in areas not covered by the investigation, should be brought to the attention of a geoenvironmental engineer.

7.7 Waste Disposal

Under the European Waste Directive, waste is classified as being either Hazardous or Non-Hazardous and landfills receiving waste are classified as accepting hazardous or non-hazardous wastes or the non-hazardous sub-category of inert waste in accordance with the Waste Directive. Waste classification is a staged process and this investigation represents the preliminary sampling exercise of that process. Once the extent and location of the waste that is to be removed has been defined, further sampling and testing may be necessary. The results from this ground investigation should be used to help define the sampling plan for such further testing, which could include WAC leaching tests where the totals analysis indicates the soil to be a hazardous waste or inert waste from a contaminated site. It should however be noted that the Environment Agency guidance WM3[14] states that landfill WAC analysis, specifically leaching test results, must not be used for waste classification purposes.

Any spoil arising from excavations or landscaping works, which is not to be re-used in accordance with the CL:AIRE[15] guidance, will need to be disposed of to a licensed tip. Waste going to landfill is subject to landfill tax at either the standard rate of £102.10 per tonne (about £190.00 per m^3) or at the lower rate of £3.25 per tonne (roughly £6.00 per m^3). However, the classifications for tax purposes and disposal purposes differ and currently all made ground and topsoil is taxable at the 'standard' rate and only naturally occurring soil and stones, which are accurately described as such in terms of the 2011 Order, would qualify for the 'lower rate' of landfill tax.

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

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

14 Environment Agency 2015. *Guidance on the classification and assessment of waste.* Technical Guidance WM3 First Edition

15 CL:AIRE March 2011. *The Definition of Waste: Development Industry Code of Practice* Version 2

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

Soil Type	Waste Classification (Waste Code)	WAC Testing Required Prior to Landfill Disposal?	Current applicable rate of Landfill Tax
Made ground	Non-hazardous (17 05 04)	No	£102.10/tonne (Standard rate)
Natural Soils	Inert (17 05 04)	Should not be required but confirm with receiving landfill	£3.25 / tonne (Reduced rate for uncontaminated naturally occurring rocks and soils)

Under the requirements of the European Waste Directive all waste needs to be pre-treated prior to disposal. The pre-treatment process must be physical, thermal, chemical or biological, including sorting. It must change the characteristics of the waste to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment but they will need to provide documentation to prove that it has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The EA has issued a position paper[16] which states that in certain circumstances, segregation at source may be considered as pre-treatment and thus excavated material may not have to be treated prior to landfilling if the soils can be segregated onsite prior to excavation by sufficiently characterising the soils insitu prior to excavation.

The above opinion with regard to the classification of the excavated soils is provided for guidance only and should be confirmed by the receiving landfill once the soils to be discarded have been identified. The local waste regulation department of the Environment Agency (EA) should be contacted to obtain details of tips that are licensed to accept the soil represented by the test results. The tips will be able to provide costs for disposing of this material but may require further testing.

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

Part 3: Ground Movement Analysis

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

8.0 Introduction

The sides of an excavation will move to some extent regardless of how they are supported. The movement will typically be both horizontal and vertical and will be influenced by the engineering properties of the ground, groundwater level and flow, the efficiency of the various support systems employed and the efficiency or stiffness of any support structures used. An analysis has been carried out of the likely movements arising from the proposed excavation and the results of this analysis have been used to predict the effect of these movements on surrounding structures.

8.1 Nearby Sensitive Structures

Sensitive structures relevant to this assessment include Nos 120, 116 and 114 Malden Road, and the rear extension of No 131 Queens Crescent 91 Leighton Road to the northeast. A plan outlining the nearby sensitive structures is shown below.

The heights of the buildings have been estimated from observations, and from drawings provided by the consulting engineers. The underside of the foundations of 116 Malden Road have been determined based on the trial pitting completed on site, and a similar founding depth has been assumed for 114 Malden Road, which is of very similar age and construction. A founding depth of 0.50 m below ground level has been conservatively assumed for 120 Malden Road and 131 Queens Crescent, for which no additional information was found during the online search of planning applications on Camden Council's website. The heights and depths to underside of foundations are summarised in the table below.

Sensitive structure	Height of building above foundation level (m)	Underside of foundation, depth (m)
116 Malden Road	6.40 to 13.19	0.44 (below existing basement level)
114 Malden Road	6.40 to 13.19	0.44 (below existing basement level)
120 Malden Road	11.00	0.50
131 Queens Crescent	6.6	0.50

It is understood that the rear extension of 118 Malden Road has previously been underpinned due to structural damage, but the exact depth of this underpinning is not known. As a result, this and any other existing underpinning has been conservatively omitted from the following analyses. The locations of the neighbouring buildings have been input into the model based on dimensions calculated from scaled drawings.

8.2 Construction Sequence

Formation level for the proposed basement is at a depth of roughly 2.80 m. It is understood that the preferred method of retaining wall construction is through traditional underpinning carried out in a hit and miss approach.

Based on information provided by the consulting engineers, Martin Redston Associates, the loading on the proposed underpinning is anticipated to vary from around 70 kN/m to around 95 kN/m run, with additional column loads of 90 kN to 120 kN., and two internal ground beams, each with a line load of 70 kN/m.

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

- construction of underpins to the existing perimeter walls in hit and miss sequence;
- installation of props and excavation of basement extension to formation level;
- installation of basement floor slab; and
- casting of ground floor slab and removal of temporary props once concrete has sufficiently cured.

It is understood that underpinning of the existing perimeter walls will take place in a 'hit and miss' sequence, in stages to be agreed with the temporary works engineer and under party wall agreement. Underpinning should generally be undertaken in short sections not exceeding 1.00 m to 1.20 m in length, with no adjacent pin to be excavated until a minimum of 48 hours after the adjacent pin has been cast and dry-packed placed, with the sides of the excavation adequately shored and propped.

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

The individual panel widths of the liner wall will need to be adequately laterally propped and sufficiently dowelled together, and the concrete will need to be cast and adequately cured prior to excavation of the basement extension and removal of the formwork and supports. It is assumed that the corners of the excavation will be locally stiffened by cross-bracing or similar and that the new retaining walls will not be cantilevered at any stage during the construction process. It is assumed that adequate temporary propping of the new retaining walls, particularly at the top level, will occur at all times prior to the construction of permanent concrete floor slabs.

9.0 Ground Movements

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

The X-Disp and P-Disp programs have been used to predict ground movements likely to arise from the excavation and construction of the proposed basement. This includes the heave / settlement of the ground (vertical movement) and the lateral movement of soil behind the proposed retaining walls (horizontal movement). Both the P-Disp and X-Disp programs are commonly used within the ground engineering industry and are considered to be appropriate tools for the purpose of this analysis.

The basement has been modelled based on scaled dimensions from plan drawings provided by the consulting engineer, and the corners of the basement have been defined by x and y coordinates. As such, for the purpose of these analyses, the y-direction is orientated approximately northwest-southeast, parallel with Malden Road, and the x-direction is orientated broadly northeast-southwest. Vertical movement is in the z-direction.

The basement extension has been modelled as a polygon with dimensions of around 9.90 m by 5.90 m, and a founding depth of around 2.80 m. The proposed basement will be formed through underpinning of the existing foundations, and a new floor slab.

It is assumed that suitable propping will be provided during the construction of the basement and in the permanent condition, such that the walls can be considered to be stiff for the purpose of the ground movement modelling.

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

9.1 Ground Movements – Within the Basement

9.1.1 Model Used

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

The elastic analysis requires values of soil stiffness at various levels to calculate displacements. Values of stiffness for the soils at this site are readily available from published data and we have used a well-established method to provide our estimates. This relates values of Eu and E', the undrained and drained stiffness respectively, to values of undrained cohesion, as described by Padfield and Sharrock[17] and Butler[18] and more recently by O'Brien and Sharp[19]. Whilst values of Eu can be taken as 750 x Cu for the London Clay and a ratio of E' to Cu of 0.75 considered appropriate and in line with more recent published data, more conservative values of 500 x Cu for Eu and a ratio of E' to Cu of 0.60 have been adopted at this stage.

Based on information provided by the consulting engineers, Martin Redston Associates, the loading on the proposed underpinning is anticipated to vary from around 70 kN/m to around 95 kN/m, with additional column loads of 90 kN to 120 kN., and two internal ground beams, each with a line load of 70 kN/m. When an allowance is made for the load spreading across the underpin bases, and the unloading from the basement excavation, the pressure beneath the underpins is estimated to range from around 1 kN/m^2 to -13 kN/m^2.

The soil parameters used in this analysis and tabulated below have been primarily derived from the onsite investigation and extrapolation of data for the London Clay at depth. A rigid boundary for the analysis has been set at around 30.00 m below ground level within the London Clay, as below this depth the clay soils of the London Clay are considered to be essentially incompressible. An initial strength of 50 kN/m^2 and a subsequent increase in cohesion of 7.5 kN/m^2 for each metre of depth has been adopted to provide a conservative estimate of the likely strength profile within the London Clay beneath the site.

Stratum	Depth Range (m) (m OD)	Bulk Density (Kg/m^3)	Eu (KN/m^2)	E'(KN/m^2)
Made Ground	GL to 0.60	1700	10,000	10,000
London Clay	0.60 to 30.00	1950	25,000 to 135,250	15,000 to 81,150

9.1.2 Results

The predicted movements are summarised in the table below; the results are presented below and in subsequent tables to the degree of accuracy required to allow predicted variations in ground movements around the structure(s) to be illustrated, but may not reflect the anticipated accuracy of the predictions.

The assessment has been carried out as three separate analyses representing three phases of the development, with Stage 1 comprising the installation of the underpins in the short term, Stage 2 comprising the subsequent excavation and completion of construction of the basement extension in the short term, and Stage 3 comprising the complete construction in the long term.

Phase	Heave Movement (mm)	
	Centre of Excavation	Along basement extension walls
Underpin installation (Short Term)	-	-1 to 4
Complete Construction (Short Term)	-3	-1 to 3
Complete Construction (Overall Term)	-5	-2 to 6
Note: -ve values denote heave, and +ve values denote settlement		

The P-Disp analysis indicates that, by the time construction is complete, around 3 mm of heave is likely to have taken place beneath the area of the basement extension, and between around 1 mm of heave and 3 mm of settlement is likely to have taken place beneath the underpins, with the highest movement beneath the proposed ground beams.

17 Padfield, CJ and Sharrock, MJ (1983) *Settlement of structures on clay soils*. CIRIA Special Publication 27
18 Butler FG (1974) *Heavily overconsolidated clays: a state of the art review.* Proc Conf Settlement of Structures, Cambridge, 531-578, Pentech Press, Lond
19 O'Brien AS and Sharp P (2001) *Settlement and heave of overconsolidated clays - a simplified non-linear method.* Part Two, Ground Engineering, Nov 2001, 48-53

The analysis using drained parameters has indicated that total heave at the centre of the excavation can be expected to increase by around 2 mm to a maximum of 5 mm, and that settlement movements beneath the rear extension can be expected to increase by around 3 mm to a maximum of 6 mm. The analysis has indicated that immediately outside of the excavation, movement of between around 2 mm heave and 3 mm settlement can be expected.

It should be noted that the movements presented in the table above reflect the total amount of movement that is anticipated to have occurred at each stage, and they should therefore not be added together.

9.2 Ground Movements – Surrounding the Basement

9.2.1 Model Used

For the X-Disp analysis, the soil movement relationships used for the embedded retaining walls are the default values within CIRIA report C760[20], which were derived from a number of historic case studies.

Installation of underpins:

Predictions of the vertical and horizontal ground movements behind the walls, as a result of underpinning, can be based on case study information within CIRIA C760[21] for a planar diaphragm wall installed into stiff clay, which is considered to be a conservative approach. Whilst this is considered to be a conservative approach, Campbell Reith, who audit basement impact assessments for Camden, have requested that total vertical and horizontal movements should be assumed to fall within the range of 5 mm to 10 mm, for a single stage of underpinning. As a result, modified curves for a planar diaphragm wall installed into stiff clay have been adopted, with the movements slightly adjusted so that when combined with the excavation movements, the total vertical and horizontal movements reflect the lower range of the above movements provided by Campbell Reith. The lower range of above movements has been adopted based on the findings of the ground investigation, the proposed propping, and the depth of excavation which at 2.80 m is slightly less than a typical single level basement.

Excavation Phase:

Suitable propping will be provided during the construction of the basement and in the permanent condition, such that the walls can be considered to be stiff for the purpose of the ground movement modelling. Thus, the horizontal ground movement curve for 'excavations in front of high stiffness wall in stiff clay' has been adopted for the subsequent excavation required to form the proposed basement extension. For the XDisp analysis, a maximum depth of 2.80 m has been adopted for the excavation

9.2.2 Results

The vertical movements obtained from the P-Disp analysis have been imported into X-Disp, and the resulting combined movements are summarised in the table below; the results are presented below and in subsequent tables to the degree of accuracy required to allow predicted variations in ground movements around the structure to be illustrated but may not reflect the anticipated accuracy of the predictions.

Phase of Works	Wall Movement (mm)	
	Vertical Settlement	Horizontal Movement
Stage 1 - Underpin installation (Short Term)	2 to 4	1 to 2
Stage 2 - Complete Construction (Short Term)	2 to 4	4 to 5
Stage 3 - Complete Construction (Overall Term)	5 to 6	4 to 5

The analysis has indicated that the vertical settlements that will result from wall installation are anticipated to be up to around 4 mm. In the long term, settlement movements are predicted to increase by around 1mm to 2 mm, to up to around 6 mm.

The analysis also indicates that maximum horizontal movements that will result from wall installation are anticipated to be up to around 2 mm, with movements increasing to around 5 mm as a result of the combined wall installation and excavation phases.

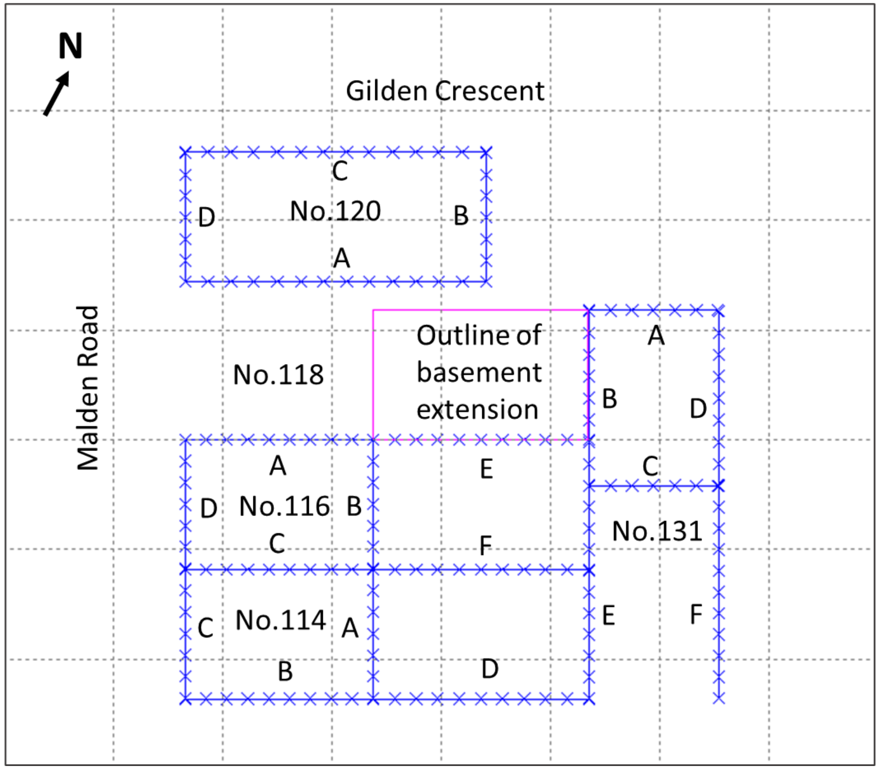
The movements set out in the table and discussed above are the maximum movements and the analysis has indicated that they occur immediately or just outside the line of the retaining walls.

20 Gaba, A, Hardy, S, Powrie, W, Doughty, L and Selemetas, D (2017) *Embedded retaining walls – guidance for economic design* CIRIA Report C760

21 Gaba, A, Hardy, S, Powrie, W, Doughty, L and Selemetas, D (2017) *Embedded retaining walls – guidance for economic design* CIRIA Report C760.

10.0 Damage Assessment

In addition to the above assessment of the likely movements that will result from the proposed development, any neighbouring buildings within the zone of influence of the excavations are considered to be sensitive structures, requiring Building Damage Assessments, on the basis of the classification given in Table 6.4 of CIRIA report C760[22]. The sensitive structures outlined previously have been modelled as displacement lines in the analysis along which the damage assessment has been undertaken. The labelling adopted is shown on the diagram below.



10.1 Damage to Neighbouring Structures

The vertical movements obtained from the P-Disp analysis have been imported into X-Disp to enable a damage assessment to be undertaken of the combined movements. A separate damage assessment has been completed for each of the major stages in the construction of the basement, to ensure that the most critical stage in terms of potential damage to the neighbouring properties has been assessed.

For the purpose of this analysis, the basement construction has been split into three stages, with Stage 1 comprising the installation of the underpins in the short term, Stage 2 comprising the subsequent excavation and completion of construction of the basement extension in the short term, and Stage 3 comprising the complete construction in the long term. The results are summarised in the tables below, for each of the major stages in the construction of the basement, as described above.

Stage 1 (Short-term movements from installation of proposed underpinning)

Sensitive Structure	Structure Reference	Category of Damage*
120 Malden Road	A, B & C	Category 0 – Negligible
	D	Below limit of detection
116 Malden Road	A, B, C, E & F	Category 0 – Negligible
	D	Below limit of detection
114 Malden Road	A	Category 0 – Negligible
	B, C & D	Below limit of detection
131 Queens Crescent	A to E	Category 0 – Negligible
	F	Below limit of detection

**From Table 6.4 of C760[1]: Classification of visible damage to walls.*

22 Gaba, A, Hardy, S, Powrie, W, Doughty, L and Selemetas, D (2017) *Embedded retaining walls – guidance for economic design* CIRIA Report C760

Stage 2 (Short-term movements following completion of construction)

Sensitive Structure	Structure Reference	Category of Damage*
120 Malden Road	B	Category 1 – *Very Slight*
	A & C	Category 0 – Negligible
	D	Below limit of detection
116 Malden Road	B	Category 1 – *Very Slight*
	A, C, E & F	Category 0 – Negligible
	D	Below limit of detection
114 Malden Road	A	Category 0 – Negligible
	B, C & D	Below limit of detection
131 Queens Crescent	A & E	Category 1 – *Very Slight*
	B, C, D & F	Category 0 – Negligible

**From Table 6.4 of C760[1]: Classification of visible damage to walls.*

Stage 3 (Long term movements following completion of development)

Sensitive Structure	Structure Reference	Category of Damage*
120 Malden Road	B	Category 1 – *Very Slight*
	A, C & D	Category 0 – Negligible
116 Malden Road	B & E	Category 1 – *Very Slight*
	A, C, D & F	Category 0 – Negligible
114 Malden Road	A	Category 0 – Negligible
	B, C & D	Below limit of detection
131 Queens Crescent	A & E	Category 1 – *Very Slight*
	B, C, D & F	Category 0 – Negligible

**From Table 6.4 of C760[1]: Classification of visible damage to walls.*

The building damage reports for the previously identified sensitive structures are summarised in the tables above, and are included in the appendix, and indicate that the damage to the adjoining and nearby structures due to the construction of the proposed basement extension would be either 'Negligible (0)' or 'Very Slight (1)' across all three stages.

Building damage categories Negligible to Very Slight are widely considered to cause only aesthetic damage to buildings such that structural instability is highly unlikely to occur. All sensitive structures have been assessed to have a damage category of 'Negligible' to 'Very Slight', such that all sensitive structures are considered to fall within acceptable limits.

The results discussed above are based on individual building lines, or walls, that in some instances, have been further divided up within the analysis into a series of segments that are assumed to be able to move independently of one another, with the most critical segment determining the result for the entire wall. In reality, this is unlikely to be the case as the walls will behave as single stiff elements that are also joined continuously with the rest of the structure.

The results therefore provide a conservative estimate of the behaviour of each of the sensitive structures and overestimate the degree of damage, although they provide a useful indication of the most critical structures within the adjoining properties that may require further assessment, as detailed below.

10.2 Monitoring of Ground Movements

The predictions of ground movement based on the ground movement analysis should be checked by monitoring of the adjacent properties and structures. The structures to be monitored during the construction stages should include the existing property and the neighbouring structure assessed above. Condition surveys of the above existing structures should be carried out before and after the proposed works.

The precise monitoring strategy will be developed at a later stage, and it will be subject to discussions and agreements with the owners of the adjacent properties and structures. Contingency measures will be implemented if movements of the adjacent structures exceed predefined trigger levels. Both contingency measures and trigger levels will need to be developed within a future monitoring specification for the works.

11.0 GMA Conclusions

The analysis has concluded that the predicted damage to the neighbouring properties from the construction of the proposed basement extension would be 'Negligible' to 'Very Slight'.

On this basis, the damage that has been predicted to occur as a result of the construction the proposed basement extension falls within the limits acceptable to the London Borough of Camden assuming that the careful control is taken during construction of the proposed excavations, and monitoring will be required to ensure that no excessive movements occur that would lead to damage in excess of these limits.

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

Part 4: Basement Impact Assessment

This section of the report evaluates the direct and indirect implications of the proposed project, based on the findings of the previous screening and scoping, site investigation and ground movement assessment.

12.0 Introduction

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

12.1 Potential Impacts

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

Potential Impact	Consequence
The site is within 100 m of a former watercourse.	The basement may alter the groundwater flow regime to former watercourse.
London Clay is the shallowest stratum at the site.	The London Clay is prone to seasonal shrink-swell (subsidence and heave).
The site is underlain by the London Clay Formation, and is susceptible to ground shrink swell stability hazards of moderate hazard potential.	In terraced properties, the implications of a deepened basement/foundation system on neighbouring properties should be considered.
The proposed development may result in an increase in differential depth relative to neighbouring properties.	The stability of all surrounding structures will need to be ensured at all times. An analysis of the predicted ground movements will be completed once the scheme is finalised, to assess the impact on neighbouring buildings.

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

The site is within 100 m of a former watercourse

The desk study has indicated that the site is located immediately to the east of a former tributary of the River Fleet, one of London's Lost Rivers. This feature is no longer present at surface, having been diverted and / incorporated into the local surface water sewer system beneath Malden Road.

In any case, the basement will not extend beneath the water table, since the underlying London Clay is classified as an unproductive stratum and cannot support a continuous water, thus it will not affect the groundwater regime in the surrounding area.

London Clay is the shallowest stratum / Seasonal Shrink-Swell

The investigation indicated that beneath a limited thickness of made ground, the London Clay is present. The London Clay has been classified as being of high volume change potential, and is prone to seasonal shrink-swell (settlement and heave).

Shrinkable clay is present within a depth that can be affected by tree roots, and trees are known to be present to the north of the site. Desiccation was recorded during the investigation, and roots were observed in both boreholes, including Borehole No 2 drilled from the existing basement level, although the maximum depth to which the desiccation extends to has not been confirmed. In this respect, it is recommended that all foundation excavations are inspected by a suitably experienced engineer. Notwithstanding NHBC guidelines, all foundations should extend beyond the zone of desiccation

Differential founding depths / Neighbouring structures

The proposed basement extension is expected to extend to a maximum depth of approximately 2.80 m, such that ground movements as a result of the proposed excavations would be expected to reduce to zero at a distance of approximately 11.2 m, corresponding to four times the retained height, based on the CIRIA ground movement curve for an 'excavation in front of a stiff wall in stiff clay' (Fig 6.15a of CIRIA C760). As the adjoining 120, 116 & 114 Malden Road, as well as the rear extension of 131 Queens Crescent are within this zone, the stability of the structures has been considered as part of a ground movement analysis and building damage assessment reported in Part 3. The analysis found that movements are anticipated to be negligible (Category 0) to very slight (Category 1) and as such, the proposed basement construction and excavation are unlikely to impact the adjacent structures.

12.2 BIA Conclusions

A Basement Impact Assessment has been carried out following the information and guidance published by the London Borough of Camden.

It is concluded that the proposed development is unlikely to result in any specific land or slope stability issues.

12.3 Non-Technical Summary of Evidence

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

12.3.1 Screening

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

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

The following table provides the evidence used to answer the slope stability screening questions.

Question	Evidence
1. Does the existing site include slopes, natural or manmade, greater than 7°?	Topographical maps and Figures 16 and 17 of the Arup report and confirmed during a site walkover
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	The details of the proposed development provided do not include the re-profiling of the site to create new slopes
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	Topographical maps and Figures 16 and 17 of the Arup report
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	
5. Is the London Clay the shallowest strata at the site?	Geological maps and Figures 3, 5 and 8 of the Arup report
6. Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	The details of the proposed development.
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	Knowledge on the ground conditions of the area and reference to NHBC guidelines were used to make an assessment of this, in addition to a visual inspection of the buildings carried out during the site walkover.
8. Is the site within 100 m of a watercourse or potential spring line?	Topographical maps acquired as part of the desk study and Figures 11 and 12 of the Arup report
9. Is the site within an area of previously worked ground?	Geological maps and Figures 3, 5 and 8 of the Arup report
10. Is the site within an aquifer?	Aquifer designation maps acquired from the Environment Agency as part of the desk study and Figures 3, 5 and 8 of the Arup report.
11. Is the site within 50 m of Hampstead Heath ponds?	Topographical maps acquired as part of the desk study and Figures 12 and 14 of the Arup report
12. Is the site within 5 m of a highway or pedestrian right of way?	Site plans and the site walkover.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Camden planning portal and the site walkover confirmed the position of the proposed basement relative the neighbouring properties.

Question	Evidence
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	Maps and plans of infrastructure tunnels were reviewed.

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

Question	Evidence
1. Is the site within the catchment of the pond chains on Hampstead Heath?	Topographical maps acquired as part of the desk study and Figures 12 and 14 of the Arup report
2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route?	A site walkover confirmed the current site conditions and the details provided on the proposed development.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	
5. Will the proposed basement result in changes to the quantity of surface water being received by adjacent properties or downstream watercourses?	
6. Is the site in an area known to be at risk from surface water flooding such as South Hampstead, West Hampstead, Gospel Oak and Kings Cross, or is it at risk of flooding because the proposed basement is below the static water level of a nearby surface water feature?	Flood risk maps acquired from the Environment Agency as part of the desk study, Figure 15 of the Arup report, the Camden Flood Risk Management Strategy dated 2013 and the North London Strategic Flood Risk Assessment dated 2008, and reference to the site specific FRA.

13.3.2 Scoping and Site Investigation

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

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

12.3.3 Impact Assessment

Section 14.0 of this report summarises whether, on the basis of the findings of the investigation, the potential impacts still need to be given consideration and identifies ongoing risks that will require suitable engineering mitigation. Section 9.0 of this report also provides recommendations for the design of the proposed development.

A ground movement analysis and building damage assessment has been carried out and its findings are presented in Part 3.

13.0 Outstanding Risks & Issues

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

13.1 Site-Specific Risks

Monitoring of the standpipe should be continued to determine the groundwater equilibrium and to establish any seasonal fluctuations.

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

The ground movement analysis has concluded that the predicted damage to the neighbouring properties would generally be 'Negligible' to 'Very Slight'. On this basis, the damage that has been predicted to occur as a result of the construction of the proposed development falls within the limits acceptable to Campden.

The depth of desiccation and the need to protect against the effects of future tree growth are significant considerations. The depth of desiccation should be determined by additional ground investigation, which must be carried out under the supervision of a properly qualified geotechnical engineer. The depths of new foundations will need to be sufficient to protect against future tree growth.

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

13.2 General Risks

The ground is a heterogeneous natural material and variations will inevitably arise between the locations at which it is investigated. This report provides an assessment of the general ground conditions based on the discrete points at which the ground was sampled, but there may be ground conditions (including soil, rock, gas and groundwater) elsewhere on site that have not been revealed by this investigation and therefore could not have been taken into account in this report. The ground conditions should be subject to review as the development proceeds to ensure that any variations from the Ground Model are properly assessed by a suitably qualified person.

The comments made regarding gas and groundwater are based on observations made during the period the work has been carried out. Conditions may vary as a result of seasonal or other effects.

Where any conclusions and recommendations contained in this report have been based upon information provided by others, it has been assumed that all relevant information has been provided by those parties and that such information is accurate. Any such information has not been independently verified by GEA, unless otherwise stated in the report. GEA accepts no liability for any inaccurate conclusions, assumptions or actions taken resulting from any inaccurate information supplied to GEA from others.

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