DESK STUDY & GROUND INVESTIGATION REPORT

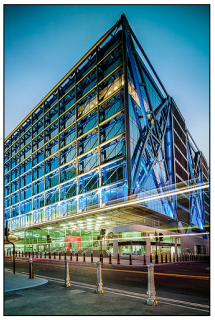
100 Grays Inn Road
Holborn
London
WC1X 8AL

Client: Lawn Mist Limited

J20106

September 2022



GEA

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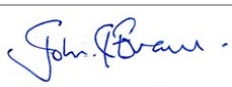
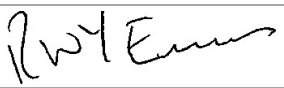
Project title	100 Grays Inn Road, Holborn, London WC1X 8AL	**Project ref**	J20106
Report prepared by			
	Matthew Penfold MSci MSc DIC CGeol FGS Principal Geotechnical Engineer		
With input from			
	Martin Cooper BEng CEng MICE FGS Technical Director		
			
	John Evans MSc FGS CGeol Consultant Hydrogeologist	Rupert Evans MSc CEnv CWEM MCIWEM AIEMA Consultant Hydrologist	
Report checked and approved for issue by			
	Steve Branch BSc MSc CGeol FGS FRGS Managing Director		

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1	Final		28 September 2020	
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This report has been issued by the GEA office indicated below. Any enquiries regarding the report should be directed to the project engineer at the office indicated below or to Steve Branch in our main Herts office.

✓	**Hertfordshire**	tel 01727 824666
	Nottinghamshire	tel 01509 674888
	Manchester	tel 0161 209 3032

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This report is intended as a Ground Investigation Report (GIR) as defined in BS EN1997-2, unless specifically noted otherwise. The report is not a Geotechnical Design Report (GDR) as defined in EN1997-2 and recommendations made within this report are for guidance only.

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Part 3: GROUND MOVEMENT ASSESSMENT

Part 4: BASEMENT IMPACT ASSESSMENT

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 Heyne Tillet Steel, on behalf of Lawn Misted Ltd, with respect to the redevelopment of the site through the demolition of the existing buildings and subsequent construction of a new ten-storey mixed use commercial and residential building. The proposals will also include deepening of the existing basement structure by 0.5 m to 1.0 m to accommodate a new raft foundation. The purpose of the investigation has been to determine the ground conditions and hydrogeology, to assess the extent of any contamination and to provide information to assist with the design of the retaining walls and suitable foundations. The report also includes information required to comply with London Borough of Camden Planning Guidance, relating to the requirement for a Basement Impact Assessment (BIA). This report has been issued in advance of completion of the proposed ground movement assessment to provide information to assist with the development of the design proposals.

DESK STUDY FINDINGS

The desk study indicates that the site does not have a potentially contaminative history as it has apparently only been developed small scale commercial and residential buildings, since prior to 1875 and the existing buildings since at least 1968. There is, therefore, assessed to be a LOW RISK of contamination at this site.

GROUND CONDITIONS

Beneath a surface layer of reinforced concrete, typically 500 mm in thickness, the made ground generally comprised light greyish brown silty sandy clay with various extraneous material and extended to a depth of 4.20 m (17.14 m OD) in Borehole No 1A and to the maximum depth of Borehole No 1 at 3.60 m (17.74 m OD). Within the basement, the made ground was similar in composition and extended to depths of between 1.20 m (17.07 m OD) and 1.50 m (16.71 m OD). In the boreholes drilled from ground level, the Lynch Hill Gravel comprised very light yellowish brown very sandy fine to coarse subangular to subrounded gravel and extended to a depth of 6.50 m (14.84 m OD). In the boreholes drilled from basement level, the Lynch Hill Gravel was found to be of medium density and extended to depths of between 3.30 m and 4.50 m (13.71 m OD to 14.89 m OD). The London Clay initially consisted of firm brown silty clay to depths of 7.00 m (14.34 m OD) and 4.30 m (13.89 m OD) in Borehole Nos 1A and 2 respectively, and to the maximum depth of Borehole Nos 3, 4 and 5, to depths of 4.90 m (13.31 m OD), 4.50 m (13.78 m OD) and 4.30 m (13.97 m OD), beneath which, stiff high strength and very high strength grey fissured silty clay with occasional to frequent mica, carbonaceous material, rare foraminifera and occasional silt pockets and fine to medium sand lenses and extended to depths of 19.10 m (-0.91 m OD) and 22.00 m (-0.66 m OD). The underlying Lambeth Group comprised very stiff high strength becoming very high strength multi-coloured silty clay and extended to the full depth of the investigation, of 25.00 m (-6.81 m OD). Groundwater has been measured within the Lynch Hill Gravel at depths of between 3.80 m (14.39 m OD) and 5.50 m (15.84 m OD). Contamination testing has revealed an elevated concentration of lead within a single sample of the made ground tested, retrieved from Borehole No 1, with respect to a residential end use without plant uptake.

RECOMMENDATIONS

Excavations for the proposed basement structure will require temporary support to maintain the stability of the existing and surrounding structures and to prevent any excessive ground movements. Formation level for the proposed development is likely to be within the made ground and close to the boundary between the made ground and Lynch Hill Gravel. Perched water may be encountered from within the made ground or underlying Lynch Hill Gravel, although significant inflows are not anticipated. For the ground conditions at this site a contiguous or secant bored pile wall could be adopted using continuous flight auger (cfa) techniques. A clean cover system will be required in the proposed soft landscaped area unless the made ground is removed.

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.

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 and a Ground Movement Assessment is included in Part 3.

1.0 INTRODUCTION

Geotechnical and Environmental Associates Limited (GEA) has been commissioned by Heyne Tillet Steel, on behalf of Lawn Mist Ltd, to carry out a desk study, ground investigation and ground movement assessment for this site at 100 Grays Inn Road, Holborn, London WC1X 8AL.

This report also forms part of a Basement Impact Assessment (BIA), which has been carried out in accordance with guidelines from the London Borough of Camden in support of a planning application. A Ground Movement Analysis (GMA) including building damage assessment has been carried out in accordance with the guidance and is included in Part 3.

1.1 Proposed Development

It is understood that it is proposed to redevelop the site through the demolition of the existing buildings at No 100 Grays Inn Road and No 127 Clerkenwell Road whilst retaining the existing basement, which will be deepened by 0.5 m to 1.0 m to accommodate a new raft foundation, and subsequent construction of a new ten-storey mixed use commercial and residential timber framed building.

Proposed formation level for the new raft is understood to between 17.0 m OD and 16.5 m OD.

No 88 Grays Inn Road will be retained as part of the proposals and converted into residential apartments with office space.

This report is specific to the proposed development and the advice herein should be reviewed once the proposals have been finalised.

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 assess the risk of encountering Unexploded Ordnance (UXO) risk beneath the site;
- to determine the ground conditions and their engineering properties;
- to provide advice and information with respect to the design of suitable foundations and retaining walls;
- to assess the impact of the proposed basement on the local hydrogeology, hydrology and stability of the surrounding natural and build environment;
- to provide an indication of the degree of soil contamination present; and

- to assess the risk that any such contamination may pose to the proposed development, its users or the wider environment.

1.3 Scope of Work

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

- a review of historical Ordnance Survey (OS) maps and environmental searches sourced from the Envirocheck database;
- a review of readily available geology maps;
- a walkover survey of the site carried out in conjunction with the fieldwork;
- commissioning and review of a Preliminary UXO Risk Assessment, and a subsequent Detailed UXO Risk Assessment, from 1st Line Defence, a specialist in the field;

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

- a single borehole advanced to a depth of 25.0 m (-6.81 m OD) from basement level at No 100 Grays Inn Road, using a dismantlable cable percussion rig;
- two boreholes advanced to depths of 3.6 m (17.74 m OD) and 25.0 m (-3.66 m OD) from ground level at No 127 Clerkenwell Road, using a dismantlable cable percussion rig;
- three drive-in window sampler boreholes advanced to a depth of up to 4.9 m (13.31 m OD) from basement level at No 100 Grays Inn Road;
- installation of four groundwater monitoring standpipes, to a maximum depth of 6.5 m (14.84 m OD) and two subsequent monitoring visits;
- a single trial pit manually excavated to a depth of 0.7 m (17.55 m OD) to determine the configuration of foundations beneath an existing column in the northeastern corner of the basement at No 100 Grays Inn Road;
- testing of selected soil samples for contamination and geotechnical purposes;
- 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); this report includes the PRA and GQRA.

[1] https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm

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

1.3.1 Basement Impact Assessment

The work carried out includes a Hydrological and Hydrogeological Assessment and Land Stability Assessment (also referred to as Slope Stability Assessment). These assessments form part of the BIA procedure specified in the London Borough of Camden (LBC) Planning Guidance[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 John Evans, 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.

1.4 Limitations

The conclusions and recommendations made in this report are limited to those that can be made on the basis of the investigation. The results of the work should be viewed in the context of the range of data sources consulted, the number of locations where the ground was sampled and the number of soil, gas or groundwater samples tested; no liability can be accepted for information in other data sources or conditions not revealed by the sampling or testing. Any comments made on the basis of information obtained from the client or other third parties are given in good faith on the assumption that the information is accurate; no independent validation of such information has been made by GEA.

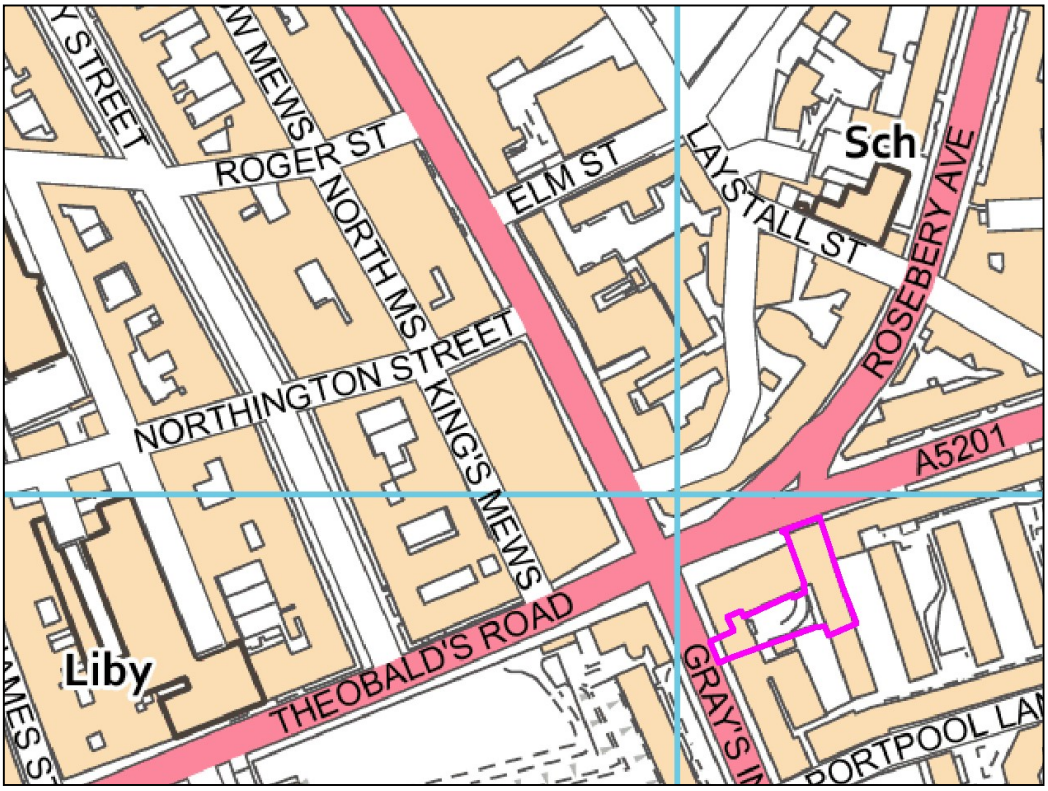
2 London Borough of Camden Planning Guidance CPG (January 2021) *Basements*
3 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010

2.0 THE SITE

2.1 Site Description

The site is located in the London Borough of Camden, roughly 350 m north of Chancery Lane Underground Station and 640 m northeast of Holborn. The site fronts onto Grays Inn Road (A5200) to the west and Clerkenwell Road (A5201) to the north and is otherwise bounded by three-storey to four-storey buildings, comprising commercial businesses on the ground level frontages, with residential and office units above and behind.

The site may additionally be located by National Grid Reference 531040, 181960 and is shown on the map extract below.



A walkover of the site was carried out by a geotechnical engineer from GEA at the time of the fieldwork.

The site is roughly rectangular in shape with maximum dimension of 35 m north-south by 50 m east-west. No 100 Grays Inn Road is in the western portion of the site and comprises a partly nine-storey and partly four-storey building, with commercial use at ground level and office use above, with a lower ground floor level and a courtyard to the rear in the south-eastern corner, used mainly for ancillary storage with an access ramp to the basement. The lower ground floor level is largely used for car and bicycle parking and has a maximum head height of 2.5 m. This building is accessed through a pedestrian front entrance or via a large roller shutter through an undercroft which provides vehicular access from Grays Inn Road.

Beyond the rear courtyard to the east, a retaining wall essentially bisects the site between No 100 Grays Inn Road and No 127 Clerkenwell Road. No damage or signs of movement were noted on this wall.

No 127 lies in the eastern portion of the site and is occupied by a partly nine-storey and partly three-storey office building with a lower ground floor level beneath the north-eastern portion of the site, which is mainly used for plant storage. A car park is also present at ground floor level which is accessed via an undercroft from Clerkenwell Road.

The site is essentially level and devoid of any significant vegetation, with the exception of ivy and shrub border and a number of semi-mature coniferous trees present along the eastern elevation at No 100 Grays Inn Road.

2.2 Site History

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

The earliest map studied, dated 1851, shows that the existing road network around the site had been established, although Clerkenwell Road was known as Liquor Pond Street at the time. The site was vacant and bordered to the south by two irregular shaped buildings.

The next map, dated 1875, shows the surrounding area to have been developed with predominantly terraced houses, much as it is today. The site was occupied by numerous adjoining buildings, likely to have been small-scale commercial and residential properties, with the centre of the site labelled as a yard. A large brewery had also been constructed about 30 m from the eastern site boundary.

At some time between 1878 and 1896, the buildings to the northwest and south of the site were reconfigured, with the former labelled as Holborn Town Hall.

On the 1916 map, the building in the south-western corner of the site, fronting onto Grays Inn Road, is labelled as a bank and the structures formerly beyond the southern boundary of the site are shown to have been cleared. A public house is annotated just to the north-eastern corner of the site and the aforementioned brewery had been demolished and replaced with five large rectangular apartment buildings, with a further smaller structure annotated as ‘Shene Building’ occupying the area to the south-eastern corner of the site.

Aerial photography dated 1946, shows the majority of structures to the south of the site as ruins, the closest of which was located approximately 30 m away.

On the next map, dated 1953, the buildings on site are labelled as No 100 and No 127 with the centre of the site labelled as Nos 131 to 133. No 127 Clerkenwell Road is indicated as ‘Working Man Club and Institute Union’. At some time between 1954 and 1958, the surrounding ruins were cleared and were mainly redeveloped as apartment buildings or terraced houses.

At some time between 1968 and 1974, the site was redeveloped into the existing configuration and has since remained essentially unchanged.

Historic building plans indicate former commercial uses on site to have included a publisher and book warehouse, printers and tobacco distributor.

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, infilled land, waste management, transfer, treatment or disposal sites within 500 m of the site. Additionally, there are no recorded pollution incidents to controlled waters or discharge consents within the same distance.

The nearest Local Authority Pollution Prevention and Controls entry listed is permitted to a dry cleaners, located 168 m to the east of the site.

The report indicates that there are eight contemporary trade directories located within 100 m of the site, all of which are small scale businesses and are listed as inactive.

The site is not located with a nitrate vulnerable zone and does not lie within any known areas of sensitive land use.

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.

Information obtained on buried services has not identified any potentially sensitive infrastructure beneath the site or neighbouring areas that could be adversely affected by the proposed development. There are also no London Underground or Network Rail Tunnels within close proximity of the site. Copies of the service search information are included within the appendix.

2.4 Geology

The British Geological Survey (BGS) map of the area (Sheet 256) indicates that the site is underlain by the Lynch Hill Gravel over the London Clay Formation.

According to the BGS memoir, the London Clay is homogenous, slightly calcareous silty clay to very silty clay, with some beds of clayey silt grading to silty fine-grained sand.

A search of the BGS records has identified records of two boreholes previously drilled on site (refs: TQ38SW3949 and TQ38SW3948) which encountered made ground to depths of 0.61 m and 3.96 m (17.07 m OD and 17.62 m OD), overlying soils of the Lynch Hill Gravel to depths of 3.66 m and 6.4 m (14.63 m OD and 14.57 m OD), beneath which the London Clay was present to the maximum depth investigated at 18.29 m (3.01 m OD).

Deeper borehole records from the area around the site, suggest that the London Clay is likely to extend to a depth of about 20 m to 22 m (approx. 1.0 m OD to -1.0 m OD) and below which the Lambeth Group is likely to be present to a depth of about 35 m (approx. -14.0 m OD. Essentially incompressible soils of the Thanet Sand are then expected to be present, with the underlying Chalk likely to be encountered at a depth in excess of 40 m (approx. -20.0 m OD).

2.5 Hydrology and Hydrogeology

The Lynch Hill Gravel is classified as a Secondary ‘A’ Aquifer, which refers to permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers, while the London Clay Formation is classified as an Unproductive Stratum, rather than its former classification as a non-aquifer, referring to rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

The permeability of the superficial deposits is expected to be between about 1 x 10^{-6} m/s and 1 x 10^{-4} m/s. The London Clay is not capable of supporting a groundwater table, although isolated pockets of perched groundwater do occur within fissures and silt and sand partings. Published data for the permeability of the London Clay indicates the horizontal permeability to generally range between 1 x 10^{-11} m/s and 1 x 10^{-9} m/s, with an even lower vertical permeability.

The Envirocheck report indicate that the nearest surface water feature is located 677 m to the southeast of the site, although it is unclear to what it refers. The River Thames is located approximately 1.15 km to the south of the site such that the general groundwater flow is likely to be in a south-easterly direction with the local topography and towards the River Thames.

The site is not indicated as being at risk from flooding, nor is it located within a Groundwater Source Protection Zone as defined by the Environment Agency. It is not listed within the London Borough of Camden report[4] as having suffered from surface water flooding in the 1975 or 2002 flooding events and is not shown on Figure 15 of the Arup report[5], or the EA surface water flood maps, as being in an area with a potential risk from surface water flooding.

Reference to Figure 11 of the Arup Report in the Camden Basement Planning Guidance indicates the site is located approximately 200 m to the southwest of the River Fleet. Historically[6], the Fleet issued from Hampstead Heath and flowed in a generally southerly direction towards the River Thames. Today the Fleet is entirely covered and culverted and forms part of the surface water sewerage system, which discharges into the Thames under Blackfriars Bridge.

A resting groundwater level of 3.08 m below ground level (15.18 m OD) is recorded on the aforementioned BGS archive record from within the Lynch Hill Gravel. Groundwater is likely to be present near the boundary between the high permeability Lynch Hill Gravel Member and the low permeability London Clay and is likely to flow in a generally south-easterly direction towards the River Thames.

The site is almost entirely covered by concrete hardstanding and buildings, with a border of limited width along the eastern elevation at No 100 Grays Inn Road, such that infiltration of rainwater is generally restricted to surface water drains, with the majority of surface runoff currently draining into combined sewers in the road.

As the development will not result in a change to the present conditions, for example through the loss of any permeable areas, there will not be an increase in runoff rate or volume into the existing sewer system, or that could have a potentially adverse impact on the surrounding area. There should not, therefore, be any requirement for any mitigation measures.

Mitigation measures are unlikely to be feasible in any case, due to a lack of available space and little opportunity to reduce runoff rates from the site via attenuation or rainwater harvesting. However, alternative SUDS measures could be considered, such as rain gardens or permeable paving which could temporarily retain surface water flows, if a requirement to reduce the rate and amount of flow into the existing sewer system from present levels is identified.

4 London Borough of Camden (2003) *Floods in Camden, Report of the Floods Scrutiny Panel*
5 Ove Arup & Partners (2010) *Camden geological, hydrogeological and hydrological study. Guidance for Subterranean Development.* For London Borough of Camden November 2010
6 Nicholas Barton (2000) *London's Lost Rivers.* Historical Publications Ltd

2.6 Preliminary Risk Assessment

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

2.6.1 Source

The desk study research has indicated that the site has only had a mixed commercial and residential end use for its entire developed history and is therefore not considered to have had a contaminative history.

The former buildings would originally have had solid fuel heating and therefore coal and ash residue may be present in the near surface soils. Fragments of asbestos building materials and lead paint and other building materials may have been deposited in the near surface soils during episodes of demolition and redevelopment. As with any previously developed site, there is also the potential for localised spillages or leakage of fuel to have occurred, although this is unlikely to represent a significant source of contamination.

On site			
Site use	**Source**	**Dates**	**Typical contaminants**
Former buildings	Solid fuel heating	From 1875 to 1968	Heating oil and hydrocarbon fuels, paraffin, ash
	Building materials including insulation	From 1875	Asbestos
	Paint	From 1875	Lead
Open land	Made ground	Prior to 1875	Unknown

No sources of soil gas have been identified on site or in the surrounding area.

2.6.2 Receptor

The future occupants of the residential units will represent relatively high sensitivity receptors. As the site is underlain by the Lynch Hill Gravel; a secondary 'A' aquifer, groundwater and adjacent sites are considered to be moderately sensitive receptors. The deep chalk aquifer is also considered to be a particularly sensitive receptor. 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.

2.6.3 Pathway

Within the site, end users will be isolated from direct contact with any contaminants present within the made ground by the proposed building and surrounding areas of hardstanding, thus no potential contaminant exposure pathways will exist with respect to end users.

Soluble contaminants within the made ground could potentially migrate onto adjacent sites as a result of infiltration of surface runoff in any areas of soft landscaping; although this pathway is already in existence along the eastern elevation of the courtyard area. The presence of the negligibly permeable London clay beneath the permeable sand and gravel of the Lynch Hill Gravel will limit the potential for groundwater percolation to a sensitive aquifer at depth, and thus it is considered unlikely for a pathway to exist to a principal aquifer. In any case, the excavation of the basement is likely to remove the majority of contaminants from beneath the

site. Buried services may be exposed to any contaminants present within the soil through direct contact and site workers will come into contact with the soils during construction works. 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.

2.6.4 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 no evidence of filled ground within the vicinity of the site and no landfill sites, there is not considered to be a significant potential for hazardous soil gas to be present on or migrating towards the site.

2.7 UXO Risk Assessment

2.7.1 Preliminary UXO Risk Assessment

A Preliminary UXO Risk Assessment has been completed by 1st Line Defence (report ref EP11269-00, dated May 2020), and a copy of the report is included in the appendix.

The risk assessment has been carried out in accordance with the guidelines provided by CIRIA, 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.

During World War II (WWII) the site was located within the Metropolitan Borough of Holborn which sustained a very high bombing density campaign according to official statistics. Numerous bomb strikes including two high explosive (HE) bombs, an incendiary bomb shower and a parachute mine are recorded on site on both consolidated and weekly London bomb census mapping. However, the report indicates that no damage is evident on post-WWII OS mapping and London Bomb Damage Mapping such that it is unknown whether the strikes reported were plotted correctly.

Therefore, the report concluded that further research in the form of a Detailed UXO Risk Assessment was required in order to ascertain precise details about the strikes identified on and near the site, and to what extent conditions may have been present whereby an item of UXO could have gone unnoticed.

2.7.1 Detailed UXO Risk Assessment

Based on the above recommendations, a Detailed UXO Risk Assessment has been completed by 1st Line Defence (report ref DA11269-00, dated June 2020) and their report is included in the Appendix.

The report indicates that archival incident records refer to a number of the aforementioned strikes, particularly the parachute mine to the south, although some strikes recorded on site were unaccounted for on written records. The structures on site appear to have remained externally intact following the war, although significant damage is evident on a number of structures which bordered the site to the south with some labelled as entirely cleared or ruined on post-WWII aerial photography.

While it is considered that the conditions on site were conducive to the detection of items of UXO due to the lack of apparent damage, the surrounding area, particular to the south is

likely to have been restricted such that items of UXO could have gone unreported or unnoticed within the rubble and debris of the damage which would have also likely impeded access to the site and possibly obscured evidence of UXO. The site was therefore classed as MEDIUM risk

Based on the findings, it was recommended that works in all areas should include site specific UXO awareness briefing to all personnel. In addition, UXO specialist on-site support should be provided during any open intrusive works, with magnetometer scanning of all borehole / pile locations to the maximum bomb depth penetration.

In accordance with the recommendations of the report, the intrusive works were undertaken with specialist on-site support including magnetometer scanning of all borehole locations to the maximum bomb depth penetration.

3.0 SCREENING

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

3.1 Screening Assessment

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

3.1.1 Subterranean (groundwater) Screening Assessment

Question	Response for 100 Grays Inn Road and 127 Clerkenwell Road
1a. Is the site located directly above an aquifer?	*Yes. The site is underlain by Lynch Hill Gravel which is designated as a Secondary 'A' Aquifer by the Environment Agency, capable of supplying local water supplies and supporting small watercourses.*
1b. Will the proposed basement extend beneath the water table surface?	*Unlikely. Groundwater is expected to be present within the Lynch Hill Gravel at a level of about 15.0 m OD, whilst proposed formation level for the proposed basement raft, is understood to be at 17.0 m OD to 16.5 m OD.*
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. Figure 14 of the Arup report confirms that the site is not located within this catchment area.
4. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No. The existing / proposed basement extends beneath the footprint of the existing / proposed building and will not therefore result in a significant change in the proportion of hard surfaced / paved areas.
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 existing surface water drainage arrangements will not be materially changed.
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. Topographical maps acquired as part of the desk study and Figures 11 and 12 of the Arup report confirm this.

The screening exercise has identified the following potential issues which should be assessed:

Q1a The site is located on the Lynch Hill Gravel, which is a Secondary 'A' Aquifer.
Q2 Groundwater could be encountered towards the base of the proposed excavations.

3.1.2 Stability Screening Assessment

Question	Response for 100 Grays Inn Road and 127 Clerkenwell Road
1. Does the existing site include slopes, natural or manmade, greater than 7°?	No, as indicated on the Slope Angle Map Fig 16 of the Arup report.
2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7°?	No. The site is not to be significantly re-profiled as part of the development.
3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7°?	No. As indicated on the Slope Angle Map Fig 16 of the Arup report.
4. Is the site within a wider hillside setting in which the general slope is greater than 7°?	No. As indicated on the Slope Angle Map Fig 16 of the Arup report.
5. Is the London Clay the shallowest strata at the site?	No
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 site.
7. Is there a history of seasonal shrink-swell subsidence in the local area and / or evidence of such effects at the site?	No
8. Is the site within 100 m of a watercourse or potential spring line?	No. Not according to Figure 12 of the Arup report, extracts from the Envirocheck report and Ordnance Survey maps.
9. Is the site within an area of previously worked ground?	No. Not according to Figure 3 of the Arup report.
10a. Is the site within an aquifer?	*Yes. The site is underlain by the Lynch Hill Gravel which is designated as a Secondary 'A' Aquifer by the Environment Agency, capable of supporting baseflow to watercourses.*
10b. Will the proposed basement extend beneath the water table such that dewatering may be required during construction?	*Unlikely. Groundwater is expected to be present within the Lynch Hill Gravel at a level of about 15.0 m OD, whilst proposed formation level for the proposed basement raft, is understood to be at 17.0 m OD to 16.5 m OD.*
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 this catchment area.
12. Is the site within 5 m of a highway or pedestrian right of way?	*Yes, the site fronts onto Grays Inn Road to the west and Clerkenwell Road to the north. However, proposed deepening of the existing basement is unlikely to result in any significant movements at surface level, likely to affect the public highways.*
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	No. The neighbouring properties include existing basement or lower ground floor levels, such that the development is unlikely to increase the foundation depths relative to the neighbouring properties to any significant extent.
14. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines?	No. Not according to Figure 18 of the Arup report and information provided by London Underground.

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

Q10a The site is underlain by a Secondary 'A' Aquifer.
Q10b Groundwater could be encountered towards the base of the proposed excavations.
Q12 The site is within 5 m of a public highway.

3.1.3 Surface Flow and Flooding Screening Assessment

Question	Response for 100 Grays Inn Road and 127 Clerkenwell Road
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. There will not be an increase in impermeable area across the site, so the surface water flow regime will be unchanged. The basement will remain beneath the footprint of the existing / proposed building and areas of hardstanding, and the 1 m distance between the roof of the basement and ground surface as recommended by section 3.2 of the CPG Basements 2018 does not apply across these areas.
3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas?	No. There will not be a change in impermeable area across the ground surface above the basement.
4. Will the proposed basement development result in changes to the profile of the inflows (instantaneous and long term) of surface water being received by adjacent properties or downstream watercourses?	No. There will not be an increase in impermeable area across the site, so the surface water flow regime will be unchanged. The basement will remain beneath the footprint of the existing / proposed building and areas of hardstanding, therefore the 1m distance between the roof of the basement and ground surface as recommended by section 3.2 of the CPG Basements 2018 does not apply across these areas
5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No. The proposed basement is very unlikely to result in any changes to the quality of surface water being received by adjacent properties or downstream watercourses as the surface water drainage regime will be unchanged and the land uses will remain the same.
6. Is the site in an area identified to have surface water flood risk according to either the Local Flood Risk Management Strategy or the Strategic Flood Risk Assessment or is it at risk of flooding, for example because the proposed basement is below the static water level of nearby surface water feature?	No. The findings of this BIA together with the Camden Flood Risk Management Strategy dated 2013 and Figures 3iv, 4e, 5a and 5b of the SFRA dated 2014, in addition to the Environment Agency online flood maps show that the site has a low flooding risk from surface water, sewers, reservoirs (and other artificial sources), groundwater and fluvial/tidal watercourses. There is a very low and low risk of surface water flooding across the site. 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 identified no potential issues that need to be assessed.

4.0 SCOPING AND SITE INVESTIGATION

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

4.1 Potential Impacts

The following potential impacts have been identified by the screening process

Potential Impact	Consequence
The site is underlain by a Secondary 'A' Aquifer.	The basement may affect the groundwater flow regime. This could potentially impact on baseflow to watercourses or local private water supplies.
The proposed basement could extend into the water table.	
The site is located within 5 m of a highway or pedestrian right of way	Deepening of a basement may result in structural damage to the road or footway.

These potential impacts have been investigated through the site investigation, as detailed in Section 10.0.

4.2 Exploratory Work

In order to meet the objectives described in Section 1.2, as far as possible within the access limitations presented by the presence of the existing building, two boreholes (Borehole Nos 1 and 1A) were advanced to depths of 3.6 m (17.74 m OD) and 25.0 m (-3.66 m OD) from ground level at No 127 Clerkenwell Road, using a dismantlable cable percussion rig. Borehole No 1 was terminated at a depth 3.60 m due to a concrete obstruction which is understood to be an old backfilled basement, and was subsequently moved about 3 m towards the southern / rear wall to drill Borehole No 1A.

At 100 Grays Inn Road, a single borehole (Borehole No 2) was advanced to a depth of 25.0 m (-6.81 m OD) from basement level using a dismantlable cable percussion rig. A further three window sampler boreholes (Borehole Nos 3 to 5) were also advanced to a depth of up to 4.9 m (13.31 m OD) to provide additional coverage of the basement.

During boring, disturbed and undisturbed samples were obtained from the boreholes for subsequent laboratory examination and testing. Standard Penetration Tests (SPTs) were carried out at regular intervals to provide additional quantitative data on the strength of soils encountered.

A total of four groundwater monitoring standpipes have been installed, in Borehole Nos 1A, 2, 3 and 5, to a maximum depth of 6.5 m (14.48 m OD), to facilitate future monitoring which has been carried out on three occasions to date.

A single trial pit was manually excavated to a depth of 0.7 m (17.55 m OD) to determine the configuration of foundations beneath an existing column in the northeastern corner of the basement at No 100 Grays Inn Road.

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

All of the work was carried out under the supervision of a geotechnical engineer from GEA.

The borehole and trial pit records are appended, together with the results of the laboratory testing and a site plan indicating the borehole locations. The Ordnance Datum (OD) levels on the borehole and trial pit records have been provided by the consulting engineers labelled on a drawing detailing existing levels undertaken by Foundation Architecture Ltd (dwg no: E099 & E100, undated).

4.3 Sampling Strategy

The boreholes and trial pit positions were specified by the consulting structural engineers, Heyne Tillet Steel and were positioned on site by a geotechnical engineer from GEA as close to the agreed positions as possible, whilst avoiding areas of known and suspected services.

Five samples of the shallow soil and were subjected to analysis for a range of common industrial contaminants and contamination indicative parameters. For this investigation the analytical suite for the soil included a range of metals, total petroleum hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH), total cyanide and monohydric phenols. The soil samples were selected to provide a general view of the chemical conditions of the soils that are likely to be involved in a human exposure or groundwater pathway and to provide advice in respect of re-use or for waste disposal classification. The contamination analyses were carried out at a 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.

A number of the disturbed and undisturbed samples of natural soil were submitted to a geotechnical testing laboratory and were subject to a number of material property tests, including four-point Atterberg Limit, moisture content tests, particle size distribution tests (PSD), triaxial tests and soluble sulphate and pH analysis.

5.0 GROUND CONDITIONS

The investigation has confirmed the expected ground conditions in that, below a moderate to significant thickness of made ground, Lynch Hill Gravel was encountered over London Clay, underlain by the Lambeth Group which extended to the full depth of the investigation at 25.0 m below ground level (-3.66 m OD) and 25.0 m below basement level (-6.81 m OD).

5.1 Made Ground

Beneath a reinforced concrete slab, typically 500 mm in thickness, at ground level in 127 Clerkenwell Road, the made ground comprised light greyish brown silty sandy clay with frequent concrete, flint gravel and occasional clinker and extended to a depth of 4.2 m (17.14 m OD) in Borehole No 1A and to the maximum depth of Borehole No 1 at 3.6 m (17.74 m OD), below ground level.

Below the basement at No 100 Grays Inn Road, the made ground typically comprised light grey, dark brownish grey and reddish brown mottled black silty sandy clay with frequent clinker, brick, occasional concrete and flint gravel and extended to depths of between 1.2 m (17.07 m OD) and 1.50 m (16.71 m OD), below basement level. The made ground was absent from Borehole No 2.

No evidence of significant contamination was identified during the fieldwork. As a precaution, five samples of the made ground were tested for the presence of contamination and the results are presented in Section 5.6.

5.2 Lynch Hill Gravel

In Borehole No 1A, at ground level, this stratum comprised very dense light yellowish brown very sandy fine to coarse subangular to subrounded gravel and extended to a depth of 6.5 m below ground level (14.84 m OD).

Within the lower ground floor level, the Lynch Hill Gravel generally comprised medium dense light yellow-brown very sandy gravel and gravelly sand and extended to depths of between 3.3 m and 4.5 m below basement level (13.71 m OD to 14.89 m OD). An initial horizon of firm light brown silty sandy clay with rare fine to medium flint gravel was encountered to 1.50 m below basement level (16.78 m OD) in Borehole No 4 only.

5.3 London Clay

The London Clay initially comprised a weathered horizon of firm brown silty clay extending to depths of 7.0 m (14.34 m OD) and 4.3 m (13.89 m OD) in Borehole Nos 1A and 2, respectively, and to the maximum depth of Borehole Nos 3, 4 and 5, to depths of 4.9 m (13.31 m OD), 4.5 m (13.78 m OD) and 4.3 m (13.97 m OD). Beneath which, stiff high strength and very high strength grey fissured silty clay with occasional to frequent mica, carbonaceous material, rare foraminifera and occasional silt pockets and fine to medium sand lenses was encountered and extended to depths of 19.1 m (-0.91 m OD) and 22 m (-0.66 m OD).

The results of four plasticity index tests indicate the clay to be of high volume change potential with moisture contents ranging from 18.4 % and 27.9 %. A further sample retrieved at depth of 3.75 m in Borehole No 2 was indicated to be of medium volume change potential with a moisture content of 43.2 %, which is likely to be attributable to water softening of the clay sample.

No visual or olfactory evidence of contamination was observed within the natural soils.

5.4 Lambeth Group

The Lambeth Group was encountered in Borehole Nos 1A and 2 only and generally consisted of very stiff high strength becoming very high strength multi-coloured silty clay and extended to the maximum depth investigated, at 25.0 m (-6.81 m OD).

The result of a single plasticity index test indicates the clay to be of high volume change potential with a moisture content value of 20 %.

No visual or olfactory evidence of contamination was observed within the natural soils.

5.5 Groundwater

During drilling, groundwater was encountered as a water strike from within the Lynch Hill Gravel at a depth of 6.0 m below ground level (15.34 m OD) in Borehole No 1A, and 3.0 m below basement level (15.19 m OD) in Borehole No 2; the necessary addition of water to assist with the drilling of the granular soils could however have masked shallower inflows.

Standpipes were installed in Borehole Nos 1A, 2, 3 and 5 and the results of three groundwater monitoring visits are presented in the table below.

Date	Borehole No	Depth to water (m below ground level) [Level (m OD)]	Depth to water (m below basement level) [Level (m OD)]
15/07/2020	1A	5.5 (15.84)	-
	2	DRY	
	3	DRY	
	5	DRY	
06/08/2020	1A	5.49 (15.85)	-
	2	-	3.8 (14.39)
	3	DRY	
	5	DRY	
11/03/2021	1A	5.9 (15.44)	-
	2	-	2.75 (15.44)
	3	Dry	
	5	-	3.46 (14.81)

5.6 Soil Contamination

The table below sets out the values measured within five samples of made ground; all concentrations are in mg/kg unless otherwise stated.

Determinant	BH3 – 0.50 m	BH3 – 1.40 m	BH4 – 0.50 m	BH5 - 0.5 m	BH1 – 0.6 m
Asbestos	Not detected	Not detected	Not detected	Not detected	Not detected
pH	8.2	8.4	9.8	8.0	8.8
Arsenic	10	7.3	11	14	16
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	19	17	29	28	22
Copper	68	80	34	75	120
Mercury	0.7	<0.3	<0.3	1.2	3.6
Nickel	21	16	24	28	23
Lead	210	140	68	210	**440**
Selenium	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc	69	160	54	110	120

Determinant	BH3 – 0.50 m	BH3 – 1.40 m	BH4 – 0.50 m	BH5 - 0.5 m	BH1 – 0.6 m
Total Cyanide	<1.0	<1.0	1	<1.0	<1.0
Total Phenols	<1.0	<1.0	<1.0	<1.0	<1.0
Sulphide	<1.0	2.2	5.7	11	<1.0
Total TPH	<10	<10	<10	26	<10
Naphthalene	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(a)pyrene	<0.05	<0.05	0.27	<0.05	<0.05
Total PAH	<0.80	<0.80	4.21	1.27	<0.80
Total organic carbon %	0.8	0.3	0.5	0.9	1.3

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

5.6.1 Generic Quantitative Risk Assessment

The use of a risk-based approach has been adopted to provide an initial screening of the test results to assess the need for subsequent site-specific risk assessments. Contaminants of concern are those that have values in excess of generic human health risk-based guideline values, which are either the CLEA[7] Soil Guideline Values where available, the Suitable 4 Use Values[8] (S4UL) produced by LQM/CIEH calculated using the CLEA UK Version 1.07[9] software, or the DEFRA Category 4 Screening values[10], assuming a residential end use without 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 a young female child aged zero to six years old;
- that young children will not have prolonged exposure to the site;
- that the exposure duration will be six years;
- that the critical exposure pathways will be indoor dust ingestion, skin contact with indoor dust, and inhalation of indoor and outdoor dust and vapours; and
- that the building type equates to a two-storey small terraced house.

It is considered that these assumptions are suitable for this generic first assessment of this site, albeit extremely conservative, as the proposed development will not introduce any new pathways, is understood to have a predominantly commercial end use at ground and basement level and will result in the removal of the majority of any made ground as part of the proposed excavations. The tables of generic screening values derived by GEA and an explanation of how each value has been derived are included in the Appendix.

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

Where contaminant concentrations are measured 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.

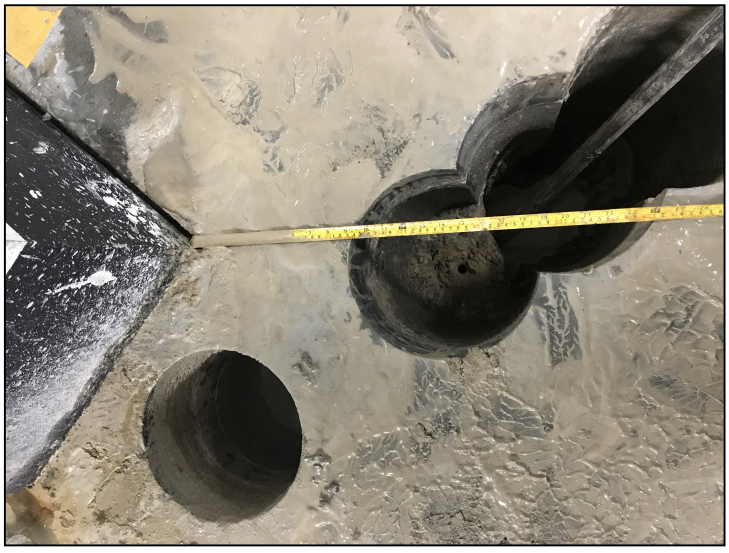
The results of the contamination testing have revealed an elevated concentration of lead at 440 mg/kg within a single sample of made ground tested from Borehole No 1 at a depth of 0.60 m, above a screening value of 310 mg/kg. All other contaminants were found to be below their respective generic guideline value and of generally low concentrations.

Asbestos was not detected within any of the samples screened.

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

5.7 Existing Foundations

A single trial pit was manually excavated to a depth of 0.7 m (17.55 m OD) to determine the configuration of foundations beneath an existing column in the northeastern corner of the basement at No 100 Grays Inn Road, as shown on the photo below.



The top of the suspected pile cap was encountered at a depth of 0.46 m, with the base at a depth of 0.7 m.

Hilti drilling in the area around the pit indicates that the pile cap is likely to be connected to the wall columns at the rear through a ground beam, which, based on the Hilti-drilling, is estimated to have a lateral projection of 0.4 m from the corner of the column.