12 Park Village West
London
NW1 4AE

Basement Impact Assessment

Private Client

March 2024

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Rev 0

Ground investigation | Geotechnical consultancy | Contaminated land assessment

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Executive summary

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

Brief

This report describes the findings of a site investigation carried out by Geotechnical and Environmental Associates Limited (GEA) on the instructions of Price & Myers, on behalf of a Private Client. with respect to the construction of a new basement beneath the existing Coach House on the western part of the site, which will be joined to the existing lower ground floor level of the main house by lower ground floor level link structures / extensions.

The ground investigation was carried out by GEA in 2014 (report ref J14300 - Report Issue 5, dated September 2019) for a previously consented scheme (2019/5121/P) and the information from this investigation has been used in preparation of this revised assessment.

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

The earliest map studied, dated 1873, shows the site to be occupied by the existing building, which was built around 1834-37 by the office of John Nash. The surrounding area had also been developed with residential buildings, with Regent's Park located approximately 120m to the west. A former branch of Regent's Canal was present on the eastern part of the site, with a railway line located 100 m to the east. Regent's Park Barracks (Cavalry) was located 100 m to the south. The next map, dated 1916, shows the site to have remained relatively unchanged apart from the expansion and widening of the railway and construction of associated carriage sheds. The barracks had also been redeveloped and three buildings had been removed to allow for the construction of four smaller buildings. During World War II the area surrounding the site was subject to bombing raids, particularly to the south, where the barracks would have been a target, leading to the destruction of St Catherine's Lodge which was located within Regent's Park, 200 m to the south-west of the site.

Reference to Bomb Sight maps has indicated that the barracks was also bombed during this time. The 1954 map shows that the aforementioned section of the Regent's Canal was no longer present at this time, and had been drained and filled, reportedly using rubble from buildings destroyed during WWII. Subsequent maps from the 1950s show this area to be covered by light woodland, before formerly becoming part of the existing garden between 1957 and 1962.

The site has remained essentially unchanged since that time.

Ground Conditions

Below a moderate thickness of made ground, the London Clay was encountered to the full depth investigated. The made ground comprised brown sandy silty clay with brick, coal, gravel and rootlets and extended to depths of between 0.3 and 1.5 m. The London Clay initially comprised firm brown slightly silty clay, underlain by stiff brown slightly silty clay which was proved to the maximum depth investigated of 5.0 m. The London Clay was found to be desiccated to a depth of approximately 3.5 m to 4.5 m within in a single location close to trees to the southeast of the existing house.

During drilling, water was struck at depths of 3.0 m and 1.2 m within Borehole Nos 1 and 3 respectively and also close to the base of the foundations in Trial Pit No 5 at a depth of 1.3 m. Subsequent monitoring measured water in the standpipes at depths of 0.60 m and 1.10 m.

Contamination testing has revealed elevated concentrations of lead within samples of made ground tested.

Recommendations

Excavations to lower the basement will require temporary support to maintain stability and prevent any excessive ground movements. The existing foundations will need to be underpinned prior to construction of the basement extension or will need to be supported by new retaining walls. On the basis of the groundwater observations recorded during the investigation, it should be possible to support the existing foundations through traditional underpinning techniques, although some limited groundwater control may be required to deal with perched water inflows.

Basement formation level is likely to be within the firm becoming stiff London Clay, which should provide an eminently suitable bearing stratum for spread foundations. The depth of the proposed excavations should be such that foundations will be placed below the depth of potential desiccation, but this should be checked once the proposals have been finalised.

As the development will result in the removal of any potentially contaminated soils, a requirement for remediation work is not envisaged. However, as with any development site, a watching brief should be maintained during the groundworks and a programme of safe working should be implemented to protect workers handling any soil.

Basement Impact Assessment

The BIA has not indicated any concerns with regard to the effects of the proposed basement on the site and surrounding area. It has been concluded that the impacts identified can be mitigated by appropriate design and standard construction practice. The ground movement analysis has indicated that the proposed excavations should not have a significant impact on neighbouring properties or the existing Grade II listed house.

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 Price & Myers, on behalf of a Private Client, to carry out a basement impact assessment (BIA) for the proposed development at 12 Park Village West, London NW1 4AE, within the London Borough of Camden.

The Basement Impact Assessment (BIA), has been carried out in accordance with guidelines from the London Borough of Camden ("Camden") in support of a planning application.

A ground investigation was carried out by GEA in 2014 (report ref J14300 - Report Issue 5, dated September 2019) for a previously consented scheme (2019/5121/P) and the information from this investigation has been used in preparation of this updated and revised assessment.

1.1 Proposed Development

The development proposals are understood to include the formation of a new basement beneath the Coach House on the western part of the site which, from the information provided, it is expected to be formed by traditional hit and miss underpinning, with excavations extending to a depth of about 4.5 m.

The development will also include a 2.5 m to 3.5 m deep link structure, connecting the new basement to the lower ground floor level of the main house.

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

1.2 Purpose of Work

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

- to check the history of the site with respect to previous contaminative uses;
- 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 updated 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 PA18161-00, 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:

- five drive-in window sampler boreholes, advanced to depths of between 2.80 m and 5.00 m;
- installation of two groundwater monitoring standpipes, to depths of 4.00 m and 5.00 m, and two subsequent groundwater monitoring visits;
- two window sampler boreholes, advanced to depths of 4.00 and 5.00 m, to provide additional coverage of the site;
- a total of seven hand-dug trial pits to provide information on the existing foundations and boundary wall conditions;
- testing of selected soil samples for contamination and geotechnical purposes;
- laboratory testing of root samples for identification purposes to aid in the determination of root zone and the likely impact of surrounding trees and plants; 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 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.

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 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.

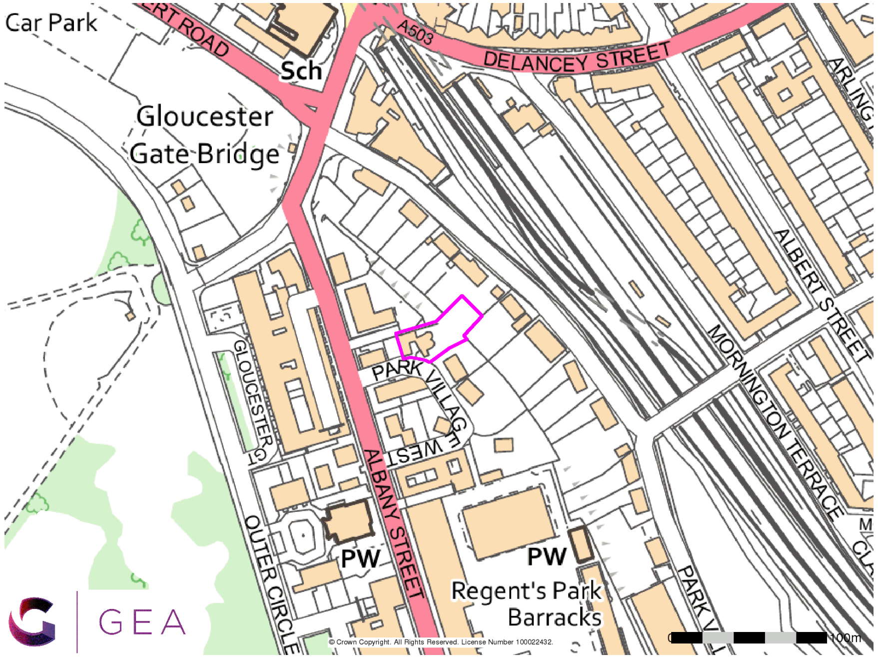
1 https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm
2 London Borough of Camden Planning Guidance CPG (January 2021) *Basements*
3 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London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

2.0 The Site

2.1 Site Description

The description of the site is based on observations made at the time of the field work in 2014 and the site has not been revisited as part of this additional work.

The site is located in a residential area in the London Borough of Camden, to the east of Regent's Park and approximately 300 m west of Mornington Crescent London Underground station. It fronts onto Park Village West to the south, is bounded to the west by gardens belonging to 14 Park Village West, to the east by gardens of houses fronting onto Park Village East and to the north by a car park for Pennythorpe House fronting onto Albany House. The site may be additionally located by National Grid Reference 528693, 183394 and is shown on the map extract below.



The site is irregular in shape, measuring approximately 55 m by 25 m in its maximum dimensions. The western part of the site is occupied by a Grade II Listed detached three-storey house, with a single-storey lower ground floor beneath the east of the building footprint. A coach house, adjoined to the main building by a corridor, is located in the western extent of the house and fronts onto Park Village West. A landscaped garden, extending over the eastern part of the site, is present at the rear of the house and is occupied by a number of mature trees and other vegetation around the patio area. Several semi-mature trees are also present around the front of the house.

The site surface steps down in a series of terraces to the east, to the level of the backfilled Regent's Canal, which previously crossed the eastern part of the site. The ground then steps up again from the old canal to the rearmost part of the garden, which is occupied by an existing terrace area, with flower beds and an existing storge building.

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 as part of the previous assessment.

Information available online[4] indicates that the building on the site was built around 1834-37 by the office of John Nash. The existing building is shown on the western part of the site on the 1873 historical town plan. The surrounding area had also been developed with residential buildings, with Regent's Park located approximately 120m to the west. A branch of the Regent's Canal, known as the 'Collateral Cut' was present on the far eastern part of the site, with a railway line located 100 m to the east of the site, running in a north-south orientation. Regent's Park Barracks (Cavalry) was located 100 m to the south.

The next map, dated 1916< shows the site to have remained relatively unchanged apart from the expansion and widening of the railway and construction of associated carriage sheds. The barracks had also been redeveloped and three buildings had been removed to allow for the construction of four smaller buildings.

During World War II the area surrounding the site was subject to bombing raids, particularly to the south, where the barracks would have been a target, leading to the destruction of St Catherine's Lodge which was located just within Regent's Park, 200 m to the south-west of the site. The barracks were also bombed during this time. However, the site is not shown

4 *https://victorianweb.org/art/architecture/nash/6.html*

as having suffered any damage.

The map and photographic records from this period also show that the Collateral Cut of the Regent's Canal had been drained and filled, reportedly using rubble from buildings destroyed during WWII. Subsequent maps from the 1950s show this area to be covered by light woodland, before formerly becoming part of the existing garden between the maps darted 1957 and 1962.

The site has remained essentially unchanged since that time.

2.3 Other Information

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

The search has revealed that there are no landfills, waste management, transfer, treatment or disposal sites within 500 m of the site.

The report does indicate the presence of potentially infilled land (water) across the eastern part of the site, which is understood to be associated with the backfilling of former canal that crossed this part of the site. The canal is understood to have been backfilled with building rubble and is not considered to represent a potential source of significant soil gas generation likely to have an adverse impact on the site, as any gas that may have been generated will have been free to escape directly upwards and disperse into the atmosphere, with any lateral migration restricted by the presence of the impermeable London Clay

There have been no pollution incidents to controlled waters within 250 m of the site, nor are there any other records of environmental controls or incidents that are likely to have an adverse impact on the site.

The site is not located within a nitrate vulnerable zone or any other sensitive land use. There are no contemporary trade directory entries within 150 m and no past or active fuel station entries within 250 m of the site.

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 300 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 will not be necessary.

2.4 Geology

The British Geological Survey (BGS) map of the area (Sheet 256) indicates that the site is underlain by London Clay, which according to the British Geological Society memoir, comprises a homogenous, slightly calcareous silty clay to very silty clay, with some beds of clayey silt grading to silty fine-grained sand. An investigation has previously been carried out by GEA roughly 25 m to the south of the site and encountered made ground, extending to depths of between 0.4 m and 0.9 m, over London Clay which was proved to the maximum depth investigated of 6.0 m. The made ground generally comprised dark brown silty sandy clay with brick, charcoal, gravel and occasional bone. The London Clay initially comprised firm brown fissured clay which became dark brown and stiff below depths of 2.7 m and 3.0 m. Selenite crystals and partings of orange-brown silt were encountered with depth.

A review of deep borehole records held on the British Geological Society (BGS) database has indicated that the London Clay is likely to extend to a depth of approximately 35 m to 40 m, below which the Lambeth Group, Thanet Sand and White Chalk are present.

Whilst Figure 17 of the Arup report does not show the site to be in an area of landslide potential, Figure No 16 indicates the presence of slopes with an angle greater than 7° to 10° on the eastern parts of the site and adjoining garden areas to the northeast and southeast, forming a linear feature along the line of the former canal. However, more recent topographical maps, including a site survey drawing, indicate that the majority of these gardens have been relandscaped and predominantly comprise a series of roughly level areas, each supported by gravity retaining walls, thus removing the majority of these previously mapped features. The proposed lower ground floor and basement structures also restricted to the western part of the site, which comprises a level area above and at sufficient distance from any remaining features to not present a potential risk of initiating any slope instability.

2.5 Hydrology and Hydrogeology

The London Clay is classified by the Environment Agency as unproductive strata, which refers to deposits that have low permeability and negligible significance for water supply or river base flow.

The site is not located within a designated Groundwater Source Protection Zones (SPZs) and there are no water abstraction points within 250 m of the site.

The nearest surface water feature is located 423 m to the northwest of the site, comprising part of the existing Regent's Canal. The site lies outside the catchment of the Hampstead Heath chain of ponds and there are no former rivers within 400 m.

Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1 x 10^{-10} m/s and 1 x 10^{-8} m/s, with an even lower vertical permeability. The London Clay cannot therefore support groundwater flow and as such does not support a "water table" or continuous piezometric surface. Boreholes constructed within clays do fill with water due to the predominantly high water content of shallow clays; however, this is not reflective of groundwater flow in a porous and permeable saturated stratum.

The site is not located in an area at risk of flooding from rivers or sea, as defined by the EA, nor is it identified as being within an area with a potential for groundwater flooding.

Park Village West is not listed within the London Borough of Camden report[5] as having suffered from surface water flooding in 1975 or 2002, nor is it shown on Figure 15 of the Arup report as being at potential risk from surface water flooding. However, the EA surface water flood maps and Figures 3i of the SFRA dated 2014 do indicate a low to high risk of surface water flooding, although this is restricted to the lower garden area on the eastern part of the site and does not impact on the western part of the site where the proposed lower ground floor extension and additional basement structure are to be constructed.

The western part of the site is almost entirely covered by the existing building and areas of external hardstanding, whilst the adjoining garden is underlain by the essentially impermeable London Clay. Infiltration of rainwater is therefore generally restricted to surface water drains, such that the majority of surface runoff is likely to drain into combined sewers in the road.

The proposed basement development is restricted to the western part of the site and is not understood to result in any change in the amount of hardstanding on this part of the site.

2.6 Preliminary UXO Risk Assessment

A Preliminary UXO Risk Assessment has been completed by 1st Line Defence (report ref PA18161-00, dated 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[6], 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 a very high bomb density, and bomb census mapping records a HE bomb strike on the south-eastern part of the site, with a large number of additional strikes in the surrounding area. Ordnance Survey mapping indicates that the plot of land to the southwest was subsequently cleared, with further area of clearance shown close by.

Based on the findings of the report, it was recommended that further research is undertaken in the form of a detailed UXO risk assessment to fully characterise the site and establish the requirement for any on-site mitigation during any future groundworks. In lieu of this assessment, UXO mitigation measures should be provided for any intrusive site works.

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.

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

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

2.7.1 Source

The desk study findings indicate that the western part of the site does not have a potentially contaminative history as it has been developed with a house for its entire developed history. The eastern part of the site may be underlain by part of an infilled canal. However, this area has been in use as a garden of over 50 years and will not affected / be affected by the proposed development.

As with any developed site, there is the potential for localised spillages and leakages, but this is not considered to represent a significant source of contamination.

No significant sources of soil gas likely to have an impact on the proposed development have been identified on site or in the surrounding area.

2.7.2 Receptor

The occupants of the proposed house will 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 any made ground, 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 proposed house and surrounding hard surfacing, thus no potential contaminant exposure pathways will exist with respect to end users. Only in areas of proposed soft landscaping will end users potentially come into contact with contaminants, although such pathways are already in existence.

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 there is not considered to be a potential for hazardous ground gases or vapours to be present on or migrating towards the site, there should be no need to consider ground gas exclusion systems, or ground gas monitoring at this site. In any case, due to the nature of construction, which will comprise reinforced concrete walls and floors, and statutory requirements with respect to ventilation and waterproofing, the proposed basement will have an inherent resistance against ground gas ingress[7], including radon, therefore mitigating any potential or residual risk.

7 Wilson S, Card, G, Mortimer S & Roberts J (2018). *Basement Waterproofing and Ground Gas.* Ground Gas Information Sheet No 4 (online). EPG and GB Card and Partners Ltd.

3.0 Screening

The Camden planning guidance suggests that any development proposals 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 12 Park Village West
1a. Is the site located directly above an aquifer?	No. The site is directly underlain by London Clay, which is classified as Unproductive Strata.
1b. Will the proposed basement extend beneath the water table surface?	Unlikely. The London Clay is classified as Unproductive Strata and cannot support a water table. However, if an upper weathered layer is present, this may have a higher permeability and could have the potential to collect groundwater if the stratum has a predominantly granular matrix, which is unlikely in this setting.
2. Is the site within 100 m of a watercourse, well (used/ disused) or potential spring line?	No. Topographical maps acquired as part of the desk study and Figures 11 and 12 of the Arup report confirm this.
3. Is the site within the catchment of the pond chains on Hampstead Heath?	No. As shown by Figure 14 of the Arup Report.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No. The proposed basement will areas of external hardstanding, such that there will not be a loss of any presently permeable area.
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. The site is underlain by clay soils which are unlikely to be suitable for soakaways or a similar SUDS based system. Site drainage will therefore be designed to maintain the existing situation with site drainage directed to public sewers.
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to or lower than, the mean water level in any local pond or spring line?	No.

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

Q1b. There is a possibility that the proposed excavations may encounter local and perched groundwater.

3.1.2 Stability Screening Assessment

Question	Response for 12 Park Village West
1. Does the existing site include slopes, natural or manmade, greater than 7°?	*Yes, the Slope Angle Map (Fig. 16) of the Arup report indicates that the eastern part of the site includes slopes associated with the former branch of the Regent's Canal, with angles of 7° to 10° and greater than 10° . However, the proposed basement development is restricted to the far western part of the site and is therefore at some considerable distance from these features, being separated from them by the footprint of the main house and is situated in a relatively level area this is not shown on Fig 16 as being an area with an slopes greater than 7.*
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No. The development of the site will not introduce any new slopes.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	*Yes, Fig. 16 of the Arup report. indicates that the neighbouring land to the east of the site includes slopes of 7° to 10° and greater than 10°, although these features are at some considerable distance from the proposed basement and Fig. 17 of the Arup report does not indicate that the site is in an area of landslide potential.*
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	No. Whilst the site surface to the east of the main house slopes down to the line of the backfilled section of Regent's Canal, and the ground surface then slopes up by a similar amount on the opposite side of the old canal, this is an isolated linear feature, such that the site is not considered to be in a sloping hillside setting
5. Is the London Clay the shallowest strata at the site?	*Yes. The site is directly underlain by London Clay.*
6. Will any trees be felled as part of the proposed development and / or are any works proposed within any tree protection zones where trees are to be retained?	No. There are no trees on the western part of the site that will need to be felled as part of the redevelopment of the site.
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	*Yes. The area is prone to these effects as a result of the presence of shrinkable clay soils. However, there is no evidence of any potential movement on the existing and / or surrounding structures.*
8. Is the site within 100 m of a watercourse or potential spring line?	No.

Question	Response for 12 Park Village West
9. Is the site within an area of previously worked ground?	No
10a. Is the site within an aquifer?	No. The site is directly underlain by London Clay, which is classified as Unproductive Strata.
10b. Will the proposed basement extend beneath the water table such that dewatering may be required during construction?	Unlikely. The London Clay is classified as Unproductive Strata and cannot support a water table. However, if an upper weathered layer is present, this may have a higher permeability and could have the potential to collect groundwater if the stratum has a predominantly granular matrix, which is unlikely in this setting.
11. Is the site within 50 m of Hampstead Heath ponds?	No. Figure 14 of the Arup report confirms that the site is not located within 50 m of the Hampstead Heath ponds.
12. Is the site within 5 m of a highway or pedestrian right of way?	*Yes. The western part of the site fronts onto Village Park West to the south.*
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	*Yes. Whilst the nearest properties are understood to be some distance from the site, the proposed basement excavation is likely to result in an increase in foundation depth with respect to the existing listed house.*
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No. An online search for London Underground Tunnels and railway tunnels did not indicate any in the proximity of the site. This is confirmed with reference to ARUPs Transport Infrastructure map, Figure 18. Thames Water has been contacted and their plans indicate that the site does not fall within the zone of influence of any deep sewers or nearby tunnels.

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

Q1 The site includes man-made slopes with an angle greater than 7°.
Q3 The development neighbours land with a slope greater than 7°.
Q5 The London Clay is the shallowest stratum.
Q7 The site is in an area that has the potential to be affected by seasonal shrink-swell.
Q10b There is a possibility that the proposed excavations may encounter local and perched groundwater.
Q12 The site is within 5 m of a public highway.
Q14 The proposed basement may increase the differential depth of foundations relative to existing listed house.

3.1.3 Surface Flow and Flooding Screening Assessment

Question	Response for 12 Park Village West
1. Is the site within the catchment of the pond chains on Hampstead Heath?	No. Figure 14 of Arup report confirms that the site is not located within this catchment area.
2. As part of the proposed site drainage, will surface water flows (e.g., volume of rainfall and peak run-off) be materially changed from the existing route?	No. Site drainage will continue to be directed to public sewer, as per the existing situation. There will not be an increase in impermeable area above the basement, so the surface water flow regime will be unchanged. The basement will be beneath the existing buildings and areas of external hardstanding and the 1 m distance between the roof of the basement and ground surface, as recommended by the Arup report and para 3.2 of the CPG (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. The proposed basement and lower ground floor extension extend below existing buildings or areas of external hardstanding, such that there will not be a loss of any presently permeable area.
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. Site drainage will continue to be directed to public sewer, as per the existing situation. There will not be an increase in impermeable area above the basement, so the surface water flow regime will be unchanged. The basement will be beneath the existing buildings and areas of external hardstanding and the 1 m distance between the roof of the basement and ground surface, as recommended by the Arup report and para 3.2 of the CPG (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 proposals will not 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 findings of this BIA together with the Camden Flood Risk Management Strategy dated 2013 and Figures 3ii, 4e, 5a and 5b of the SFRA dated 2014, in addition to the Environment Agency online flood maps show that the western part of the site, where the proposed basement structures are located, has a very low flooding risk from surface water, sewers, reservoirs (and other artificial sources), groundwater and fluvial/tidal watercourses. It is possible that the basement will be constructed within pockets of perched water and the recommendations outlined in the BIA with regard to waterproofing and tanking of the basement will reduce the risk to acceptable levels. In accordance with paragraph 5.11 of the CPG, a positive pumped device will be installed in the basement in order to further protect the site from sewer flooding.

The above assessment has not identified the any potential issues that need to be addressed.

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
There is a possibility that the proposed excavations may encounter local and perched groundwater.	It is possible that the proposed excavations could encounter local perched groundwater. Should this happen, the proposed structure is capable of diverting groundwater flow such that groundwater level is affected on both the up slope and down slope side of the sub-terranean structure. This in turn has the potential to affect the local hydrogeology and any adjacent structures.
The site includes a man-made slope with an angle in excess of 7°.	The presence of a slope may cause local instability within the site. However, the prosed excavations are remote from these features and so will have no effect on its stability.
The development neighbours land with a slope greater than 7°?	Slopes greater than 7° are present adjacent to the site. However, the proposed excavation is remote from these features and so will have no effect on its stability.
London Clay is the shallowest stratum at the site.	The London Clay is prone to seasonal shrink-swell (subsidence and heave).
The site is within an area likely to be affected by seasonal shrink-swell	If a new foundations are not dug to below the depth likely to be affected by tree roots this could lead to damaging differential movement between the subject site and adjoining properties.
The development is located within 5 m of the public highway	Should the design of retaining walls and foundations not take into account the presence of nearby infrastructure, it may lead to the structural damage of footways, highways and associated buried services.
The development may increase the differential depth of foundations relative to neighbouring properties.	Excavation of a sub-terranean structure may result in structural damage to neighbouring properties if there is a significant differential depth between adjacent foundations.

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

4.2 Exploratory Work

In view of the limited access and in order to meet the objectives described in Section 1.2 as far as possible within these access constraints, five window sampler boreholes were drilled in accessible locations across the site under the supervision of a geotechnical engineer from GEA. In addition, seven trial pits were manually excavated to depths of between 0.50 m and 1.80 m to investigate the foundations of the existing house and garden boundary wall.

Groundwater monitoring standpipes were installed in two boreholes to depths of between 4.00 m and 4.50 m and have been monitored on a two occasions to date, roughly three weeks and six weeks after installation.

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

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

4.3 Sampling Strategy

The scope of the works was specified by the previous consulting engineers, and focused on the western part of the site where the lower ground floor extension and basement structure are proposed, where access was available for the proposed investigation works.

Four 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 polycyclic aromatic hydrocarbons (PAH), banded total petroleum hydrocarbons (TPH), 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 ground investigation generally encountered the expected ground conditions, in that beneath a moderate thickness of made ground, London Clay was encountered to the full depth of the investigation.

5.1 Made Ground

The made ground generally comprised brown silty sandy clay with brick, coal, slate, and gravel which extended to depths of between 0.3 m and 1.7 m below ground level. Along the northern boundary wall, made ground was overlain by a layer of topsoil comprised of dark brown slightly clayey, slightly sandy silt with gravel and abundant vine roots.

Apart from the presence of fragments of extraneous material noted above, no visual or olfactory evidence of contamination was observed during the fieldwork. Four samples of the made ground have been sent for contamination testing as a precautionary measure and the results are presented in Section 5.4.

5.2 London Clay

The London Clay initially comprised firm becoming stiff brown or grey silty fissured clay with occasional selenite crystals, which extended to a depth of 5.00 m, the maximum depth investigated.

Borehole No 5, located to the southeast of the existing house and in close proximity to a number of trees, indicated that the London Clay was desiccated to a depth of approximately 3.5 m to 4.5 m. Laboratory plasticity index test results indicate the clay to be of high volume change potential.

No evidence of contamination was noted in these soils.

5.3 Groundwater

During drilling, perched water was encountered towards the base of the made ground at a depth of 1.2 m in Borehole No 3, and close to the base of the foundation in Trial Pit No 5 at a depth of 1.3 m. An isolated groundwater inflow was also recorded within the London Clay at a depth of 3.0 m in Borehole No 1 only, whereby the soils were observed as being 'wet', which due to the absence of any further instances of groundwater within this stratum confirms the absence of an extensive saturated groundwater level across the site and is taken to represent an isolated pocket of trapped water.

Two standpipes were installed, in Borehole Nos 1 and 5, and have been monitored on two occasions, roughly three weeks and six weeks after the fieldwork. The results of the monitoring visits are shown in the table below.

Borehole No	Standpipe depth (m)	Depth to groundwater (m)	
		10/04/2015	01/05/2015
1	4.50	Standpipe not accessible	1.10
5	4.00	0.60	0.60

The presence of water in each of these standpipes is considered to represent the ingress of surface water or perched water into the installations, which is then unable to drain away due to the low permeability of the surrounding soils, rather than being indicative of a general groundwater table.

5.4 Soil Contamination

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

Determinant	BH1 0.8 m	BH3 0.5 m	BH4 0.4 m	BH4 0.3 m
pH	8.1	9.4	7.6	9.2
Arsenic	17	21	12	13
Cadmium	0.18	0.10	0.11	0.20
Chromium	54	33	29	28
Lead	180	**460**	200	**2000**
Mercury	0.59	0.60	1.4	0.11
Selenium	0.32	<0.2	0.3	<0.2
Copper	52	34	47	29

Determinant	BH1 0.8 m	BH3 0.5 m	BH4 0.4 m	BH4 0.3 m
Nickel	42	29	27	28
Zinc	89	87	83	150
Total Cyanide	<0.5	<0.5	<0.5	<0.5
Total Phenols	0.3	0.3	0.3	0.3
Total PAH	<0.3	<0.3	<0.3	<0.3
Sulphide	1.7	1.4	1.1	0.71
Benzo(a)pyrene	<0.1	<0.1	<0.1	<0.1
Naphthalene	<0.1	<0.1	<0.1	<0.1
TPH	<10	<10	<10	<10
Total Organic Carbon %	1.5	1.2	3.6	0.84
Figure in bold indicates concentration in excess of risk-based soil guideline values, as discussed in Part 2 of this report				

5.5.1 Generic Quantitative Risk Assessment

The use of a risk-based approach has been adopted to provide an initial screening of the test results to assess the need for subsequent site-specific risk assessments. Contaminants of concern are those that have values in excess of generic human health risk-based guideline values, which are either the CLEA[8] Soil Guideline Values where available, the Suitable 4 Use Values[9] (S4UL) produced by LQM/CIEH calculated using the CLEA UK Version 1.07[10] software, or the DEFRA Category 4 Screening values[11], 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, albeit conservative given the actual nature of the development. The tables of generic screening values derived by GEA and an explanation of how each value has been derived are included in the Appendix.

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

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

The chemical analyses have revealed two elevated concentrations of lead within samples of made ground tested, which could thus pose a potentially unacceptable risk to human health through direct contact, accidental ingestion or inhalation of soil or soil derived dust. However, the samples were taken from areas located within the footprint of the proposed lower ground floor and basement excavations and will therefore be removed from site.

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

8 *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.
9 *The LQM/CIEH S4Uls for Human Health Risk Assessment* S4UL3065 November 2014
10 Contaminated Land Exposure Assessment (CL|EA) Software Version 1.071 Environment Agency 2015
11 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

5.6 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	Southern Wall of Coach House	One tier concrete corbel Top 0.85 m Base 1.10m. Lateral projection 100mm	MADE GROUND (brown silty clay with red brick, concrete, coal, gravel and rootlets)
2	Internal western wall of Coach House	One tier concrete corbel with sloped edge Top 0.68 m Base 1.15 m Lateral projection 220 mm	MADE GROUND (brown sandy slightly silty clay with brick, concrete, coal fragments, gravel and rootlets)
3	Chimney stack on western wall of Coach House	Brick wall to base Base 1.15 m Lateral projection 0 mm	MADE GROUND (red brick fill with silty slightly clayey matrix)
4	Northern wall of Coach House	Brick Wall Base 0.50 m Lateral projection 0 mm	MADE GROUND (brown sandy silt with brick, concrete and abundant rootlets)
5	Eastern wall of Coach House	One tier brick corbel Top 0.75 m Base 1.2 m Lateral projection 60 mm	MADE GROUND (brown slightly sandy clayey silt with brick, concrete, gravel and roots)
6	Northern wall of gym	One tier brick corbel Top 0.15 m Base 0.7 m Lateral projection 400 mm	MADE GROUND (brown sandy silt with brick, concrete and abundant rootlets)
7	Southern wall of main house	Two tier with additional step up Top 0.22 m Base 0.5 m Lateral projection 400 mm	MADE GROUND (slightly sandy silty clay with rootlets, brick and concrete fragments)

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 form a new basement structure beneath the Coach House on the far western part of the site, with a new 2.5 m to 3.5 m deep link structure to the existing lower ground floor level of the main house.

The basement structure is proposed to be formed by traditional hit and miss underpinning, with excavations extending to a depth of about 4.5 m below the Coach House. Anticipated line loads to be applied at basement level by the new structure are expected to be in the region of 190 kN/m, with line loads in the order of 75 kN/m for the new link structure.

The desk study revealed that the site has not had a potentially contaminative history, having had a residential end use, and on the basis of the fieldwork, the ground conditions can be characterised as follows:

- beneath a moderate thickness of made ground, London Clay was encountered and proved to the full depth of the investigation;
- the made ground generally comprises brown silty sandy clay with brick, coal, slate, and gravel which extended to depths of between 0.30 m and 1.7 m;
- below this depth, London Clay was encountered comprising firm becoming stiff fissured brown or grey silty clay with occasional selenite and encountered and proved to the maximum depth investigated of 5.00 m;
- desiccation was encountered within Borehole No 5, to the southeast of the existing house, and extends to a depth of about 3.50 m to 4.50 m;
- perched groundwater was encountered at the base of Trial Pit No 5;
- during drilling, water was struck at depths of 3.00 m and 1.2 m;
- subsequent monitoring on two occasions has measured water within the standpipes at depths of 0.60 m and 1.10 m; and
- contamination testing has revealed elevated concentrations of lead in two samples of the made ground tested.

6.1 Recommended Parameters

The table below summarises the vertical soil parameters to be used in any subsequent analysis and is based on the findings of the investigation. Values of stiffness for the soils at this site are readily available from published data[12, 13, 14 & 15] and a well-established method has been used to provide the estimated values.

Stratum	Base of Stratum (m)	Bulk Unit Weight (kN/m^3)	Effective Friction Angle (ϕ' °)	Undrained Cohesion (C_u - kN/m^2)	Undrained Young's Modulus* (E' - kN/m^2)	Drained Young's Modulus* (E_u - kN/m^2)
Made Ground	1.0 (varies)	17.0	27	25	12,500	7,500
London Clay	5.0$^+$	19.0	23	50 to 90	25,000 to 45,000	15,000 to 27,000
	>5.0**			90 +7.5	45,000 + 3750	27,000 + 2250

$^+$Maximum depth of investigation. *Values based on the highly conservative relationship of E_u = 500 C_u and E' = 300 C_u for the London Clay. **An increase in cohesion of 7.5 kN/m^2 per metre increase in depth has been adopted to provide a conservative estimate of the likely strength profile below the depth of the investigation.

The values in the above table are unfactored and are considered to be moderately conservative 'characteristic' parameters suitable for routine calculations that require cautions, or lower bound, estimates of strength and stiffness, such as those required for piled foundation and embedded retaining wall design. The designer may therefore need to consider alternative characteristic values where an upper bound estimate is considered more appropriate, such as in the evaluation of structural forces within the proposed structures.

12 Padfield CJ and Sharrock MJ (1983) *Settlement of structures on clay soils*. CIRIA Special Publication 27
13 Butler FG (1974) *Heavily over-consolidated clays: a state-of-the-art review.* Proc Conf Settlement of Structures, Cambridge, 531-578, Pentech Press, Lond.
14 O'Brien AS and Sharp P (2001) *Settlement and heave of over-consolidated clays - a simplified non-linear method.* Part Two, Ground Engineering, Nov 2001, 48-53
15 Burland JB, Standing, JR, and Jardine, FM (2001) *Building response to tunnelling, case studies from construction of the Jubilee Line Extension.* CIRIA Special Publication 200

7.0 Advice & Recommendations

Excavations for the proposed basement and lower ground floor link structures will require temporary support to maintain stability of the excavation and surrounding structures at all times. The existing foundations will need to be underpinned prior to construction of the proposed new basement or will need to be supported by new retaining walls.

Formation level for the new structure will be within the London Clay, which should provide an eminently suitable bearing stratum for spread foundations excavated from proposed ground floor level.

Some form of groundwater control is likely to be required to deal with any inflows of perched groundwater within the made ground, or from any siltier horizons within the London Clay.

7.1 Basement Construction

Is understood that the proposed basement will extend to a depth of about 4.5 m , with the upper and lower level link structures extending to depths of between 2.5 m and 3.5 m, respectively; formation level is therefore expected to be within the stiff clay of the London Clay.

Perched water was encountered at the base of some of the foundations during excavation of trial pits and water was encountered during drilling at depths of 3.0 m and 1.2 m within Borehole Nos 1 and 3, respectively. Subsequent monitoring to date has measured water in the standpipes at depths of 0.60 m and 1.10 m although this may reflect inflows of perched groundwater from within the made ground. Monitoring of the standpipes should be continued to establish equilibrium levels and the extent of any seasonal fluctuations. It would also be prudent to carry out a number of trial excavations, to depths as close to the full basement depth as possible, to determine the extent to which the excavation will be affected by groundwater, although this may not be possible due to the access restrictions.

Groundwater may be present within the weathered London Clay as discrete pockets of water rather than in continuous layers from silt and sand partings. Each individual pocket may therefore be of relatively low volume and individual inflows may cease once the pocket is emptied. On this basis inflows should not be significant and could be adequately dealt with through sump pumping. However, as the basement excavation will cover a much larger area than that covered by the investigation, it is possible that larger pockets or inter-connected layers of groundwater could be encountered. It would therefore 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. It is likely that the rate of inflow will be relatively slow from the London Clay.

In any case, inflows could conceivably occur from perched water tables, particularly in the vicinity of existing foundations but should be adequately dealt with through sump pumping.

There are a number of methods by which the sides of the basement excavation could be supported in the temporary and permanent conditions. The choice of wall may be governed to a large extent by the requirement to prevent ground water inflows and whether it is to be incorporated into the permanent works and have a load bearing function. Consideration will also need to be given to the support of the adjacent buildings and structures on all sides.

The basement will be constructed beneath the existing coach house which is to be retained and it should therefore be possible to form the retaining walls by underpinning of the existing foundations, using a traditional 'hit and miss' approach. Careful workmanship will be required to ensure that movement of the surrounding structures does not arise during underpinning of the existing foundations, but this method will have the benefit of minimising the plant required and maximising usable space in the new basement. The contractor should however have a contingency in place to deal with any groundwater inflows that may be more significant than has been indicated by the results of this investigation.

Alternatively, consideration could also be given to piled retaining walls and it should be possible to utilise contiguous bored piles without the requirement for significant groundwater control, with grouting between the piles if necessary. A contiguous bored piled wall would have the disadvantage of reducing usable space in the basement, and in this respect a secant wall may be preferable as it would overcome the requirement for any secondary groundwater protection in the permanent works and maximise the basement area.

The ground movements associated with the basement excavation will depend on the method of excavation and support and the overall stiffness of the basement structure in the temporary condition. Thus, a suitable amount of propping will be required to provide the necessary rigidity. In this respect the timing of the provision of support to the wall will have an important effect on movements. The stability of the adjacent foundations will need to be ensured at all times and the existing foundations will need to be underpinned prior to construction of the proposed new basements or will need to be supported by new retaining walls. A Ground Movement Analysis has been carried out in accordance with the requirements of CPG and is presented 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/m³)	Effective Cohesion (c′ – kN/m²)	Effective Friction Angle (ϕ′ – degrees)
Made ground	1750	Zero	27
London Clay	1950	Zero	23

Groundwater was encountered at the base of an existing footing and during drilling and is thought to represent water from perched water tables, although further monitoring should be carried out in order to establish a design water level. Groundwater is unlikely to be encountered within the basement excavations during construction, although monitoring of should be continued in order to establish equilibrium levels.

Provided that a fully effective drainage system can be ensured in order to prevent the build-up of groundwater behind the retaining walls from surface water inflows and periodic seepages within the made ground, 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 1.0 m, should be assumed. The advice in BS8102:2009[16] should be followed in this respect and with regard to the provision of suitable waterproofing.

7.1.2 Excavation Heave

The excavation of 2.5 m to 4.5 m of soil to form the new basement structure will result in a net unloading of between 45 kN/m² and 85 kN/m², 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

On the basis that all foundations bypass any made ground then moderate width pad or strip foundations, bearing beneath proposed lower ground floor or basement level within the stiff clay of the London Clay may be designed to apply a net allowable bearing pressure of 150 kN/m². This value provides an adequate factor of safety against bearing capacity failure and should ensure that settlement remains within normal tolerable limits. The recommended bearing pressure takes account of the variable nature of the soils.

The depth of the proposed lower ground floor or basement excavations 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. Notwithstanding NHBC guidelines, all foundations should extend beyond the zone of desiccation, and it should be noted that desiccation was recorded in Borehole No 5 to a depth of about 3.5 m to 4.5 m, although this borehole was located to the southeast of the existing house, and therefore remote from the proposed excavations. It would be prudent to have all foundation excavations inspected by a suitably experienced engineer and 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.

If for any reason spread foundations are not considered appropriate, piled foundations would provide a suitable alternative although additional investigation will be required to provide pile design parameters.

7.3 Shallow Excavations

On the basis of the borehole and trial pit 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 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

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

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 Slabs

Following excavation to proposed formation level, it is likely that the basement floor slab will need to be suspended over a void or a layer of compressible material to accommodate the anticipated heave, unless the slab can be suitably reinforced to cope with these movements.

Further information on the likely movements that her lower ground floor slab will need to be designed to accommodate is provided in the ground movement assessment in Part 3.

7.5 Effect of Sulphates

Chemical analyses have revealed moderate concentrations of soluble sulphate and near-neutral pH in accordance with Class DS-3 conditions of Table C2 of BRE Special Digest 1:SD Third Edition (2005). The measured pH values of the samples show that an ACEC class of AC-2s would be appropriate for the site. This assumes a static water condition at the site. The guidelines contained in the digest should be followed in the design of foundation concrete.

7.6 Contamination Risk Assessment

The desk study findings indicate that the site does not have a potentially contaminative history. However, the results of the contamination testing have identified elevated concentrations of lead within three samples of the made ground tested.

The exact source of the lead contamination is unknown. However, the made ground was noted as containing variable amounts of extraneous material, and it is therefore likely that a fragment of such material was present within the samples tested, accounting for the elevated concentration. Information on Urban Soil Chemistry provided by the BGS also indicates that background concentrations for lead in the vicinity of the site are likely to be between 300 mg/kg and 900 mg/kg, such that a significant proportion of the measured concentrations are likely to be the result of residual airborne sources, rather than being specific to the site.

Lead compounds are relatively immobile and 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. In addition, as it is proposed to excavate a lower ground floor extension and basement beneath a large part of the site, the majority of the made ground encountered during the investigation, including those area where elevated concentrations of lead were encountered, will be removed from site.

A risk to end users is not therefore envisaged. However, the contamination will pose a risk to site workers during the ground works and protective measure should be employed as detailed below.

7.6.1 Site Workers

Apart from the physical hazards represented by the fill materials, concentrations of potentially carcinogenic lead have been measured in the shallow soils in the southwest of the site. 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[17] and CIRIA[18] and the requirements of the Local Authority Environmental Health Officer.

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

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

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

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[19] 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[20] 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 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.

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 non-hazardous (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 in order to reduce its volume, hazardous nature, facilitate handling or enhance recovery. The waste producer can carry out the treatment, but they will need to provide documentation to prove that this has been carried out. Alternatively, the treatment can be carried out by an approved contractor. The Environment Agency has issued a position paper[21] 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 in-situ 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.

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

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

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

Part 3: Ground Movement Analysis

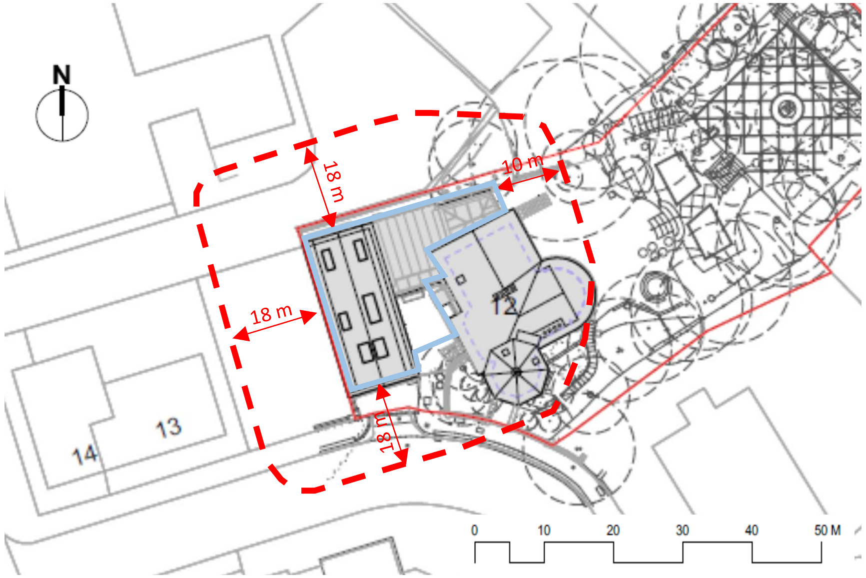
This section of the report comprises an analysis of the ground movements arising from the proposed basement and foundation scheme discussed in Part 2 and the information obtained from the investigation, presented in Part 1 of the report.

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 during underpinning 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



As shown on the plan opposite, the new basement is located at some distance from any nearby structures, with the nearest building being in excess of 20 m from the site boundary, and therefore outside the likely zone of influence of the proposed excavations of approximately 10 m to 18 m, based on four times the retained height of 2.5 m to 4.5 m, for the shallowest and deepest parts of the proposed excavations for the lower ground floor extension and basement below the existing Coach House, respectively.

As per the previous assessment, it is not considered that there are any neighbouring structures that require further assessment. However, the proposed excavations have the potential to impact upon the existing Grade-II listed house and the adjoining roadway to the south.

8.2 Construction Sequence

From the information provided, it is understood that the new basement and upper and lower level link structures will extend to depths of between 2.5 m and 4.5 m below existing ground level and are expected to be formed through underpinning of the existing foundations and boundary walls.

Anticipated line loads to be applied at basement level by the new structure are expected to be in the region of 190 kN/m, with line loads in the order of 75 kN/m for the new link structure.

The following sequence of operations has been derived to enable analysis of the ground movements around the basement, both during and after construction, and is based on the proposed construction sequence drawings provided by the consulting engineer, copies of which are included in the appendix.

Essentially the sequence may be considered as two groups of activities, the first comprising the short-term temporary works, whilst the second represents the construction of the permanent works.

The detail of the support provided to adjacent walls is beyond the scope of this report and the structural engineer will be best placed to agree the methodology with the chosen contractor(s) once appointed.

8.2.1 Temporary Support to Underpinned Walls

It is understood that underpinning 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 is to be undertaken in short sections not exceeding 1.0 m to 1.2 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 underpins will be adequately laterally propped and sufficiently dowelled together, and the concrete will be cast and adequately cured prior to excavation of the basement 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.

8.2.2 Bulk Excavation

Excavation will proceed in stages and in broad terms the order of operations will be install capping beam props, excavate to a suitable depth below the next propping level, install props and then repeat the operation until the final excavation level has been reached.

8.2.3 Permanent Works

When the final excavation depths have been reached the permanent works will be formed which, from the information provided, are understood to comprise reinforced concrete walls with a drained cavity discharging to a sump pit. Reinforced concrete will be used for the basement floor slab.

It is anticipated that the floor slabs, which will act as permanent props, will be constructed lowest level first and when each floor has achieved adequate strength, the temporary props will be removed, and the subsequent walls and floors cast until the structure is complete.

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).

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

The footprint of the proposed basement below the existing Coach House has been modelled as a rectangle with dimensions of about 6.5 m by 15.0 m, with an approximate formation level approximately 4.5 m below existing ground level. The adjoining link structures / lower ground floor extensions have been modelled as polygons, with dimension of about 4.0 m by 6.5 m and 7.5 m by 11.0 m, respectively, and excavation depths of between 3.5 m to 2.5 m; although, it is noted that the depth of the excavations for the upper part of the proposed link structure / lower ground floor extension will in realty reduce in an easterly direction due to the reduction the level of the site on the eastern side of the existing property, where the existing lower ground floor is directly accessible from the adjoining garden terrace. The analysis therefore becomes progressively more conservative from west to east across the footprint of this part of the proposed structure.

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.

Selected inputs of all the analyses, along with movement contour plots and tabular outputs are included within the appendix.

9.1 Ground Movements – Surrounding the Excavation(s)

9.1.1 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[22], which were derived from a number of historic case studies.

Installation of Piled Retaining Walls: On this site it is assumed that the mass concrete underpinning will be supported or propped in the temporary condition to maintain stability during the excavation and that reinforced concrete retaining walls will be cast at a later stage in the appropriate areas.

Whilst it might appear reasonable to adopt the ground movement curves for 'no horizontal and vertical movement' for this analysis, in practice there will always be a potential for some movement to take place and the installation curves for the panel-like planar diaphragm wall have therefore been adopted as most appropriate for the soil movement relationship for walls installed by underpinning techniques.

In order to fully assess the proposed underpinning, the vertical movements obtained from the corresponding P-Disp analysis of the installation phase of structures has also been imported into X-Disp to account for any additional vertical movements likely to result from this construction technique.

Excavation Phase: Published data for ground movements associated with underpinned retaining walls and the subsequent excavation of a new basement is limited compared to other types of retaining wall, although it is possible to use the well-documented predictions and movement curves for embedded retaining walls contained within CIRIA C760.

It is generally accepted that horizontal movements from underpinning would be expected to be in the order of 5 mm for a single stage underpin with a retained height of about 3.0 m, equivalent to a normalised relationship of 0.15%, with movement that diminishes with distance from the wall according to the trend line set by a wall within clay (see Fig 6.15a of CIRIA C760). As movements are intrinsically linked to retained height, it therefore follows that there would be a corresponding increase or decrease in movements, reflecting any changes in the height of the proposed underpinning, i.e., underpins of less than 3.0 m would experience proportionally less movement, whilst underpinning in excess of 3.0 m would be expected to experience movement in excess of 5 mm.

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

The ground movement curves for 'excavations in front of a stiff wall in stiff clay' have therefore been adopted for the subsequent excavation phase, which when combined with the previous curves from the installation curves, gives an overall normalised relationship of 0.20% for horizontal movements and a slightly lower relationship of 0.125% on the vertical movements, which is in keeping with the observed difference in vertical and horizontal movements resulting from lateral deflection. However, the vertical movements obtained from the corresponding P-Disp analysis have also been imported into the corresponding X-Disp model to account for any additional vertical movement on the proposed underpinning.

9.1.2 Results

The range of movements predicted by X-Disp are summarised in the table below, with the full pattern of movements presented in the contour plot extracts included in the appendix.

Phase of Works	Maximum Movements due to Wall Deflection (mm)	
	Vertical Settlement	Horizontal Movement
Installation of proposed underpinning	3 to 8	1 to 3
Combined movements from installation and subsequent excavation behind underpinned walls	5 to 10	6 to 12

The analysis has indicated that the maximum vertical and horizontal settlements that will result from the combined wall installation and excavation phases are likely to range between 5 mm to 10 mm of vertical settlement and 6 mm to 12 mm of horizontal movement.

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

9.2 Ground Movements – Within the Excavation(s)

9.2.1 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[23] and a well-established method has been used to provide estimated values. For this preliminary analysis a highly conservative relationships of E_u = 500 C_u and E' = 300 C_u for the cohesive soils have been used to obtain values of Young's modulus.

The excavation of soil to form the proposed new basement and adjoining link structures, will result in a net unloading of between 45 kN/m^2 and 85 kN/m^2, which will result in heave of the underlying clay soils.

The soil parameters used in this analysis are tabulated in Section 6.1. However, the stiffness values are repeated in the table below for ease of reference.

Stratum	Base of Stratum (m)	Eu (kN/m^2)	E' (kN/m^2)
Made Ground	1.0 (varies)	12,500	7500
London Clay	5.0	25,000 to 45,000	15,000 to 27,000 to
	35.0	45,000 to 157,500	27,000 to 94,500

A rigid boundary for the analysis has been set at the base of the London Clay at a depth of 35 m, with the underlaying soils of the Lambeth Group and Thanet Sand considered as being essentially incompressible.

Information provided by the consulting engineer indicates that loads on the proposed underpinning is likely to vary from 190 kN/m to 75 kN/m, which is expected to result in bearing pressures of between 150 kN/m^2 to 75 kN/m^2 based on the anticipated size of the underpinned foundations. An assessment of the potential behaviour of these foundations has been included within the analysis.

9.2.2 Results

The P-Disp analysis indicates that in the short term, between 3 mm to 6 mm of heave can be expected across the proposed basement and lower ground floor excavations, whilst initial movements of between 2.0 m to 5.0 mm are expected on the proposed underpinning, reducing to 1.0 mm to 3.0 mm due to some short-term recovery following the completion of the excavation stage.

In the long term, a further 4 mm to 8 mm of heave is estimated in the centre of the proposed basement and lower ground floor excavations, as a result of long-term unloading of the underlying clay soils, with a further 1 mm to 3 mm of settlement on the proposed underpinning.

The results are summarised in the table below with the full pattern of movements presented in the contour plot extracts included in the appendix.

Location	Short-term Movements*		Total Movements*
	Underpinning	Underpinning & Excavation	
Centre of proposed Excavations	1.0 to 2.0	-3.0 to -6.0	-7.0 to -14
Edge of proposed Excavations / Underpinning	2.0 to 5.0	1.0 to 3.0	2.0 to 6.0

*Negative values indicate heave and positive indicates settlement

If a compressible material is used beneath the slab, it will need to be designed to be able to resist the potential uplift forces generated by the ground movements. In this respect, potential heave pressures are typically taken to equate to around 40% of the total unloading pressure.

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

10.0 Damage Assessment

In addition to the above assessment of the likely movements that will result from the proposed development, any buildings or structures 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[24].

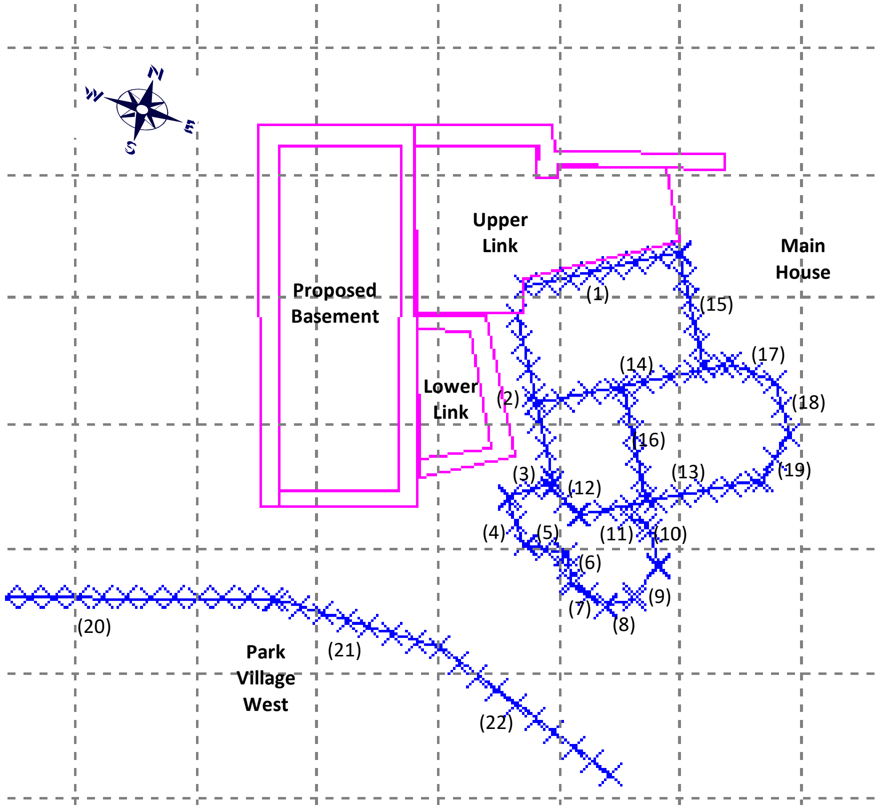
In this respect, the nearby buildings or structures included in this assessment are as follows, with all other structure at sufficient distance as not to be affected by the proposed development, as outlined in Section 8.1;

- The existing Grade II listed house, located immediately to the east of the proposed basement and lower ground floor link structures; and
- the existing public roadway to the south.

The sensitive structures outlined above have been modelled as lines in the analysis and are the lines along which the damage assessment has been undertaken. For clarity, these critical lines and the specific reference numbers used in the assessment are shown on the plan opposite.

The critical lines are expected to be sensitive at their foundation level, which, based on the trial pit findings, have been assumed to be at a depth of no more than 0.5 m below existing lower ground floor level, and therefore at a depth of approximately 2.5 m below ground level.

Building heights have been derived from the number of storeys, as observed during the site walkover and from information obtained by Price & Myers.



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

10.1 Damage to Neighbouring Structures

The combined ground movements resulting from the underpinning and excavation phases calculated using X-Disp and P-Disp modelling software have been used to carry out an assessment of the likely damage to adjacent properties and the results are discussed below.

Structure	Elevation	Max tensile strain %	Category*
12 Park Village West (Grade II listed property)	1	0.06	Very Slight (1)
	2	0.04	Negligible (0)
	3	0.01	Negligible (0)
	4	0.06	Very Slight (1)
	5	0.04	Negligible (0)
	6	0.02	Negligible (0)
	7	0.01	Negligible (0)
	8	<0.01	Negligible (0)
	9	<0.01	Negligible (0)
	10	<0.01	Negligible (0)
	11	0.01	Negligible (0)
	12	0.07	Very Slight (1)
	13	0.02	Negligible (0)
	14	0.04	Negligible (0)
	15	0.03	Negligible (0)
	16	0.01	Negligible (0)
	17	<0.01	Negligible (0)
	18	<0.01	Negligible (0)
	19	0.02	Negligible (0)

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

Structure	Elevation	Max tensile strain %	Category*
Park Village West (roadway)	20	0.01	Negligible (0)
	21	0.03	Negligible (0)
	22	0.03	Negligible (0)

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

The building damage reports for sensitive structures highlighted in the above table predict that the damage to the adjoining and nearby structures would generally be Category 0 (negligible), with some limited areas of Category 1 (very slight) damage to the nearby elevations of the existing house.

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.

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 existing Grade II listed property from the construction of the proposed basements would be 'Negligible', with some limited areas of 'Very Slight' damage.

On this basis, the damage that has been predicted to occur as a result of the construction the proposed basement 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.

In practice, underpinning of the existing foundations and the subsequent excavation of the proposed basement, will be staged processes and will take place over a number of weeks. This will provide an opportunity for the ground movements during and immediately after the 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.

Whilst it is recommended that movement monitoring is carried out on all structures prior to and during the proposed excavation and construction, it is unlikely that specification of these works will be required as part of the planning conditions but may be required in order to satisfy party wall awards.

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
There is a possibility that the proposed excavations may encounter local and perched groundwater.	Perched water was encountered within the made ground and underlying London Clay in a number of isolated location during the fieldwork and has subsequently been monitored at depths of between 0.6 m and 1.1 m. As such, it is considered that the basement structure will not impact local groundwater levels or flow and as such will not have an impact on the wider hydrogeological setting.
The site includes man-made slopes with an angle in excess of 7°.	The slopes on the eastern part of the site were created historically by cutting into the natural soils and have subsequently been re-landscaped and sub-divided with supporting retaining walls to form the existing garden layout. There is no sign of movement, and the area of the proposed basement excavation is above this area and at a distance that they will not affect the stability of any remaining slopes.
The development neighbours land with a slope greater than 7°?	Slopes greater than 7° are present adjacent to the site. However, the proposed basement is remote from these features and so will have no effect their stability.
The London Clay is the shallowest strata at the site and as such may be subject to seasonal shrink-swell	The London Clay is prone to seasonal shrink-swell and desiccation was noted within Borehole No 5 during the fieldwork. However, this was not located near the area of the lower ground floor extension and proposed basement. Desiccation may be present within close proximity to existing trees elsewhere on site, although the proposed excavations would be expected to bypass any desiccated soils present but this should be subject to inspection on site. In any case, new foundations will need to be designed in accordance with NHBC guidelines to protect from future shrinking and swelling associated with tree removal / growth
The development is located within 5 m of the public highway	The investigation has not indicated any specific problems, such as weak or unstable ground, voids or a high-water table that would make working within 5 m of public infrastructure particularly problematic at this site. Furthermore, the closest part of the proposed basement is set back from the road and adjoining footpath.
The development is likely to increase the differential depth of foundations relative to neighbouring properties.	An assessment of ground movements has been carried out to determine the potential for damage to adjacent properties and indicates that any building damage is likely to be Category 0 (Negligible) to Category 1 (Very Slight).

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 proposed basement may encounter local perched water.

The London Clay was encountered directly beneath the made ground and a continuous groundwater table is not therefore expected to be present within these clayey sediments. As such, groundwater flows are unlikely to be encountered and will not be materially altered by the presence of the proposed lower ground floor and basement structures, such that the local hydrogeological setting will not be impacted.

The investigation did confirm the presence of localised occurrences of perched water within the near surface deposits and protection measures may therefore be required as part of the proposed construction sequence. However, such inflows should be minor in nature and it is anticipated that a provision for sump pumping will be adequate with respect to this development, although it would be prudent, as with any site, for the chosen contractor to have a contingency plan in place to deal with any short or long-term inflows, that are more significant than expected.

The site includes slopes greater than 7° and neighbours land with slopes greater than 7°.

The existing house and adjoining Coach House are located on the western part of the site, at the top of the slope where the ground is sensibly level. Historic slopes were present on the eastern part of the site, with further slope in the adjoining sites, forming part of a liner feature associated with the former canal. Whilst some of these slopes remain, the majority have been reduced through historic re-landscaping and / or are supported by existing retaining structures, such as those present on the eastern part of the site.

The proposed basement will be excavated from this level at some distance from any remaining slope features on the site or on neighbouring land and will therefore not have any detrimental effect on the stability of these slopes.

London Clay is the shallowest Stratum / Seasonal Shrink-Swell.

Desiccation of the shallow soils was not encountered within close vicinity of the proposed lower ground floor and basement excavations, which are in any case, expected to extend to a depth such that new foundations will bypass any desiccated soils and found below the required founding depths in accordance with National House Building Council (NHBC) requirements.

Subject to inspection of foundation excavations in the normal way to ensure that there is not any unexpectedly deep root growth, it is not considered that the occurrence of shrink-swell issues in the local area will have any bearing on the proposed development.

Location of public highway

Whilst the closest part of the proposed basement is set back from the entrance to the site, it is within 5 m of the public highway of Village Park West. However, there is nothing unusual or exceptional in the proposed development or the findings of the investigation that give rise to any concerns with regard to stability over and above any development of this nature.

Provided that the design of the retaining walls takes into account any loading from the adjacent highway and the construction work is carried out in accordance with best practice, it is unlikely to result in any adverse impact , which has been confirmed by the ground movement assessment in Part 3.

Increase in the differential depth of neighbouring foundations

The stability of neighbouring properties and structures will be ensured at all times, through a suitable retention system. There is nothing unusual or exceptional in the proposed development or the findings of the investigation that give rise to any concerns with regard to stability over and above any development of this nature.

An analysis of the potential ground movements resulting from construction of the proposed basement is included in Part 3 of this report and has concluded that the predicted damage to the neighbouring properties would be Category 0 (Negligible) to Category 1 (Very Slight).

On this basis, the damage that would inevitably occur as a result of such an excavation would fall well within the acceptable limits although monitoring and mitigation measures will be required to ensure that no excessive movements occur that would lead to damage in excess of these limits.

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°?	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°?	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?	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?	Figures 12 and 14 of the Arup report
12. Is the site within 5 m of a highway or pedestrian right of way?	Site plans and the site walkover.
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Camden planning portal and the site walkover confirmed the position of the proposed basement relative the neighbouring properties.
14. Is the site over (or within the exclusion zone of) any tunnels, e.g., railway lines?	Maps and plans of infrastructure tunnels were reviewed.

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

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

12.3.2 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 13.0 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.

8.1 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 ground conditions based on the discrete points at which the ground was sampled, but the ground conditions should be subject to review as the work proceeds to ensure that any variations from the Ground Model are properly assessed by a suitably qualified person.

The comments made regarding 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.

8.2 Site-Specific Risks

As discussed throughout the report, groundwater is unlikely to be encountered during the proposed excavations, although, groundwater monitoring should be continued, and trial excavations should be considered to assess the extent of any perched water inflows to be expected within the proposed excavations.

The investigation has not identified the presence of any significant contamination. However, as with any site there is a potential for further areas of contamination to be present within the made ground beneath parts of the site not covered by the investigation it is recommended that a watching brief is maintained during any groundworks for the proposed new foundations and basement excavation and if any suspicious soils are encountered that they are inspected by a geo-environmental engineer and further assessment may be required.

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 findings of the ground movement analysis and damage assessment should be reviewed once the design proposals have been finalised, particularly if any changes are made to the proposed basement construction.

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.

Appendix

a. Desk Study

Existing & Proposed Site Plans
Envirocheck Extracts
Historical Maps
UXO Preliminary Risk Assessment
Service Searches

b. Field Work

Site Plan
Borehole Records
Trial Pit Records

c. Lab Testing

Geotechnical Test Results
Chemical Test Results
Generic Risk Based Screening Values

d. Ground Movement Analysis

PDisp Analysis – Short-term Movements (Input data & outputs)
PDisp Analysis – Total Movements (Input data & outputs)
XDisp Analysis – Installation Movements (Input Data & outputs)
XDisp Analysis – Combined Movements – Short-term & Total (Input Data & outputs)
XDisp Analysis – Building Damage Assessment Results (Installation Stage & Combined Movements)

appendix a

Desk Study

Existing & Proposed Site Plans
Envirocheck Extracts
Historical Maps
UXO Preliminary Risk Assessment
Service Searches