OD Camden Hotel Ltd, c/o Best Star Real Estate 2 Ltd

5 - 17 Haverstock Hill, London

Contamination Risk Assessment and Remediation Strategy

HH-ARP-REP-451

Issue 2 | 5 October 2020

Job number 268265

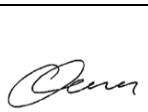
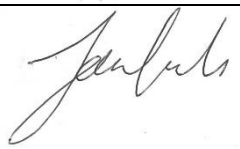
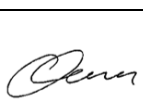
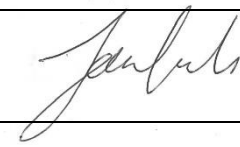
Ove Arup & Partners Ltd
13 Fitzroy Street
London
W1T 4BQ
United Kingdom
www.arup.com

ARUP

\\GLOBAL.ARUP.COM\LONDON\BEL\JOBS\200000\268200\268265-00 HAVERSTOCK HILL\4 INTERNAL DATA\05 REPORTS\08 CONTAMINATION\20200908 PRELIMINARY RISK ASSESSMENT OPTION 1\HAVERSTOCK HILL CONTAMINATION ASSESSMENT AND RS 300920 OG.DOCX

Document Verification

ARUP

Job title		5 - 17 Haverstock Hill, London			**Job number** 268265
Document title		Contamination Risk Assessment and Remediation Strategy			**File reference**
Document ref		HH-ARP-REP-451			
Revision	**Date**	**Filename**	Haverstock Hill Contamination Assessment and RS		
1	17 September 2020	**Description**	For issue to Client to support discharge of Condition 11 Parts a) and b) of planning permission ref. 2016/3975/P		
			Prepared by	Checked by	Approved by
		Name	Oliver Gernon	Jason Lumb	Jason Lumb
		Signature			
2	5th October 2020	**Filename**			
		Description	Amended to describe how the report meets the requirements of Condition 11 parts a) and b) of planning permission ref. 2016/3975/P within conclusion		
			Prepared by	Checked by	Approved by
		Name	Oliver Gernon	Jason Lumb	Jason Lumb
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

Contents

Tables

Figures

Appendices

Executive summary

This contamination risk assessment and remediation strategy report has been prepared for OD Camden Hotel Ltd, c/o Best Star Real Estate 2 Ltd to support the redevelopment of 5 to 17 Haverstock Hill, Camden, London. Planning permission (2016/3975/P) was granted by Camden Council for demolition of the existing building and erection of a part-six, part-seven storey residential unit, with retail use at ground floor and associated amenities. This report is intended to support the discharge of Parts a) and b) of Condition 11 (Ground Investigation) of that planning permission.

This report presents the desk-based information for the site and considers the historical and current land uses, the environmental setting, development proposals and provides an assessment of the potential for contamination at the site. This report includes an assessment of the previous 2016 ground investigation undertaken at the site and provides a remediation strategy and verification plan.

The site comprises a six-storey building with outside area referred to as Eton Garage. It is adjacent to the Chalk Farm London Underground Tube Station. The interior comprises a series of 10 staggered floor levels with spiral ramps for car parking, ancillary use and office space. The building was last used by the British Transport Police to store vehicles.

Mapping for the site indicates the site to have been developed for residential properties on early historical mapping. The site was redeveloped during the 1930s into a garage. The garage was mostly a showroom but anecdotally contained a petrol fuelling facility, workshop, washing bay, store and vehicle battery charging room.

A detailed unexploded ordnance (UXO) desktop threat assessment was undertaken in 2015 and concluded that, whilst areas directly adjacent to the site were recorded as destroyed, there is a minimal risk of encountering UXO on site.

Based on a ground investigation undertaken in 2016, Made Ground was encountered up a depth to 2.6m in some areas overlying London Clay, which was encountered to a depth of 24.7m below ground level but the thickness was not proven. It is likely to be thicker than this. Less than 1m of Made Ground was identified beneath the existing building area.

During the previous ground investigation, a metal obstruction was encountered in the southwest area of the site and it is suspected that this may be a possible underground storage tank (UST). Soil testing identified hydrocarbon concentrations slightly above the laboratory detection limits surrounding the metal obstruction, but not at a level that indicates significant contamination. Although not indicated by the available ground investigation, there remains the potential for localised hydrocarbon contamination to present in the vicinity of any USTs and associated pipework etc.

The chemical test results were low and not indicative of significant contamination however concentrations of arsenic and lead were observed above generic

assessment criteria (GAC). The proposed development will mostly incorporate hardstanding effectively limiting exposure for future users to these contaminants.

No specific remediation (i.e. source removal) is warranted for the site, however where required, the risk of harm to human health will be mitigated via appropriate design, such as the provision of clean cover layers in proposed soft landscape areas.

The risk rating for each identified receptor (without mitigation) is summarised below.

Receptor	**Risk rating**
Risk to human health: construction workers	Moderate to low
Risk to human health: adjacent site users	Low
Risk to human health: end users	Moderate to very low
Risk to controlled waters: underlying chalk aquifer	Low
Risk to controlled waters: Regent's Canal	Negligible
Ecology and soft landscaped areas	Negligible
Risk to the built infrastructure	Very low

The potential risks from contamination can be managed and mitigated by appropriate design and implementation of controls during the construction works. The remediation strategy for the site includes the following remedial objectives to reduce the potential risk any remaining contaminant linkages:

- After demolition, investigate and remove possible USTs and associated infrastructure and localised contamination (if present) to reduce potential indoor vapour inhalation;
- To reduce potential exposure during construction through site management and appropriate controls; and
- To break viable pathways to end users through the form of the development and to ensure an appropriate thickness of clean cover in soft landscaped areas.

A verification report will be required following completion of the works to demonstrate the requirements of the remediation strategy have been implemented and in order to fully discharge Condition 11 of 2016/3975/P. The verification plan presented within this report provides details of the verification records required to demonstrate that the objectives of the remediation strategy have been achieved.

1 Introduction

1.1 Background

Ove Arup & Partners Limited (Arup) has been appointed by OD Camden Hotel Ltd, c/o Best Star Real Estate 2 Ltd (the client) to prepare a contamination risk assessment and remediation strategy report for the proposed redevelopment of 5 to 17 Haverstock Hill, London, NW3 2BL.

Planning permission (2016/3975/P) has been granted by Camden Council for demolition of the existing building and erection of a part-six, part-seven storey residential unit, with retail use at ground floor and associated amenities. As part of this application, a basement impact assessment (BIA) was submitted. The BIA included a site investigation and land contamination assessment by Geotechnical and Environmental Associates (GEA) [1].

The information assessed and previously presented by GEA has been reviewed as part of this report.

1.2 Report objectives

This report presents a contamination risk assessment and remediation strategy for the site and is intended to support the discharge of Parts a) and b) of Condition 11 (Ground Investigation) of Camden Council planning permission ref. 2016/3975/P. Condition 11 states:

Condition 11 Ground Investigation

At least 28 days before development commences (other than site clearance & preparation, relocation of services, utilities and public infrastructure, but prior to removal of any soil from the site):

a) a written programme of ground investigation for the presence of soil and groundwater contamination and landfill gas shall be submitted to and approved by the local planning authority in writing; and

b) following the approval detailed in paragraph (a), an investigation shall be carried out in accordance with the approved programme and the results and a written scheme of remediation measures shall be submitted to and approved by the local planning authority in writing.

The remediation measures shall be implemented strictly in accordance with the approved scheme and a written report detailing the remediation shall be submitted to and approved by the local planning authority in writing prior to occupation.

Parts a) and b) are the pre-commencement elements of Condition 11. The last paragraph of Condition 11 requires a verification report to be submitted prior to occupation of the development.

1.3 Scope of assessment

The scope of the contamination risk assessment (Sections 2 to 8) comprises the following:

- A review of desk-based information collated for the site concerning historical and current uses and provide an assessment of the potential for ground contamination and the nature of any potential contamination sources;
- Outline the local geology, hydrogeology and hydrology and provide an appraisal of the environmental setting and sensitivity;
- Consider relevant information (e.g. ground investigation) and details of the proposed development to inform a conceptual site model and risk assessment, to assess potential implications from ground contamination to the development; and
- Provide recommendations for the redevelopment of the site.

The scope of the remediation strategy (Section 9 and Section 10) comprises the following:

- A definition of the remediation objectives and remediation criteria;
- Identification of feasible technical and management options which address the contaminant linkages and meet remedial objectives; and
- Definitions of the requirements to verify the remedial objectives have been achieved (the verification plan).

1.4 Relevant policy and guidance

This report has considered the requirements of relevant national and local policy and technical guidance relevant to contaminated land.

The National Planning Policy Framework (NPPF) [2] advocates making effective use of land including brownfield land (paragraph 118 Part C) and endorses the principle of a 'suitable for use' approach for contaminated land (paragraph 178 Part A).

The Planning Practice Guidance (PPG) [3] endorses the principle of a 'suitable for use' approach and refers to Part 2A of the Environmental Protection Act 1990 and statutory guidance [4]. It also advocates a strategic phased approach including risk assessment prepared by a competent person which identifies potential sources, pathways and receptors (pollutant or contaminant linkages).

Policy 5.21 of the adopted London Plan [5], states that the Mayor supports the remediation of contaminated sites and will work to bring contaminated land to beneficial use. The policy states that measures should be taken to ensure that development on previously ground contamination does not activate or spread contamination' and paragraph 5.95 states '*it is essential that wherever practicable, brownfield sites – including those affected by contamination – should be recycled into new uses*' and '*Any land that is affected by contamination,*

whether or not identified under the regulations, may require measures to prevent contamination being activated or spread when building takes place'.

The new draft London Plan (Intend to Publish version) [6] includes Policy SD1 which states that Boroughs should '*take appropriate measures to deal with contamination that may exist*' and in paragraph 2.1.8 states that '*it is important that development proposals appropriately deal with contamination so that land can be safely used*'.

Camden's Policy Guidance on Amenity [7] relates to contaminated land and states that '*contamination assessments should accompany a planning application'* which should determine *'the existence if, or potential for contamination'* and '*the nature and risks it may pose'*. If necessary, then remediation or mitigation measures will be secured through conditions requiring further work.

The assessment has also taken account of relevant guidance including BS10175:2011+A2:2017 Investigation of potentially contaminated sites, Code of Practice [8] and Environment Agency guidance (Land Contamination: Risk Management) [9].

1.5 Limitations

This report has been produced by Arup for the use of OD Camden Hotel Ltd, c/o Best Star Real Estate 2 Ltd in connection with the proposed development. It takes into account our client's particular instructions and requirements and addresses their priorities at the time. It is not intended for, and should not be relied upon by, any third party except as provided for in Arup's appointment with Best Star Real Estate.

Arup has based this report on the sources of information detailed within the report text and believes them to be reliable but cannot and does not guarantee the authenticity or reliability of third-party information. Notwithstanding the efforts made by the professional team in undertaking this contamination assessment, it is possible that ground conditions and contamination other than that potentially indicated by this report may exist at the Site.

This report has been prepared based on current legislation, statutory requirements, planning policy and industry good practice at the time of writing. Any subsequent changes or new guidance may require the findings, conclusions and recommendations made in this report to be reassessed in the light of the circumstances. Should the proposed layout or use of the site change, the assessments and conclusions presented in this report may need to be revised.

This report does not present a survey or assessment of the location, condition or liabilities associated with hazardous materials in the building fabric and the implications of those hazardous materials. Arup has not carried out a survey of hazardous materials in the buildings, for example asbestos containing materials or lead, as part of this assessment. This report does not assess geotechnical constraints and hazards.

2 The site

2.1 Information sources

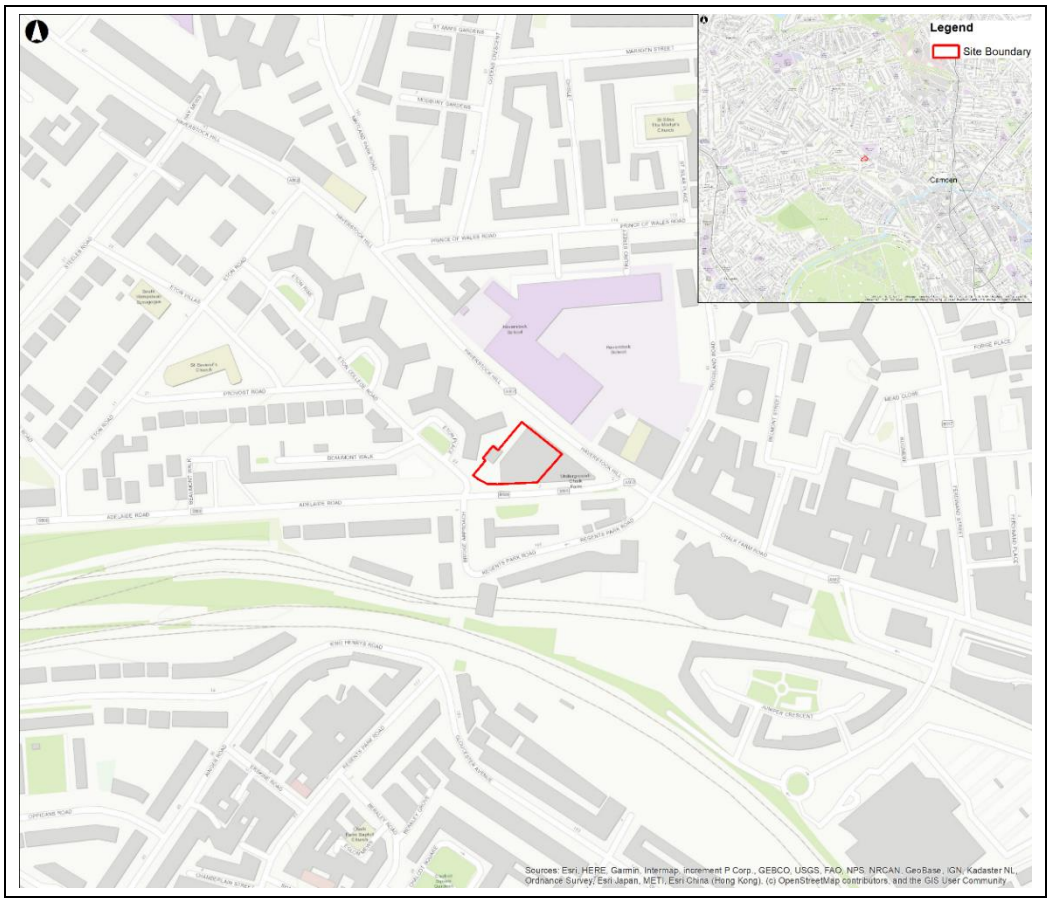
The site and surrounding area have been described based on the following data sources:

- GEA (2016) Site Investigation and Basement Impact Assessment (BIA) [1]. The full report is available on the LBC planning portal (ref. 2016/3975/P);
- Landmark (2020) Envirocheck Report (dated 8th July 2020) contained in Appendix A [10];
- Google Inc (2020) *Google Earth*. Accessed August 2020 [11]; and
- A site walkover undertaken by an Arup consultant on the 7th August 2020.

2.2 Site location

The site is approximately 0.27 hectares and situated in the London Borough of Camden at National Grid Reference 528102E 184424N. The site is an irregular block shape situated at the junction between the A502 Haverstock Hill and B509 Adelaide Road. Chalk Farm Tube Station is located adjacent to the south eastern site boundary. The site boundary and location plan are shown in Figure 1.

Figure 1 Site location plan



2.3 Site description

2.3.1 Current site uses

The site comprises a six-storey building with a partial basement and associated outside referred to as Eton Garage, adjacent to Chalk Farm Tube Station. The interior comprises a series of 10 staggered floor levels with spiral ramps for car parking and ancillary office space. Small retail units are along the frontage of Adelaide Road and a showroom along the Haverstock Hill frontage. The site layout drawings are included in Appendix B1.

2.3.2 Topography

The site is relatively flat at approximately 31.9 metres above Ordnance Datum (OD). There are no major changes in topography across the site area.

2.3.3 Site reconnaissance

The following site visits have been undertaken:

- A walkover in 2016 by GEA as part of the BIA [1]; and
- A site reconnaissance by an Arup environmental consultant on 7th August 2020.

The GEA site walkover made the following observations:

- Three interceptors were observed on the lower ground level floor. The covers were lifted and were observed to be filled with sludge with a sewage odour;
- A storage room with spare car parts and chemical containers were observed, although no indication was available on the contents;
- Scarring of likely utilities and services were observed within an area of hardstanding towards the northwest of the main building. A vent was observed along a manhole cover which was lifted and found to have been infilled. Additional interceptors were identified within this area; and
- Anecdotally the lower ground floor becomes flooded during heavy rainfall.

The Arup visit notes and photographs are provided in Appendix C. The following observations were made:

- The site was previously occupied by “live-in guardians” and all external access doors and windows at ground level have been sealed apart from a single entrance from the yard;
- The stores and office rooms were typically empty apart from waste left from previous occupants;
- A room labelled as a chemical store was locked and not accessible;
- Three manhole covers within the garage area appeared to be linked to drainage and may have provided access to interceptors or tanks; and

- Three manhole covers in the external yard may be linked to previous refuelling activities onsite although no infrastructure associated with refuelling such as pumps or refill points were observed.

2.3.4 Surrounding area

The site is situated within an area of mixed residential and light commercial use. Chalk Farm Tube Station and associated underground line is located adjacent to the south eastern boundary. A block of high-rise flats is present adjacent to the north west. The London Overground rail line is present 120m to the south.

2.4 Proposed development

The proposed development comprises the demolition of the existing building and construction of a part six, part seven-storey development comprising 77 residential units and retail use at ground floor with associated cycle parking, amenity space, refuse and recycling store and associated works. The proposed development includes an area of soft landscaping is proposed at ground level and a semi-basement beneath part of the site. The consented development drawings are presented in Appendix B2.

Preliminary foundation options are indicated to be a piled solution with pile lengths anticipated to be between 25m to 35m, within the London Clay.

3 Site history

3.1 Information sources

The historical development of the site has been determined on the following information sources:

- Historical mapping from Envirocheck report (2020) [10];
- John Rocque's London 10 miles round map (1746);
- C. and J. Greenwood (1828) map;
- Google Inc (2020) *Google Earth*. Accessed August 2020 [11];
- Camden Council, environmental search, August 2020 (Appendix D);
- GEA (2016) Site Investigation and Basement Impact Assessment [1];
- The Bomb Sight Website [12], accessed August 2020; and
- 1st Line Defence (2015) Preliminary UXO Assessment [13] as contained within the GEA BIA [1].

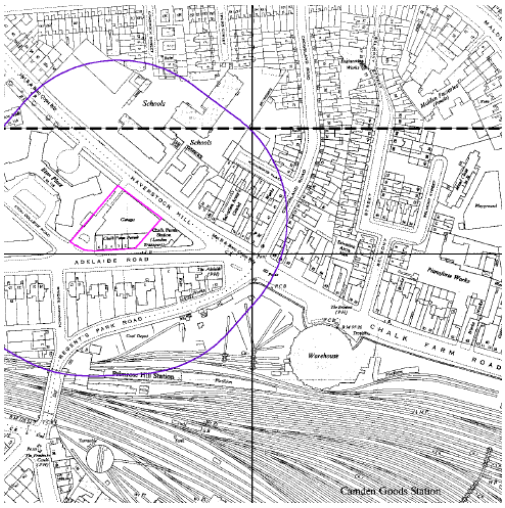
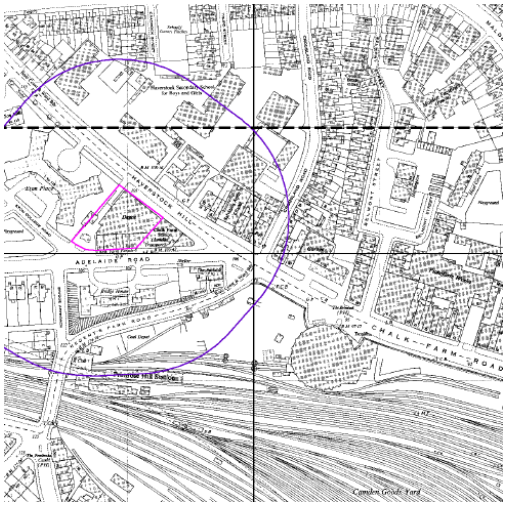
3.2 Site history

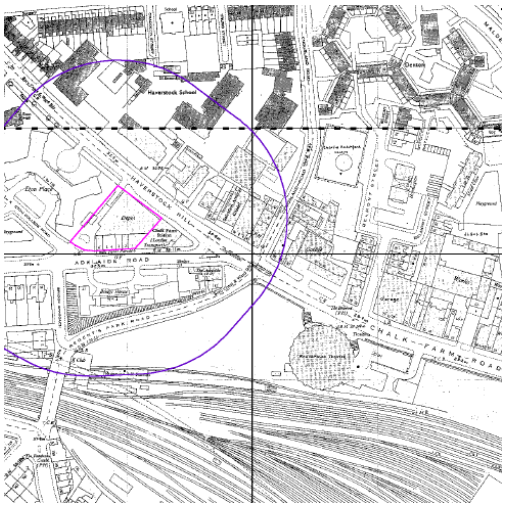
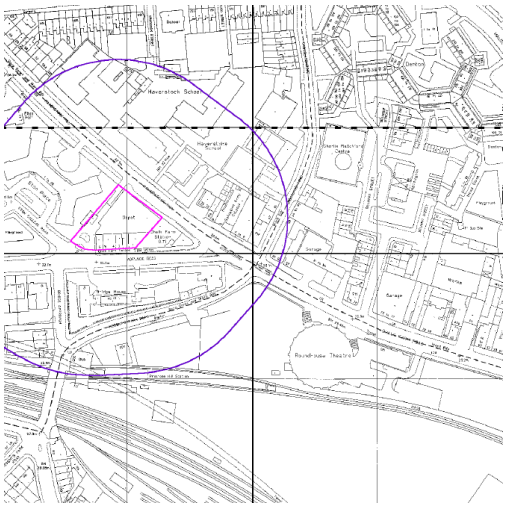
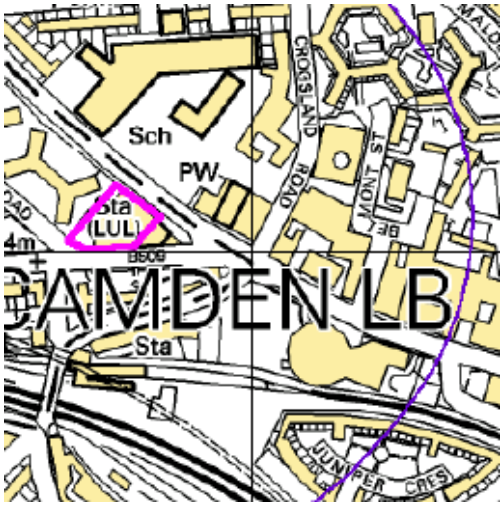
A summary of the site history and development outlining potentially contaminative land uses is presented in Table 1. All readily available historical maps are presented within the Envirocheck Report in Appendix A and are licensed under © crown copyright licence number 100022432.

Table 1 Historical review

Date	Map extract	Description
John Roque 1746	This map was viewed online. The site and its surroundings are shown as undeveloped land comprising of open fields.	
Greenwood 1828	This map was viewed online. The site is shown as undeveloped land comprising fields. Residential properties line Haverstock Hill Road.	
1873 to 1882 Ordnance Survey 1:10,560 1875 Ordnance Survey 1:2,500 (shown)		**Onsite** The site comprises of five terraced residential properties with gardens. **Offsite** The site is surrounded by a residential area to the west, north and east. Camden Goods Rail Depot is present 90m to the south comprising rail sidings, weighing machines, a railway turntable and engine sheds.

Date	Map extract	Description
1896 Ordnance Survey 1:10,560 1896 Ordnance Survey 1:2,500 (shown)		**Onsite** No significant changes to the site are shown. **Offsite** A school has been constructed 80m to the northeast. Chalk Farm Train Station is present within the Camden Goods Rail Depot 90m to the south. Additional sidings have been constructed linking Chalk Farm Station to a coal depot.
1916 Ordnance Survey 1:2,500 (shown) 1920 Ordnance Survey 1:10,560		**Onsite** No significant changes to the site are shown. **Offsite** Chalk Farm Tube Station is shown to be present adjacent and east of the site. The school to the north east has expanded towards the site.
1938 Ordnance Survey 1:10,000		**Onsite** The residential properties on the site are no longer present. The contemporary building is shown to have been constructed, which was used as a private garage, with motor showroom and petrol station and shops at ground level on Adelaide Road. **Off-site** Residential properties to the north west have been demolished and replaced with high-rise flats.

Date	Map extract	Description
1946 Aerial photography		**Onsite** No significant changes to the site are shown. **Offsite** The school to the north east is shown to be in a different layout than on previous mapping.
1954 Ordnance Survey 1:2,500 (shown) 1957 - 1958 Ordnance Survey 1:10,000		**Onsite** The six shop units along Adeline Road are show as Chalk Farm Parade. From c.1956, the site was occupied by the British Transport Police. **Offsite** An unspecified works is shown to be approximately 60m to the south east, adjacent to a public house.
1963 Ordnance Survey 1:2,500 (shown) 1968 Ordnance Survey 1:10,000		**Onsite** No significant changes to the site are shown. The garage is denoted as a depot. **Offsite** The most northerly sidings within Camden Goods Yard are no longer present. A garage (petrol fuelling station) is present 130m to the east. Residential properties adjacent and to the south of the site have been developed into three small blocks of residential flats.

Date	Map extract	Description
1982 – 1983 Ordnance Survey 1:1,250 (shown) 1985 Ordnance Survey 1:10,000		**On-site** No significant changes to the site are shown. **Off-site** The sidings at Primrose Hill Station are no longer shown as present. By 1987, a large section of the most northern sidings from Camden Goods Depot have been removed. The unspecified works 60m to the south east is no longer present and the building layout has changed.
1991 - 1996 Ordnance Survey 1:1,250 (shown) 1991 - 1996 Ordnance Survey 1:10,000		**On-site** No significant changes to the site are shown. **Off-site** The garage 130m to the east is no longer present. Residential development is shown on the area that was formerly the northern sidings of Camden Goods Depot.
2006 Ordnance Survey 1:10,000 and aerial imagery		**On-site** No significant changes to the site are shown. **Off-site** The area sidings are shown to be a vehicle storage area. This was then developed into five small buildings and paved car parking. A multi-use games area has been developed at the school to the north east.

On-site, the main historical changes can be summarised as follows:

- Initially the site was open field then developed for residential properties shown in earliest available mapping to the 1930s;
- The building in its current form was developed by 1938;

- The site is labelled on mapping as a garage from the 1954 to 1963; and
- From 1963 onwards, the site is shown as a depot.

Off-site development has largely occurred to the southeast and includes:

- Camden Goods Depot which has included a coal depot, engine sheds and large-scale rail infrastructure located approximately 100m to the southeast. The area closest to the site is shown to have been redeveloped into a car park during the late 1980s and early 1990s.
- A petrol station was present 130m east of the site, however this is shown to have been redeveloped and is no longer shown on the 1991 mapping.

3.2.1 Additional information

The GEA BIA identifies that the existing building previously included a petrol fuelling facility, workshop, washing bay, store and battery charging room [1]. The small fuelling facility was associated with the former use as a garage and that an underground storage tank may have been present. The GEA report highlighted that whilst the site has been recorded as a garage and depot on historical maps, the building has primarily been used as a showroom and vehicle storage for the British Transport Police.

An enquiry to the London Fire and Emergency Planning authority was included in the GEA BIA [1]. The response indicated that there was no specific information for the tanks held on file.

3.3 Environmental search and planning records

A request for a search for environmental information related to the site was submitted to Camden Council in August 2020. The Camden Council website [14] has also been reviewed and provides information on planning applications. The following information was provided for the site:

- The site has not been classified as ‘contaminated land’ under Part 2A of the Environmental Protection Act 1990. The definition of contaminated land under the Part 2A regime applies to existing sites, and is different to that applied to ‘land affected by contamination’ under the planning regime for sites being developed, with the latter being more sensitive;
- There are no records of current or former landfills on-site or within 250m of the site boundary;
- The site is recorded as being formerly used as a motor garage and repair workshop;
- Land uses within 100m of the site include coal and coke merchants (1923 to 1961), plumbing and sanitary engineers (1971), numerous plots of railway land (1894 to 1971), three unspecified works (1934 to 1939 and 1952 to 1954), garages (1952 to 1954) and a coal depot (1952 to 1955);
- No current Part A or Part B environmental permitted industrial processes are present within 100m of the site;

- There are no private water supplies within 2km of the site;
- Camden Council has provided a moderate risk score of contamination being present within 100m of the site, and
- A planning application (ref: 2016/3975/P) was submitted in 2016 to develop the site which included the demolition of the existing building and erection of a part-six, part-seven storey development comprising 77 residential units (Use Class C3) and retail (Use Class A1-A5) use at ground floor with associated cycle parking, amenity space, refuse and recycling store and associated works.

The environmental search received from Camden Council is included in Appendix D.

3.4 Unexploded ordnance

The bombsight website [12], as adapted from the Bomb Census Maps contained within the National Archives Image Library [15] identifies several high explosive bombs and a parachute mine to have been recorded in areas adjacent to the site. The LCC bomb damage maps [16] shows that the building onsite sustained blast damage but was not directly hit and that buildings surrounding the site were seriously damaged and/or damaged beyond repair.

A desk based preliminary unexploded ordnance (UXO) assessment was undertaken by 1st Line Defence [13] to support the previous planning application and was included as part of the GEA BIA [1]. The UXO assessment provided the following conclusions:

- There were no known military uses close or on site;
- There was evidence of bomb strikes near the site including the adjacent school and buildings to the north west, although no direct hits to the site;
- The adjacent school was recorded as being destroyed;
- The garage and depot were observed to have survived the second world war intact and unchanged based on available mapping; and
- There is a minimal risk of encountering ordnance at the site and additional research would not cause a significant change to the assessed minimal level of risk.

4 Environmental setting

4.1 Information sources

The environmental setting describes the published geology, published hydrogeology, groundwater and surface water features and abstractions, and any waste or permitted activities. A search distance of up to 500m has been used to identify features relevant to the site. The following data sources have been used to inform this section:

- Landmark (2020) Envirocheck Report (dated 8th July 2020) contained in Appendix A [10];
- GEA (2016) Site Investigation and Basement Impact Assessment [1];
- British Geological Survey (BGS) GeoIndex, accessed August 2020 [17], [18];
- BGS Geological Map for North London Sheet 256 [19];
- Bromhead, C. (1925), Memoirs of the Geological Society for England and Wales, Explanation of Sheet 256: The Geology of London [20]
- DEFRA's MAGIC Maps accessed August 2020 [21],
- Environment Agency's Long-Term Flood Risk Map [22]; and
- OpenStreetMap Website [23]

4.2 Published geology

The BGS map for North London sheet 256 [19] indicates the geology at the site comprises of the London Clay Formation. The London Clay is underlain at depth by a downward sequence comprising the Lambeth Group, Thanet Formation and Chalk [20].

No superficial deposits are recorded on BGS maps or historical boreholes. A description of the strata is provided in the following sections:

4.2.1 Made Ground

Made Ground is not shown to be present on the BGS map. However, it has been identified during previous investigations undertaken at the site.

Descriptions, thicknesses and distribution of Made Ground encountered within previous investigations are discussed in detail within Section 5.2. The Made Ground at the site is variable comprising of brown mottled clay with rare orange-brown partings of sand and silt with medium to coarse subangular flint, brick, metal, ash, coal and rootlets.

4.2.2 Bedrock geology

Bedrock geology at the site is recorded as the London Clay Formation, which is described by the BGS [18] as mainly comprising bioturbated or poorly laminated blue-grey or brown-grey silty clay with some layers of sandy clay.

The London Clay within the Camden area is anticipated to have a thickness of approximately 50m underlain by the Lambeth Group, the Thanet Formation and Chalk. One historic borehole (TQ28SE6) 390m to the southeast has proven the base of the clay at 49m below ground level (bgl) (-19m OD). The Lambeth Group is described by the BGS as a sequence of mainly clays with some silty or sandy minor limestones and occasional sandstone. The Thanet Formation is described as glauconite, pale-brown fine-grained sand, and the Chalk, which forms the primary water bearing strata in London.

4.2.3 Geological faults and linear features

No faults or linear features are shown to be within 500m of the site [17].

4.2.4 BGS borehole records

No BGS boreholes are recorded on site. Four borehole records were identified within 100m [17] of the site. One borehole beyond the 100m search has been included based on the depth of 129m bgl and records the base of the London Clay. The strata recorded within the BGS boreholes typically conforms to published geology encountering Made Ground over London Clay. BGS boreholes are summarised in Table 2. A summary has been included within Section 5.22 where the findings of the previous ground investigation are discussed in more detail.

Table 2 Summary of BGS boreholes

Reference	Distance[1]	Date	Depth[2] (m bgl)	Strata encountered[1] (m bgl)
TQ28SE299	44m east	N/A	9.1	0 to 0.6 Made Ground 0.6 to 9.1 London Clay
TQ28SE23	44m east	N/A	9.3	0 to 9.3 London Clay
TQ28SE217	82m north east	May 1999	5.0	0 to 0.3 Hard core 0.3 to 0.6 Made Ground 0.6 to 5.0 Brown Clay
TQ28SE217/A-B	82m north east	May 1999	5.0	0 to 0.4 Topsoil 0.4 to 1.2 Made Ground (Clay) 1.2 to 5.0 Brown Clay
TQ28SE6	390m south east	1849	129	0 to 5.5 Made Ground 5.5 to 49 London Clay 49 to 69 Lambeth Group (clay and sand) 69 to 71 Thanet Sand 71 to 120 Chalk

1 Distances are based on the position shown on the BGS' GeoIndex and are not likely to be reflective of the exact borehole position

2 Depths have been converted from feet and inches to metres and rounded to two significant figures.

4.3 Radon

The site is within a lower probability radon area where less than 1% of homes are estimated to be at or above the action level (200Bq/m^3) [10]. The Envirocheck report states that no radon protection measures are necessary in the construction of new dwellings or extensions.

4.4 Hydrogeology and hydrology

4.4.1 Hydrogeology

The London Clay is designated as an unproductive aquifer which is defined as rock that has negligible significance for water supply or baseflow to rivers, lakes or wetlands. The London Clay is low permeability [24].

A deep aquifer is present within the lower permeable layers of the Lambeth Group, the Thanet Formation and the Chalk. This is often referred to as the chalk-basal sands aquifer of the London Basin. The Chalk is classified as a principal aquifer, described as layers of rock or drift deposits with high intergranular or fracture permeability providing a high level of water storage. The lower Lambeth Group and Thanet Formation are classified as secondary A aquifers.

No vulnerability rating has been assigned to the London Clay due to its unproductive designation and can be considered protective from surface activities and their associated risks to groundwater.

Localised groundwater is anticipated to be perched above the London Clay with no defined flow or flow direction. Groundwater flow is likely to be influenced by the presence of basements and inhibited vertically with the London Clay acting as an aquiclude.

The site is not located within an Environment Agency designated source protection zone (SPZ). A SPZ is located to the south west with the SPZ Zone 2 388m and the SPZ Zone 1 597m from the site boundary.

The closest permitted abstraction is recorded as 725m to the east and is used for commercial and industrial use. The closest potable water supply is recorded as 827m to the southwest.

4.4.2 Hydrology

The closest recorded surface water feature is the Regent's Canal located approximately 520m to the south east at its closest point. The Lost Rivers of London map [25] indicates that historically the River Fleet was located approximately 150m to the east of the site flowing in a south easterly direction, and a tributary of the River Tyburn was located approximately 120m west of the site flowing in a southerly direction. No major rivers or other notable surface water features are recorded within 500m of the site.

There are no surface water abstraction licences or discharge consents within 500m of the site. The closest surface water abstraction licence is recorded as 543m to the southeast and is used for industrial and commercial use.

4.4.3 Discharge consents

No active or historic discharge consents to groundwater or surface water are located within 500m of the site.

4.5 Flood risk

The site is situated within a Flood Risk Zone 1 which is recorded as having a very low probability (less than 0.1% per annum [22]) of flooding from rivers or sea.

Flood risk from surface water on-site is indicated to be very low (less than 0.1% per annum). The risk adjacent to the site along Adelaide Road and Haverstock Hill is recorded as medium (between 1.1% and 3.3% per annum [22]).

The site is recorded as not situated within an area susceptible to groundwater flooding [10].

The GEA BIA indicated that during heavy rainfall the basement of the current building floods, however it is unknown how water enters the building [1].

4.6 Waste and permitted activities

There are no recorded current or historic landfill sites, waste transfer or treatment sites within 500m of the site.

There are seven listed Local Authority pollution and prevention controls within 500m of the site. The recorded controls are summarised in Table 3.

Table 3 Records of pollution prevention and control records

Name and Address	Distance from Site	Status	Activity	Date
Texaco, 81-85 Chalk Farm Road, London, NW1 8AR	149m east	Site Closed	Petrol / Filling Station	24-DEC-1998
Lex Volvo, 1 Dumpton Place, Gloucester Avenue, Chalk Farm, London, NW1 8JB	273m south west	Authorised	Respraying of road vehicles	07-JAN-1994
Primrose Valet, 91 Regent's Park Road, London, NW1 8UR	290m south west	Permitted	Dry cleaning	28-JAN-2009
The Dry Cleaners of Hampstead, 80 Haverstock Hill, London, Nw3 2be	317m north west	Permitted	Dry Cleaning	25-JUN-2007
Wm Morrisons Supermarkets Plc, Chalk	421m south east	Permitted	Dry Cleaning	26-JAN-2007

Name and Address	Distance from Site	Status	Activity	Date
Farm Road, London, NW1 8AA			Petrol Filling Station	22-DEC-1998
Esso, 29 Chalk Farm Road, London, NW1 8AG	461m east	Permitted	Petrol Filling Station	24-DEC-1998

4.7 Sensitive environmental land uses

Adelaide Local Nature Reserve is shown to be 400m to the south west. There are no other environmentally sensitive sites such as Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC) or Special Protection Areas (SPA) within 500m of the Site.

Two Grade II listed buildings are present within 100m of the site. These are summarised in Table 4.

Table 4 Summary of listed buildings

Name	Distance From Site	Date Listed
Chalk Farm Underground Station	6m east	20/07/2011
2 and 3, Eton College Road	90m west	14/05/1974

4.8 Tunnels and underground features

The nearest underground tunnel is located adjacent and to the north of the site. The tunnel is the London Underground Northern Line (Edgeware Branch) and traverses beneath Haverstock Hill Road in a north westerly-south easterly direction. Correspondence contained within the GEA BIA [1] indicates that the tunnel crown is at an elevation of 21.9mOD which is approximately 10m bgl.

5 Previous ground investigations

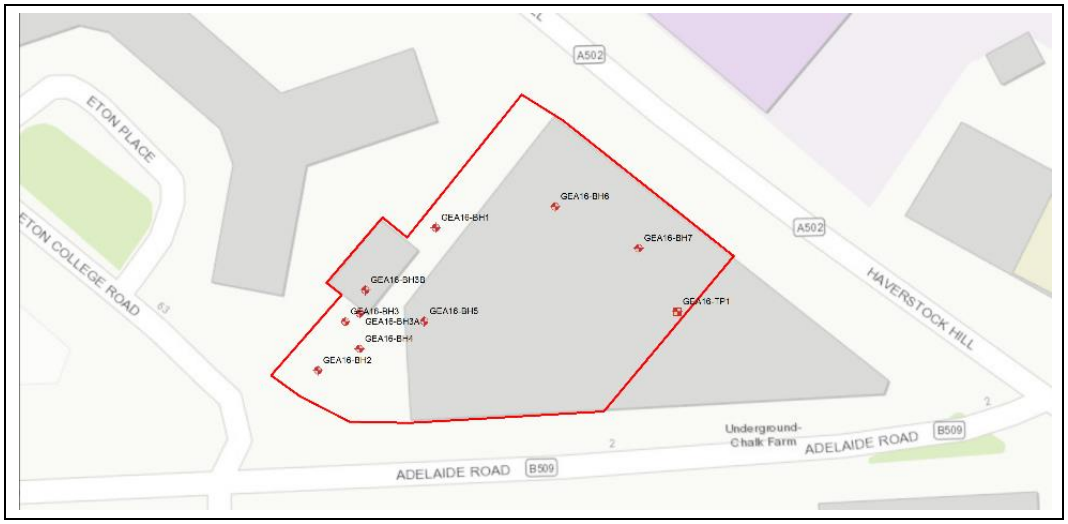
5.1 Scope of investigations

As part of a previous planning application for the site, GEA undertook a ground investigation to support a BIA [1]. The scope of the investigation included both geotechnical and geoenvironmental objectives. The geoenvironmental elements of the investigation comprised of:

- Two cable percussion boreholes to depths of 15m bgl and 24.7m bgl;
- Two window sample boreholes within the lower car park to depths between 3m bgl and 10m bgl;
- Three window sample boreholes at ground level to depths between 4m bgl and 5.2m bgl;
- One hand dug trial pit to a depth of 1.2m bgl;
- Installation of three groundwater monitoring standpipes. Level monitoring was undertaken on two occasions; two and six weeks after the investigation;
- A soil vapour survey using a photoionisation detector (PID) across the lower car park level and internal ground level; and
- Fifteen soil samples scheduled for chemical testing.

No ground gas monitoring or groundwater sampling was undertaken as part of the investigation. Most of the boreholes were located within the south western extent of site due to access restrictions that prevented additional boreholes within the main building. A plan showing the borehole locations is shown in Figure 2.

Figure 2 Borehole location plan



5.2 Ground conditions

The investigation encountered the anticipated geological conditions as previously outlined in Section 4.2. A summary of the strata encountered is presented in Table

5. The elevations of the boreholes are not included on the borehole logs and as such only strata thickness ranges can be summarised. The borehole logs are included in Appendix E.

Table 5 Summary of stratigraphy

Strata	Typical Description	Depth (m bgl)
Made Ground (Hardstanding)	Tarmac	0.00 to 0.08
	Reinforced concrete	0.15 to 0.60
Made Ground	Made Ground: brown mottled clay with rare orange-brown partings of sand and silt. Medium to coarse subangular flint, brick, metal, ash, coal and rootlets	0.15 to 2.60
London Clay	Firm becoming stiff brown mottled grey fissured clay with occasional selenite crystals.	0.45 to 24.7[1]
1 The base of the London Clay was not proven		

A metal obstruction was encountered at a depth of 0.56m bgl in BH3A and identified by GEA as a possible underground tank. Concrete was encountered at a depth of 2.5m in BH2 and identified by GEA as a possible foundation of a previous building.

Made Ground was encountered across the areas investigated. In the north eastern area (BH6 and BH7), the Made Ground had a nominal thickness between 0.15m and 0.20m of screed and concrete overlying clay. Made Ground is likely to be absent in these areas as it would have been excavated to form the existing basement structure. Made Ground was observed to be 1.8m thicker within the western extent of the site and was recorded to typically comprise of brown to orange sand with fragments of concrete and brick, metal, ash and coal.

Made Ground encountered within the building footprint in BH5 was noted to differ and is described as ‘brown silty sandy clay and dark grey mottled black clay with concrete fragments and decayed wood’. Visual and olfactory observations included organic odours and ‘mottled black clay with decayed wood’ noted in BH6.

5.3 Groundwater monitoring

Groundwater was not encountered during the GEA investigation works however seepage from the base of the Made Ground in BH2 (2.6m bgl) was observed. Perched water was encountered within the upper horizon of the London Clay at BH3B (3.43m bgl) and at the base of TP1 (0.98m bgl) adjacent to the western wall of Chalk Farm Station.

Three standpipes were installed in BH1, BH2 and BH6 and level monitoring was undertaken on two occasions; 18th December 2015 and 13th January 2016.

The response zones of the monitoring wells are not detailed on the borehole logs. The records indicate the standpipes were installed to depths of 6m bgl in all three locations. Therefore, it is possible that the screening zones are across both the Made Ground and London Clay. A summary of groundwater monitoring is shown in Table 6. The elevations of the boreholes are not presented within the GEA

report and as such water level can only be expressed as depths below ground level.

Table 6 Summary of groundwater monitoring

Date	Borehole	Depth (m bgl)	Corresponding Strata
18th December 2015	BH1	2.08	Made Ground
	BH2	1.88	Made Ground
	BH6	Dry	N/A
13th January 2016	BH1	2.05	Made Ground
	BH2	1.87	Made Ground
	BH6	3.72	London Clay

5.4 Chemical testing

GEA scheduled four samples of Made Ground and eleven samples of London Clay for the following chemical testing:

- General inorganics;
- Metals and metalloids;
- Speciated banded total petroleum hydrocarbons (TPH);
- Speciated polyaromatic aromatic hydrocarbons (PAH); and
- Total phenol.

Three of the four Made Ground samples were scheduled for asbestos testing. Based on the conceptual site model (and lack of controlled waters receptors), no groundwater or soil leachability tests were undertaken as part of the investigative works.

5.5 GEA contamination assessment

GEA included an assessment of contamination within the BIA [1] as part of the previous planning permission 2016/3975/P. The contamination assessment included a basic conceptual site model (CSM), qualitative risk assessment and a generic quantitative risk assessment based on the data obtained.

GEA's qualitative assessment identified the following:

- The main source of contamination is likely to be the associated with the former fuelling facility and potentially buried tanks at the site;
- Buried services are likely to come into contact with any contaminants;
- Site workers are likely to be exposed to contaminants in soil via dermal contact and inhalation of vapours during demolition and construction;
- End users will be isolated from any contamination in shallow soils however a pathway may exist for any soft landscaped areas;

- Groundwater is not a receptor based on the low permeability of the London Clay and limited migratory pathway;
- There are no potential sources of soil gas on or within 250m of the site; and
- The overall risk rating for the site was considered by GEA as low to moderate.

There are a number of potential plausible pollutant linkages that were not considered in the GEA report which are discussed later in this report.

5.5.1 GEA generic quantitative risk assessment

GEA's assessment compared chemical data to generic assessment criteria (GAC) for residential use including consumption of homegrown produce using the following generic assessment criteria:

- DEFRA (2014) SP1010 Development of Category 4 Screening Levels for the assessment of land affected by contamination (C4SLs) [26];
- LQM/CIEH (2015), The LQM/CIEH Generic Assessment Criteria for Human Health Risk Assessment [27]; and
- Environment Agency's soil guideline values [1].

This is an overly conservative assessment considering the proposed development.

GEA's assessment identified arsenic and lead as above the GAC within the Made Ground. This included arsenic in BH4 (0.60m bgl) and three lead results in BH3A (0.40m bgl), BH3B (0.80m bgl) and BH5 (0.60m bgl). No asbestos was identified within the samples scheduled for tests.

5.5.2 Soil vapour survey

GEA undertook a soil vapour survey (SVS) within the existing lower level car park in the area of the manhole covers which are understood to have been interceptor tanks. The SVS comprised 32 probe holes in a uniform grid at lower car park level and three positions at internal ground level to a depth of 1.00m bgl.

A plan showing the area of the survey is included in Appendix E. GEA conclude that no vapours were detected during the survey.

5.5.3 GEA conclusions

The contamination assessment undertaken by GEA concluded the following:

- There are no records relating to fuel tanks and it is unknown if any tanks have been removed or decommissioned;
- Chemical testing identified one instance of arsenic and four instances of lead as elevated above GAC within the Made Ground;

[1] These are withdrawn and should not be used

- GEA infers the source of the metal contamination is likely to be extraneous fragments;
- The lead and arsenic are non-volatile or of low volatility and does not present a vapour risk;
- Compounds are likely to be of low solubility and a risk to groundwater has not been identified;
- Contamination could pose a risk to human health through direct contact, accidental ingestion or inhalation of soil or derived dust;
- TPH bands EC16 to EC35 were measured as above detection limits and are characteristic of diesel and heavy heating oil;
- Concentrations within the London Clay were not elevated above the assessment criteria;
- End users are isolated from direct contact with contaminants by the extent of the building and external hardstanding. For soft landscaped areas a cover thickness of imported subsoil and topsoil of 600mm was recommended to break any pathways;
- GEA recommended a discovery strategy to be in place during construction to define the procedures should previously unidentified contamination be encountered; and
- GEA identify that the metal object encountered in BH3 may be a buried tank and state that it would further investigation should be undertaken once services have been disconnected.

6 Updated review of existing data

6.1 Overview

The data from the GEA investigation has been reviewed for suitability of the design as outlined in Section 2.4. Review of the GEA BIA has highlighted the following uncertainties:

- The ground conditions within the central and southern area are unknown;
- No chemical testing was undertaken within the north western and south western extents of the site;
- Arsenic and lead were shown to exceed generic assessment criteria that were overly conservative for the proposed development, and;
- There is a potential for USTs to be present within the south western extent of the site.

The adequacy of data including the spatial distribution of exploratory holes, chemical testing and the findings of the GEA Generic Quantitative Risk Assessment have been reviewed using relevant guidance including BS10175:2011+A2:2017 Investigation of potentially contaminated sites, Code of Practice [8], BS ISO 18400-104:2018 Soil Quality – Sampling [28], and Environment Agency guidance (Land Contamination: Risk Management) [9].

6.2 Ground investigation

It is understood that the ground conditions within the central and southern area are unknown as access was limited during the GEA investigation. Despite access restrictions, ten exploratory holes have been advanced within the site area of 0.27ha. The total number of chemical tests on Made ground was low, with most tests undertaken on London Clay. The higher proportion of tests undertaken on natural soils appears to be due to the absence of Made Ground encountered (other than hard cover and sub-base) in the building area (and boreholes BH4 to BH7).

Based on the spatial distribution of the exploratory holes and the site layout, the investigation can be zoned into two distinct areas; the external area and the building footprint area.

The following observations can be made regarding the external area:

- Borehole density is considered sufficient as six out of ten boreholes were advanced within this area;
- Scheduling of testing is mostly sufficient however no samples were scheduled from BH1 and BH2 located within the northwest and southwest extents;
- Chemical testing undertaken is considered appropriate based on GEA's historical review and conceptual site model. However, volatile organic compounds and semi-volatile organic compounds (VOC and SVOC) testing would have been beneficial to inform the assessment from vapour risk; and

- Asbestos testing was limited to three of the four samples of Made Ground.

The following observations can be made regarding the building footprint area:

- Borehole distribution is spread across the western and northern extent of the building;
- No exploratory holes were advanced within the southern and central areas of the site due to access restrictions and the presence of the building;
- The existing basement structure is constructed directly on the London Clay;
- Made Ground was encountered within the western area of the building but not in the north and eastern area;
- Chemical testing was considered appropriate based on GEA's historical review and conceptual site model. However, VOC and SVOC testing would have been beneficial to support the assessment from vapour risk; and
- GEA undertook a soil vapour survey within the areas that could not be investigated. Whilst this does not provide detail on potentially contaminative conditions such as presence and composition of Made Ground within this area, it does provide an indication that no elevated vapours were present.

6.3 Generic quantitative risk assessment review

GEA's assessment only comprised of a human health risk assessment. GEA qualitatively addressed risks to controlled waters by stating that there are no sensitive controlled water receptors, and risk from ground gas by stating that there are no significant sources.

A maximum thickness of 2.6m of Made Ground has been encountered. Using the guidance contained in CLAIRE's Research Bulletin 17 [29], it is reasonable to assume Made Ground of this thickness is unlikely to have a high gassing potential and be a credible source of ground gas.

GEA have not included the aquifers underlying the London Clay as a receptor. As the foundation design has not been fully conceived yet, these aquifers have been included in the conceptual site model detailed in Section 7. However, at this stage it is considered unlikely that piling would extend down to the deep aquifer.

GEA compared the soil chemical analysis to residential with consumption of home grown produce GAC. The production and consumption of homegrown produce was not included in GEA's conceptual site model and is not anticipated within the proposals for the new development. As such it provides a very conservative assessment of the potential risks to future users.

Due to the conservative nature of the previous assessment, Arup have reassessed the soil chemical analysis against 'residential without homegrown produce' assessment which are considered more applicable to the consented development.

Comparison to Arup's GAC identified lead and arsenic above the GAC within the Made Ground and London Clay, although the sample of London Clay could be

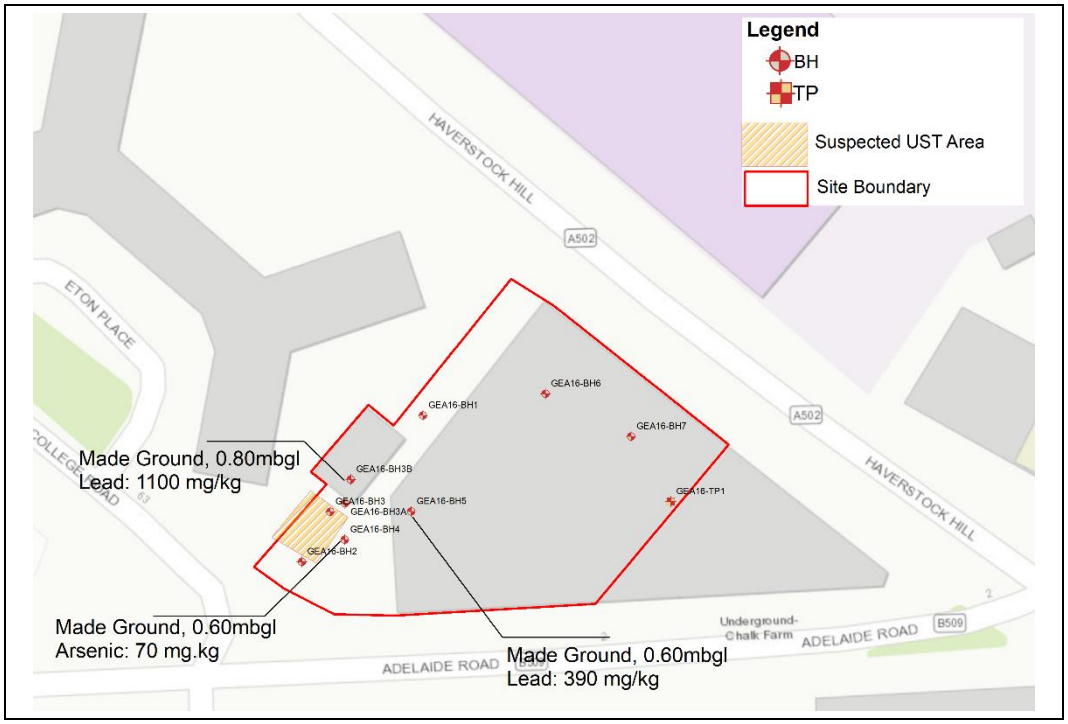
interpreted as Made Ground based on the lithological description. A summary of exceedances above the adopted criteria is presented in Table 7.

Table 7 Comparison of chemical data to Arup assessment criteria

Analyte	GAC	Min	Max	Number	Location	Depth (m bgl)	Strata
	mg/kg						
Arsenic	37	11	70	1	BH4	0.60	Made Ground
Lead	200	16	1100	2	BH3B	0.80	Made Ground
					BH5	0.60	Made Ground

Locations of the results above GAC and the area of the potential underground storage tank (UST) and interceptors are shown in Figure 3.

Figure 3 Location of results above GAC



TPH bands EC16 to EC25 and PAHs (chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, indeno(1,2,3-c,d)pyrene, dibenzo(a,h)anthracene and benzo(g,h,i)perylene) were above saturation limits ranging between 9.6mg/kg to 28mg/kg for TPH and between 0.13mg/kg to 1.8mg/kg for PAHs. The concentrations are in Made Ground within BH3, BH3B and BH4 within the vicinity of the metal obstruction encountered during the investigation and the interceptors observed during the Arup site walkover

These concentrations are low and are not characteristic of significant contamination and there was no indication of free product being present. The volatile TPH fractions (i.e. >EC5 to EC16) were not identified above the laboratory detection limit and are unlikely to present a vapour risk. Furthermore, the soil vapour survey did not identify any significant vapours within the existing basement structure. Whilst ground conditions are unknown within the central and southern areas, given the existing development and basement, likely over London

clay, the proposals to extend the basement, and the reassessment of data, any residual risks can be managed during construction and design of the development. Any uncertainties or data gaps have been included within the conceptual site model and contamination risk assessment contained in Section 7.

7 Contamination risk assessment

7.1 Risk classification methodology

A contamination risk assessment has been undertaken based on the available information for the site and the updated assessment of the data undertaken in Section 6.

The method for risk evaluation has been based on a qualitative assessment, taking into consideration the magnitude of the potential severity of the risk, as well as the probability of the risk occurring. The definition of risk and risk characterisations have been adopted from CIRIA 552 [30] and summarised in Appendix F which outlines the risk assessment methodology.

7.1.1 Potential sources

Potential sources of contamination (onsite and offsite) have been identified and are presented in Table 8. Sources have been assigned references S1 to S3.

Table 8 Potential sources of contamination

Source		Contaminants of concern	Comments	Ref.
On-site	Made Ground	Metals and metalloids, PAHs TPH Asbestos, Ground gas VOCs/SVOCs.	Previous investigation confirmed the presence of Made Ground and has identified some contaminants present. Made Ground is typical across London and whilst it can contain sporadic concentrations it is typically not regarded as a significant source term.	S1
	Historical site uses including a garage and vehicle repair workshop	Metals and metalloids, PAHs TPH VOCs/SVOCs	The site has had little development however it is known that the garage and depot had facilities for fuelling and vehicle repair. It is unlikely that the historical uses at the site are a significant source. See item on tanks below	S2
	Underground Storage Tank (UST) and associated pipework and interceptors.	PAHs, TPH, VOCs/SVOCs.	An underground storage tank is anticipated on site along with interceptors and pipework. Soil results indicate low concentrations of hydrocarbons. The contents and the integrity of the tank are unknown. If a tank has deteriorated, then there may be localised contamination; any migration of potential contamination (if present) is likely to have been restricted by the impermeable London Clay.	S3
Off-site	Rail goods depot, petrol	Made Ground from the adjacent developments are unlikely to be contributing significant contamination to the site due to the		N/A

Source		Contaminants of concern	Comments	Ref.
	station, coal and coke merchants, and Made Ground from adjacent development.	distances and no viable pathway for migration. Previous investigations have indicated the presence of perched groundwater, but it is not continuous and there is no defined flow or flow direction. Therefore, any off-site sources are unlikely to migrate to the site.		

7.1.2 Potential receptors

The identified receptors associated with the site are summarised in Table 9. These have been assigned references R1 to R6.

Table 9 Summary of potential receptors

Potential receptor	Sensitivity	Ref.
Human health		
Construction workers and site visitors	Moderate: Construction workers are likely to come into direct contact with potentially contaminated soil and groundwater. Exposure to construction workers can be reduced through by adopting best site practice, good hygiene and task appropriate personal protective equipment (PPE).	R1
Neighbouring site users during construction	Moderate: Neighbouring residential and commercial users could be impacted during construction from airborne dust, fibres and nuisance odours.	R2
End users: site workers, residents and visitors	Low: The proposed development comprises offices, hotel, and residential properties. The site will be mostly covered in hardstanding, with a limited area of soft landscaped with buildings and basement over most the site.	R3
Maintenance workers during operation	Very low: Services are likely to be connected via the basement, removing the requirement for any onsite below-ground maintenance works for utilities.	R4
Ecological receptors		
Vegetation (e.g. shrubs and trees), and soft landscaped areas.	Negligible: there are no designated ecological receptors on or surrounding the site. The development contain a limited area of soft landscaping at ground level, located adjacent to the western site boundary.	N/A
Controlled waters		
Underlying Lambeth Group, Thanet Sands and Chalk Aquifer	Low: The significant thickness of London Clay underlying the site acts as an aquiclude and will prevent downward migration of contaminants. If piled foundations are of sufficient length to penetrate the base of the strata, then a preferential pathway may be created. However, the initial indications are that the proposed piled foundations will not penetrate the London Clay.	R5
Perched water at the base of the Made Ground	Negligible: The London Clay is designated as an unproductive aquifer and of negligible sensitivity. Limited water is anticipated to be perched along the interface between the Made Ground and London Clay.	N/A

Potential receptor	Sensitivity	Ref.
Regent's Canal	Negligible: The nearest surface water feature is the Regent's Canal 520m to the southeast. This has not been considered within the conceptual site model based on no defined groundwater flow from the site, lack of shallow aquifer and underlying London Clay deposits.	N/A
Building materials and services		
Onsite building materials and services	Low: Built infrastructure, foundations and services will come into direct contact with soils and perched groundwater. Built infrastructure such as concrete and water supply pipes should be designed to mitigate aggressive chemical attack or permeation into supply pipes.	R6

7.1.3 Potential pathways

The potential contaminant pathways associated with the are summarised in Table 10. These have been assigned references P1 to P7.

Table 10 Summary of potential contaminant pathways

Potential migration / exposure pathway	Presence of pathway	Ref.
Ingestion of soil or dust (P1a) Inhalation of dust or fibres (P1b) Dermal contact with soil or dust (P1c)	During construction: Construction stage bulk earthworks and excavation, including stockpiling and material movement. During operation: Limited to areas of soft landscaping.	P1a, P1b, P1c
Migration of hazardous gas and vapours and accumulation in confined spaces Inhalation of ground gases (P2a) or vapours (P2b)	Migration, including along any preferential pathways (such as utility trenches, underground tank infrastructure or permeable strata) and accumulation in confined spaces, such as excavations (during construction) or future buildings.	P2a, P2b
Infiltration of rainwater and leaching of contaminants from Made Ground	The proposed development is covered in hardstanding and likely to be positively drained and infiltration and percolation through Made Ground is limited.	P3
Migration of dissolved phase contaminants	Associated with perched water in Made Ground limited potential for mobile contamination to vertically or laterally migrate both on and offsite.	P4
Migration of free phase contaminants	There is the potential for a UST to be present on site. Residual product may be present within the suspected tank or have leaked to the ground.	P5
Creation of preferential pathways during construction	The depth and method of piling is not confirmed but will likely terminate in London Clay. If significant then a foundation works risk assessment may be required to outline any specific mitigation	P6
Direct contact of concrete and services with contaminated soils or groundwater.	Materials such as below ground concrete and potable water supply pipes will be in direct contact with underlying soils. Permeation of contaminants into supply pipes will create a secondary pathway to human receptors.	P7

7.2 Conceptual site model

A CSM for the site has been produced based on the identified sources, pathways and receptors. The CSM identifies the potential contaminant linkages (PCL) at the site and the associated risks. These have been assigned references of PCL1 - PCL5. The CSM is presented in Table 11 (overleaf).

Table 11 CSM and assessment of potential risks

Potential contaminant linkage				**Classification / risk estimation**			**Assessment of potential risks**
Ref.	Source	Pathway	Receptor	Probability	Consequence	Risk Rating	
Risk to human health (construction phase)							
PCL1	S1 – Made Ground S2 – Historical site uses S3 – Potential UST	P1a, b and c – Ingestion, inhalation or dermal contact with soil, dust or fibres P2a and P2b – Migration and inhalation of ground gas or vapours P4 – Vertical and lateral migration of dissolved phase contaminants	R1 – Construction workers	Low Likelihood	Medium	Moderate to Low	Construction workers are the most likely to be exposed to contaminants within Made Ground and/or perched groundwater. Exposure can be mitigated through good site practice, task specific risk assessments, site environmental controls and task appropriate PPE. Advance works may be undertaken in the construction phase (post demolition) to further investigate the tanks and associated pipework and interceptors and specialists used to safely decommission and remove if encountered. If there has been leaks this is likely localised due to the London Clay and can be dealt with in advance of subsequent construction works. Appropriate measures and mitigation would reduce the risk to very low.
PCL2	S1 – Made Ground S2 –Historical site uses	P1b – Inhalation of dust, fibres	R2 - Adjacent site users during construction	Low Likelihood	Mild	Low	Pollution prevention measures and environmental site management will be required during construction. Appropriate mitigation and site controls would reduce the risk to very low.
Risk to human health (end users)							
PCL3	S1 – Made Ground S2 – Historical site uses S3 – Potential UST and associated pipework and interceptors.	P1a, b and c – Ingestion, inhalation or dermal contact with soil, dust or fibres	R3 – Site residents, workers and visitors during operation R4 – Maintenance workers during operation	Unlikely	Mild	Very Low	Chemical data has identified some elevated metals within the Made Ground. The form of construction will prevent exposure to end users and a clean cover system should be placed within areas of soft landscaped areas to break any viable pathways. If hydrocarbons have leaked from the tanks, pipes or interceptors this is best dealt with during advance construction works when proper access can be provided. Any impacted soils can be assessed and removed and documented in the verification report.
		P2a and – Migration and inhalation of ground gas		Unlikely	Mild	Very Low	No significant sources of ground gas have been identified. The Made Ground encountered was up to 2.5m in thickness outside the existing building area and is likely to have a low gassing potential (based on the soil descriptions and low total organic carbon content). Limited thickness of Made Ground was encountered beneath the building area. London Clay has a low gassing potential and there is a lack of natural deposits with a high organic content (e.g. alluvium and peat) at the site and immediate surrounding area. No specific gas protection measures are warranted for the proposed development.
		P2b and P5 – Vertical and lateral migration of non-aqueous phase liquids and vapour potential		Likely	Medium	Moderate	The available information (soil logs, chemical results and soil vapour survey) indicate that there is not a significant vapour risk associated with the site. Ingress of vapour generated from residual free phase product can pose a potential long-term risk to human health. If there were leaks of volatile hydrocarbons from the tanks this can be dealt with during the construction stage and the remediation strategy. It is proposed, if present, to decommission and remove any USTs and potentially impacted surrounding soils. Verification will be required to demonstrate that any tanks and associated infrastructure have been fully removed and no residual significant hydrocarbon source(s) exists within the soil or groundwater.
Risk to controlled waters							
PCL4	S1 – Made Ground S2 – Historical site uses S3 – Potential UST	P6 – creation of preferential pathways through foundation design	R5 – Underlying Lambeth Group, Thanet Formation and Chalk aquifers	Unlikely	Medium	Low	The London Clay will prevent downward migration of contaminants. The depth of the London Clay at the site has been confirmed up to 25m bgl although it is anticipated to be around 50m from historic borehole records for the area. Therefore, it is unlikely that the proposed pile depths (25m to 35m) will penetrate the London Clay. If the proposed piled foundations penetrate the London Clay (and create a potential) pathway then a foundation works risk assessment may be required to address the risks and identify suitable mitigation.
Risk to the built infrastructure							
PCL5	S1 – Made Ground S2 – Historical site uses	P7 – Direct contact of concrete and services with contaminated soils or groundwater	R7 – Onsite building materials and services	Unlikely	Mild	Very low	Risks to the built infrastructure can be mitigated through design. Concrete should be designed in accordance with BRE SD1 [31] to resist aggressive ground conditions. Water supply pipes should be designed in accordance with UKWIR guidance [32] using materials that are suitably resistant to permeation and chemical attack.

8 Conclusions and recommendations

8.1 Conclusions

The site has had limited history of potentially contaminative land-uses. The site is recorded as being a private garage and car showroom, with a petrol station and workshop from the 1930s prior to becoming a depot for vehicle storage in the 1950s.

The previous ground investigation undertaken by GEA in 2016 [1] demonstrates the geological sequence comprises of Made Ground, which is thickest towards the west of the site up to 2.6m. which overlies the London Clay formation, which was encountered to a depth of 24.7m bgl. Localised groundwater is recorded to be perched at the base of the Made Ground.

Nearby BGS boreholes show the Lambeth Group, Thanet Formation and Chalk to underly the London Clay, although these were not encountered during the investigation. The London Clay is not designated as an aquifer while the underlying Thanet Formation and Lambeth Group are designated as secondary A aquifers and the Chalk as a principal aquifer.

Potential sources of contamination are limited to onsite Made Ground and potential underground storage tanks. An underground tank or tanks and associated infrastructure are suspected to be present within the south western extent of the site based a metal obstruction encountered during previous investigations. However, there are no formal records of the presence or of decommissioned tanks at the site.

The previous contamination assessment undertaken by GEA was reviewed in context of the proposed development with chemical testing of soils re-assessed. Arsenic and lead were above residential GAC.

Gaps have been identified within the existing ground investigation data, particularly in the southern and central areas of the site. However, there are various valid reasons for these gaps such as the existing basement overlying mostly London Clay and constraints of the existing building. All the identified contaminant linkages can be managed through construction and design.

A summary of the risk ratings from the contamination risk assessment and conceptual site model is presented in Table 12.

Table 12 Summary of the contamination risk assessment

Receptor	Risk rating
Risk to human health; construction workers and	Moderate to low
Risk to human health; adjacent site users	Low
Risk to human health; end users	Moderate to very low
Risk to controlled waters; underlying chalk aquifer	Low
Risk to controlled waters; Regent's Canal	Negligible

Receptor	Risk rating
Ecology and soft landscaped areas	Negligible
Risk to the built infrastructure	Very low

The potential risks from contamination can be managed and mitigated by appropriate design and implementation of controls during the construction works, as detailed as part of the remediation strategy (refer to Section 8.2.1 and Section 9).

Whilst some results were above GAC, the form of construction will prevent exposure to end users. Therefore, no specific remediation (i.e. source removal) is warranted with regards to those results and the potential risks to human health will be mitigated via appropriate design, such as the provision of clean cover layers in soft landscape areas.

There is a potential for existing underground storage tanks and associated pipework etc. If contamination is present it is likely to be localised due to the underlying low permeability nature of the London Clay deposits. Post demolition, confirmation should be sought as to the presence or absence of tanks and impacted soils through an advanced investigation and remediation strategy. If the USTs, pipework, interceptors and any residual contamination are removed, then the risk of harm to end users will be very low.

8.1.1 Discharge of planning conditions

This report has been prepared to support the discharge Condition 11, parts a) and b) of planning permission 2016/3975/P. It is considered that this report meets the requirements for both parts a) and b) for the reasons as outlined below.

Condition 11 Ground Investigation – part a)

> *"a) a written programme of ground investigation for the presence of soil and groundwater contamination and landfill gas shall be submitted to and approved by the local planning authority in writing; and"*

A ground investigation further to the one undertaken by GEA in 2016 [1] is not considered to be required. The previous investigation was designed to support planning permission 2016/3975/P and whilst this report has identified data gaps, they are considered valid due to the constraints of the existing building. The information from the previous investigation has been sufficient to allow a robust assessment of site conditions to have been undertaken which has concluded that the form of the development combined with cover systems in soft landscaped areas will prevent exposure to end users. It is unlikely that additional testing or investigative works would alter the findings of the risk assessment or the remediation strategy.

Additional investigation to identify the presence/absence of suspected USTs and interceptors (including within the building footprint) will be undertaken the construction phase (post demolition) whereby any encountered USTs, associated infrastructure can be managed under site controls and any affected soils and groundwater can be fully assessed and removed if required. Contingencies for

encountering unexpected gross contamination and USTs are included within the remediation strategy, in section 9.

Condition 11 Ground Investigation – part b)

> *"b) following the approval detailed in paragraph (a), an investigation shall be carried out in accordance with the approved programme and the results and a written scheme of remediation measures shall be submitted to and approved by the local planning authority in writing."*

Sections 9 and 10 of this report provide the remediation strategy and verification plan to be approved by the local planning authority. The remediation strategy and verification plan are suitably robust, considering the encountered ground conditions, proposed end-use and environmental sensitivity.

8.2 Recommendations

8.2.1 Remediation strategy and verification

No specific remediation (i.e. source removal) is warranted based on the available ground investigation information and form of development, where most of the site will be capped with the proposed building. The remediation strategy, as detailed in Section 9, consists of:

- Construction controls e.g. watching brief, dust suppression, good hygiene and appropriate personal protection equipment (PPE);
- Investigate the potential presence of disused USTs and any surrounding contamination and if present, with decommissioning, removal and verification of remaining soils; and
- Verification of the works undertaken above and the imported soils.

Prior to occupation of the development, a verification report will be required to demonstrate that works have been undertaken in accordance with the remediation strategy. The verification plan is provided in Section 10.

8.2.2 Foundation works risk assessment

Depending on the detailed design, a foundation works risk assessment may be required to assess the potential risks of piling through brownfield sites. If required, the foundation works risk assessment should be a standalone document and prepared in accordance with the relevant Environment Agency guidance [33]. This is likely to be a requirement if piles are proposed to fully penetrate the London Clay and create potential pathways to the underlying aquifers.

8.2.3 Aggressive ground conditions assessment

Aggressive ground poses a risk to the built infrastructure which can be mitigated through design. Concrete should be designed in accordance with BRE SD1 [31] to resist aggressive ground conditions. Water supply pipes should be designed in accordance with UKWIR guidance [32] using materials that are suitably resistant

to permeation and chemical attack. These assessments are beyond the scope of this report but should be completed as separate design statements as part of the detailed design.

8.2.4 Waste management

The proposed development will generate quantities of material from excavated Made Ground and the London Clay. Testing for waste classification in accordance with the Environment Agency's WM3 Guidance [34] and waste acceptance criteria testing to identify the most suitable waste disposal stream should be undertaken.

Where possible, the proposed development design and construction works should aim to minimise offsite disposal to landfill. However, based on the proposed development (including semi-basement), potential reuse of site-won material is not anticipated. Where possible, excess material should be sent to a suitably licensed soil reclamation or recycling facility.

8.2.5 Unexploded ordnance

A desktop threat assessment undertaken for the site concludes that there is an overall minimal risk of encountering ordnance at the site [13]. Whilst UXO has not been considered as part of the conceptual site model and is considered a minimal risk, it is recommended that construction workers are made aware of the potential to encounter UXO and the risk should be included as part of the site risk register.

9 Remediation strategy

9.1 Approach and guidance

In accordance with the Environment Agency's LCRM guidance [9], the approach to developing a remediation strategy involves completion of the following:

- Undertake risk assessment (as contained in Section 6.3 and Section 7);
- Define relevant contaminant linkages (as contained in Section 7);
- Define remediation objectives and identify feasible technical and management options which address the contaminant linkages and meet those remedial objectives (as contained in Section 9.1.1);
- Define remediation criteria to provide a measure against which conformity to the remediation objectives can be determined (as contained in Section 9.1.2); and
- Define the requirements to verify the remedial objectives have been achieved (as contained in Section 10).

9.1.1 Remediation objectives

Whilst some results were above GAC, the risk assessment has identified that the form of the development will break pathways to end users. Therefore, deploying technical remedial solutions at the site to reduce the concentration of these contaminants is not required.

The remedial objectives are focused on managing risks by breaking viable pathways, reducing exposure, and removing residual hydrocarbon sources if encountered during construction.

The remedial objectives are summarised below in Table 13 with the relevant contaminant linkage identified within the CSM contained in Section 7.

Table 13 Remediation objectives

Ref.	Source	Pathway	Receptor	Remediation objective
PCL1	S1 – Made Ground S2 – Historical site uses S3 – Potential UST	P1a, b and c – Ingestion, inhalation or dermal contact with soil, dust or fibres P2a and P2b – Migration and inhalation of ground gas or vapours P4 – Vertical and lateral migration of dissolved phase contaminants	R1 – Construction workers	To reduce exposure through site management and correct protocol (Section 9.2). To provide a strategy for encountering unexpected or unidentified contamination (Section 9.2).
PCL2	S1 – Made Ground	P1b – Inhalation of dust, fibres	R2 - Adjacent site users	To reduce exposure through site management

Ref.	Source	Pathway	Receptor	Remediation objective
	S2 – Historical site uses		during construction	and correct protocol. (Section 9.2).
PCL3	S1 – Made Ground S2 – Historical site uses S3 – Potential UST and associated pipework and interceptors.	P1a, b and c – Ingestion, inhalation or dermal contact with soil, dust or fibres	R3 – Site residents, workers and visitors during operation R4 – Maintenance workers during operation	To break viable pathways to end users through the form of the development and to ensure an appropriate thickness of clean cover system in soft landscaped areas (Section 9.3). To provide a strategy to investigate and remove possible USTs and associated infrastructure (Section 9.4).
Note: Measures associated with PCL4 and PCL5 will be addressed separately to the remediation strategy: • PCL4 (Controlled Waters): If required, a foundation works risk assessment will be separately prepared to assess potential risks to the deep aquifer from piling. • PCL5 (Built infrastructure): Will be dealt with by appropriate design of construction materials.				

9.1.2 Remediation criteria

Remediation criteria provide a measure against which conformity with the remediation objectives can be determined. As no technical remediation is required for this site the remediation criteria are not based on derived numerical values. However, criteria have been set for imported soils which are described in the verification plan.

There is a potential to encounter previously unidentified contamination including USTs and associated infrastructure. As such the remediation criteria have been developed based on visual and olfactory indicators which would be deemed unacceptable. The following actions are proposed:

- Removal of tanks, metal pipes and their contents[2];
- Removal of significant levels of petroleum hydrocarbons such as free product, sheens, heavy staining of soils or soils with petroleum odours;
- Removal of pockets of visible asbestos fragments[3]; and
- Assessment of any other suspicious materials due to visual or olfactory evidence of contamination. If necessary, these artefacts will be removed.

[2] Tanks and the associated infrastructure would need to be fully removed which may require extending excavations.
[3] Asbestos has not been identified within previous investigations however is typically a common component of Made Ground.

If suspicious material cannot be easily identified by briefed site staff, then a geoenvironmental consultant should be contacted to provide further advice and assessment. Encountering unidentified contamination is detailed in the watching brief and discovery strategy in Section 9.2.2.

9.2 Site management and controls

Works should be managed by the principal contractor (and associated contractors) to ensure the protection of the environment and human health to meet health and safety requirements under the Construction (Design and Management) Regulations (CDM) [35] and may adopt measures contained in relevant guidance such as HSG66 [36], Annex C of BS10175 [8], BS ISO 18400 103 [28], and CIRIA Reports R132 [37] and C741 [38].

9.2.1 Site inductions and toolbox talks

The contractor will be responsible for preparing site inductions, toolbox talks and task specific risk assessment and method statements which emphasise the potential to encounter contamination whilst working within the Made Ground and detail task appropriate PPE. The details of the watching brief and discovery strategy should be communicated to all site workers who have the potential to be exposed to excavated material and all site workers should be familiar with the actions to take if potential contamination is encountered.

9.2.2 Watching brief and unidentified contamination

During breaking ground and excavation activities, the contractor should implement a watching brief for contamination to be maintained throughout the works.

The watching brief should include the monitoring of the base and sides of excavations where safe and reasonable to do so. The watching brief should be documented, reported on during progress meetings and records should be compiled in the verification report.

Unidentified contamination may comprise of unacceptable materials as previously described in Section 9.1.2 as well as coloured soils (white, red, green, black or blue for instance), unusual strong odours (sweet, organic, solvents, acidic, sulphurous or acrid), buried drums or containers that might contain contamination, or visible fragments of asbestos.

If unidentified contamination, or suspicious materials are identified during excavations (i.e., contamination that is not of a similar nature to that previously identified) then the following steps should be taken:

- Cease works within the immediate area and cordon the area off to prevent unauthorised access;
- A specialist should be consulted who will advise on the next steps and prepare a method statement for dealing with the material;

- The contractor should arrange for a specialist who is suitably qualified and experienced with sampling contaminated soils to attend site. Soils should be sampled in-situ where possible and material should be left undisturbed whilst results are being interpreted. If safe to do so material should be excavated and stockpiled separately in an appropriate manner (see Section 9.2.3); and
- All areas of encountered contamination should be delineated on site plans, which should be updated as required throughout the construction period.

Tanks, containers or drums should not be moved, penetrated or unsealed unless under the direct instruction and supervision of a specialist contractor.

Whilst asbestos has not been encountered during the previous ground investigations, it is commonly encountered in Made Ground (either as fragments or dispersed fibres) and beneath hardcover (either in the sub-base or underground voids and structures). If asbestos, or suspected asbestos, is encountered on site, then all earthworks activities should cease in that area. The contractor should arrange for a specialist who is experienced with identifying and sampling asbestos in soils. A sample of the asbestos should be taken for identification as well as the surrounding soils to identify the extent of degradation and presence of fibres. The asbestos identification and quantification testing should be undertaken by a UKAS accredited laboratory in accordance with the draft SCA Blue Book Method - The determination of asbestos in soil and associated materials [39].

Results should be used to undertake an assessment in accordance with CL:AIRE's CAR-SOIL guidance [40] to provide an appropriate classification of works (Non-Licenced, Licenced or Notifiable Non-Licenced) under the Control of Asbestos Regulations 2012 [41]. This will determine any additional PPE requirements for ground workers and site control measures.

If no significant material is encountered, then as minimum a written statement from a competent individual confirming the brief was implemented and there was an absence of unexpected contamination during the works should be compiled as part of the verification report.

While the watching brief may be implemented by various staff on site, where necessary, sampling of soils, conducting assessments, or dealing with unexpected contamination should be undertaken in an appropriate manner by a suitably experienced and qualified person. All soil testing should be conducted by a UKAS and MCERTS accredited laboratory. All records of such activities and testing results should be compiled for the verification report.

9.2.3 Stockpiling and quarantine area

Stockpiles of soils arising from construction should be appropriately managed to prevent the spread of material, dust generation and potential cross contamination. Stockpiles should be segregated depending on the source of the material, be placed on a low permeability liner, suitably protected from damage by earthmoving plant and leachate appropriately collected and disposed off-site or treated and disposed by an appropriately licensed contractor or facility. Stockpiles should be covered to reduce dust generation.

If suspect materials cannot be left in-situ and is deemed as gross contamination whereby the aforementioned controls are unsuitable, then a specific quarantine area should be constructed to isolate materials from site workers and other stockpiles. The quarantine area should comprise the following:

- A securely fenced area displaying suitable warning signage;
- A lined and bunded area, comprising 1000-gauge polythene with a sand layer immediately above to prevent puncturing; and
- The lined and bunded area shall have a shallow gradient drainage system flowing to a single sump to allow capture of surface water run-off and any leachate from stockpiled materials.

9.3 Clean cover

A minimum thickness of 600mm of imported topsoil and subsoil should be placed in soft landscaped areas. A geotextile visual marker layer should be placed at the base of the cover layer in order to inform future maintenance groundworks. This should be recorded in the verification report.

9.3.1 Imported soils and aggregates

All imported topsoil/subsoil should be compliant with BS3882:2015 Specification for Topsoil [42] and BS8601:2013 Specification for subsoil and requirements for use [43]. The results of the testing of imported soils should be assessed by comparison to residential without homegrown produce criteria (at 1% Soil Organic Matter) (refer to Table 14).

Imported topsoil and subsoil should be tested prior to arrival to confirm suitability. Once brought to site, verification sampling and testing of imported soils should be carried out on one sample per source and soft landscape area, with a minimum frequency of one sample every 50m^3.

Product materials such as quarried aggregate, sand and shingle will not be chemically tested. Source certificates should be verified prior to import and visually inspected after import but prior to placement. Any imported recycled aggregates should be tested for asbestos as minimum (one sample every 50m^3) and visually inspected prior to entering the site.

9.4 Advance investigation and tank removal

No tanks have been identified however at least one UST is suspected to be present towards the south-western extent of the site. Once demolition of the existing building has been completed and services have been disconnected, this area should be broken out and investigated for the potential presence of USTs and associated infrastructure. The works should be undertaken under the supervision of a specialist contractor competent in tank decommissioning and removal.

The specialist contractor should prepare a risk assessment method statement for the decommission and removal of the tank which should be written in accordance

with best practice outlined in The Association for Petroleum & Explosives Administration (APEA) 'Blue Book' Guidance [44] and Hela Lacots PETEL 65/34 [45]. The general procedure should be:

- Break out hardstanding within the area and uncover the previously encountered buried structure;
- Removal and decommission of any encountered UST and associated infrastructure in accordance with the specialist's risk assessment and method statement;
- Provision of photographic records of encountered items and materials;
- Provision of a detailed description of the tank including the location and depth indicated on a site plan;
- Provision of details of the tank decommissioning and removal, with supporting documentation, of works undertaken during construction;
- Provision of relevant duty of care information for the tanks (and its contents), pipework, base, and any contaminated soils demonstrating appropriate removal and disposal; and
- Testing and assessment of the base and sides of the excavation to demonstrate that any residual contamination has been adequately removed. Over digging may be required to verify that no residual source of contamination remains.

10 Verification plan

10.1 Verification report

A verification report will be required following completion of the works to demonstrate the requirements of the remediation strategy and verification plan have been achieved. The verification plan has been written in accordance with the Environment Agency's LCRM guidance [9].

The verification report should include the following information:

- Details of involved parties and a summary of their role within the scheme;
- A summary of works undertaken including methods of works, health and safety and environmental control measures, as built records and photographs of each key stage of ground works;
- Records of communication with regulators when required, including Local Authority and Environment Agency and compliance with any permit, consent and licence and relevant planning condition requirements;
- Waste management records including volumes leaving site, destinations, waste disposal permit details, laboratory results and waste classification certificates and evidence of compliance with the relevant waste regulations (e.g., consignment notes and material tracking proforma);
- Details of any outstanding actions and site constraints and how these will be addressed, including maintenance plans; and
- A description of the final site conditions.

The verification report should form part of the health and safety file in accordance with the Construction Design and Management (CDM) Regulations 2015 and the development operations & maintenance (O&M) manual or maintenance plan. This is to allow the building management to protect against any residual ground contamination risks associated with future operations and maintenance.

10.2 Site management and controls

The verification report should include evidence that the measures described in Section 9.2 were implemented. Records should be maintained throughout the excavation works confirming the watching brief was implemented. This will include:

- Details of the responsible site manager;
- Confirmation of inductions, toolbox talks and briefings;
- In the area(s) where no unexpected contamination was encountered (which might be most or all the site), a written confirmation that the brief was undertaken and that nothing was identified.

If unexpected or gross contamination was encountered, then the minimum amount of information to be recorded and reported in the verification report is:

- A general description of the situation including the context of the find, a description of the area, depth encountered, and the immediate steps taken to make the area safe;
- A location plan showing the extent of contamination;
- Photographs of the suspected contamination and cordoned off area;
- Details of sampling and testing carried out. This should include details of sampling and laboratory analysis, accredited laboratory certificates and associated information;
- A record of the assessment carried out and the proposed actions;
- Records of consultation with the planning authority and additional measures agreed with the planning authority; and
- Records of the implementation of the agreed actions and lines of evidence confirming it was dealt with appropriately.

10.3 Clean cover

The verification report should include evidence to confirm the placement of a 600mm cover layer in soft landscaped areas including:

- Clear photographs with a scale demonstrating the thickness of soils placed;
- Clear photographs demonstrating the placement of a geotextile marker layer; and
- Plans delineating where clean covers have been placed.

10.3.1 Assessment criteria for imported soils

Imported soils are anticipated to greenfield or manufactured topsoil and subsoils and be compliant with BS3882:2015 Specification for Topsoil [42] and BS8601:2013 Specification for subsoil and requirements for use [43]. It possible that ‘product’ material (e.g. shingle or borrow-pit sand) or recycled aggregate may be imported, for example, as a piling mat, sub-base or as backfill to underground services.

The verification report should include:

- Provision of supplier’s certificates for all imported materials;
- Testing certificates of imported topsoil and subsoil materials in accordance with the analytes outlined in Table 14;
- Confirmation that compliance sampling for imported soils was undertaken at a frequency of one sample per source, and one sample every 50m^3 imported soils or one sample per landscaped area (whichever is smaller);
- Records of visual inspections and confirmation that all materials imported to site are free of anthropogenic material and visual/olfactory evidence of contamination;

- An assessment demonstrating that the assessment criteria were not exceeded;
- Asbestos testing certificates for imported recycled aggregate; and
- Records of any rejected materials.

The results of the testing of imported soils shall be assessed by comparison to residential without homegrown produce criteria (at 1% soil organic matter) unless stated otherwise, as presented in Table 14.

Table 14 Criteria for imported soils

Analyte	**Imported soils (mg/kg)**	**Criteria source**
Metals and inorganics		
Arsenic	39.9	GAC for residential without homegrown produce
Cadmium	85	GAC for residential without homegrown produce
Chromium (III)	907	GAC for residential without homegrown produce
Hexavalent chromium	6	GAC for residential without homegrown produce
Copper	100 (pH < 6.0) 135 (pH 6.0 to 7.0) 200 (pH > 7.0)	Ecotoxic thresholds based on BS 8332:2015.
Lead	310	GAC for residential without homegrown produce
Mercury (inorganic)	56.2	GAC for residential without homegrown produce
Nickel	60 (pH < 6.0) 75 (pH 6.0 to 7.0) 110 (pH > 7.0)	Ecotoxic thresholds based on BS 8332:2015.
Zinc	200 (pH < 7.0) 300 (pH > 7.0)	Ecotoxic thresholds based on BS 8332:2015.
Total cyanide	800	GAC for free cyanide in the absence of criteria for total cyanide. Residential without homegrown produce
Asbestos	Absent	No formal assessment criteria for asbestos.
TPH and BTEX		
Aliphatic >EC5to EC6	42.4	GAC for residential without homegrown produce
Aliphatic >EC6 to EC8	103	GAC for residential without homegrown produce
Aliphatic >EC8 to C10	26.8	GAC for residential without homegrown produce
Aliphatic >EC10 to C12	132	GAC for residential without homegrown produce
Aliphatic >EC12 to EC16	1061	GAC for residential without homegrown produce
Aliphatic >EC16 to C35	11925	GAC for residential without homegrown produce
Aliphatic >EC35 to C44	11925	GAC for residential without homegrown produce
Aromatic >EC5 to EC7	0.38	GAC for residential without homegrown produce
Aromatic >EC7 to EC8	880	GAC for residential without homegrown produce
Aromatic >EC8 to C10	47.2	GAC for residential without homegrown produce
Aromatic >EC10 to EC12	47.2	GAC for residential without homegrown produce

Analyte	Imported soils (mg/kg)	Criteria source
Aromatic >EC12 to EC16	251	GAC for residential without homegrown produce
Aromatic >EC16 to EC21	1800	GAC for residential without homegrown produce
Aromatic >EC21 to EC35	1400	GAC for residential without homegrown produce
Aromatic >EC35 to EC44	1930	GAC for residential without homegrown produce
Benzene	0.38	GAC for residential without homegrown produce
Ethylbenzene	880	GAC for residential without homegrown produce
Toluene	82.4	GAC for residential without homegrown produce
o-Xylene	88.3	GAC for residential without homegrown produce
m-Xylene	79	GAC for residential without homegrown produce
p-Xylene	104	GAC for residential without homegrown produce
PAH		
Acenaphthene	2995	GAC for residential without homegrown produce
Acenaphthylene	2893	GAC for residential without homegrown produce
Anthracene	30603	GAC for residential without homegrown produce
Benzo(a)anthracene	11	GAC for residential without homegrown produce
Benzo(a)pyrene	3.2	GAC for residential without homegrown produce
Benzo(b)fluoranthene	3.9	GAC for residential without homegrown produce
Benzo(k)fluoranthene	105	GAC for residential without homegrown produce
Benzo(g,h,i)perylene	355	GAC for residential without homegrown produce
Chrysene	29.6	GAC for residential without homegrown produce
Dibenzo(a,h)anthracene	0.31	GAC for residential without homegrown produce
Fluoranthene	1526	GAC for residential without homegrown produce
Fluorene	2794	GAC for residential without homegrown produce
Indeno(1,2,3-c,d)pyrene	45	GAC for residential without homegrown produce
Naphthalene	2.3	GAC for residential without homegrown produce
Phenanthrene	1291	GAC for residential without homegrown produce
Pyrene	3661	GAC for residential without homegrown produce

10.4 Tank investigation works and removal

A record of the tank investigation works should be summarised and included in the verification report. This should include:

- A general description of the area investigation, depth investigated to, and the encountered ground conditions;
- Photographs of the area investigated;
- Details of any sampling and testing carried out. This should include details of sampling and laboratory analysis, accredited laboratory certificates and associated information; and

- A record of any assessments carried out.

If tanks and associated infrastructure are encountered, the verification report should include:

- The methodology by which the tanks and infrastructure were decommissioned and removed;
- Photographs and description of encountered tanks, including the location and depth indicated on a plan;
- Photographs, description and record of tank removal;
- Waste records and duty of care information of impacted materials, tanks (and its contents) and pipework;
- Copies of clean and gas free certificates;
- Copies of Dangerous Substances and Explosive Atmosphere Regulation (DSEAR) and Atmosphere Explosible (ATEX) assessments, if required; and
- Verification testing of soils within the base and sides of excavations and/or groundwater as appropriate.

References

[1] GEA (2016), "Site Investigation and Basement Impact Assessment Report for 12491 Haverstock Hill".

[2] Ministry of Housing, Communities and Local Government (2019), "National Planning Policy Framework," ISBN: 978-1-5286-1033-9.

[3] Ministry of Housing, Communities and Local Government (2019), "Planning Practice Guidance: Land Affected by Contamination," https://www.gov.uk/guidance/land-affected-by-contamination.

[4] DEFRA. (1990), "Environmental Protection Act 1990," [Online]. Available: http://www.legislation.gov.uk/ukpga/1990/43/contents. [Accessed August 2020].

[5] Greater London Authority (2016), "The London Plan, Chapter 5: London's response to Climate Change," Policy 5.21 Contaminated Land.

[6] Greater London Authority (December 2019), "The London Plan Intend to Publish Version," [Online] https://www.london.gov.uk/sites/default/files/intend_to_publish_-_clean.pdf .

[7] Camden London Borough Council (2018), "Camden Planning Guidance - Amenity".

[8] British Standards Institution (2017), "BS 10175:2011+A2:2017 Investigation of potentially contaminated sites. Code of practice," British Standard Institute, London.

[9] Environment Agency. (2019), "Land Contamination Risk Management," EA, [Online]. Available: https://www.gov.uk/guidance/land-contamination-how-to-manage-the-risks. [Accessed August 2020].

[10] Landmark Information Group. (2020), "Envirocheck Report (247250880)".

[11] Google Earth (2020), [Online]. Available: https://earth.google.com/web/. [Accessed August 2020].

[12] Bomb Sight (2020), "Mapping of WW2 bomb census," [Online]. Available: http://bombsight.org/. [Accessed August 2020].

[13] 1st Line Defence (2015), "Preliminary UXO Risk Assessment for 5-17 Haverstock Hill".

[14] Camden Council (2020), "Contaminated Land," [Online]. Available: https://www.camden.gov.uk/contaminated-land. [Accessed August 2020].

[15] The National Archives (2020), [Online]. Available: https://nationalarchives.gov.uk/. [Accessed August 2020].

[16] Ward, L (2015), "The London County Council Bomb Damage Maps 1939-1945, Tames and Hudson.".

[17] British Geological Survey. (2020), "BGS GeoIndex," [Online]. Available: http://mapapps2.bgs.ac.uk/geoindex/home.html. [Accessed August 2020].

[18] British Geological Survey (2020), "The BGS Lexicon of Named Units," [Online]. Available: https://www.bgs.ac.uk/lexicon/home.cfm?. [Accessed August 2020].

[19] British Geological Survey (2006), "North London. England and Wales Sheet 256. Bedrock and Superficial Deposits. 1:50,000," BGS.

[20] Bromhead, C (1925), "Memoirs of the Geological Society of England and Wales, Explanation of Sheet 256: The Geology of North London".

[21] Department for Environment and Rural Affairs. (2002), "Multi-Agency Geographic information for Countryside," DEFRA, [Online]. Available: https://magic.defra.gov.uk/MagicMap.aspx. [Accessed August 2020].

[22] Environment Agency (2020), "Long Term Flood Risk Maps," [Online]. Available: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map. [Accessed August 2020].

[23] OpenStreetMap (2020), [Online]. Available: https://www.openstreetmap.org/. [Accessed August 2020].

[24] Environment Agency (2017), "New Groundwater Vulnerability Mapping Methodology in England and Wales (SC040016/R)".

[25] Barton N. (1962), "The Lost Rivers of London".

[26] DEFRA (2014), "SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination - Policy Companion Document".

[27] Land Quality Management. (2015), "LQM/CIEH S4ULs for Human Health Risk Assessment Publication".

[28] British Standard Institute (2017), "BS ISO 18400-103:2017 Soil Quality - Sampling - Safety".

[29] CL:AIRE (2012), "A Pragmatic Approach to Ground Gas Risk Assessment".

[30] CIRIA (2001), "Contaminated land risk assessment. A guide to good practice (C552)," Construction Industry Research and Information Association, London.

[31] Building Research Establishment (2017), "Special Digest 1: Concrete in aggressive ground. 3rd Ed.".

[32] UK Water Industry Research (UKWIR), (2011), "Guidance for the Selection of Water Supply Pipes. (Ref 10/WM/03/21)".

[33] Environment Agency (2001), "Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention".

[34] Environment Agency. (2015), "Guidance on the classification and assessment of waste," EA, Bristol.

[35] The Construction (Design and Management) Regulations 2015.

[36] Health and Safety Executive (1991), "HSG 66 Protection of workers and the general public during the development of contaminated land".

[37] CIRIA (1996), "A guide for safe working on contaminated sites.".

[38] CIRIA (2015), "Environmental good practice on site (4th ed)".

[39] Standing Committee of Analysts (2017), "The quantification of asbestos in soil and associated materials.".

[40] CL:AIRE. (2016), "CAR-SOIL Control of Absestos Regulations 2012, Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials, Industry Guidance," Joint Industry Working Group (JIWG)/Contaminated Land: Applications in Real Environments (CL:AIRE), London.

[41] Health and Safety Executive. (2012), "Control of Asbestos Regulations 2012," HSE, London.

[42] British Standards Institute (2015), "BS 3882:2015 Specification for Topsoil".

[43] British Standards Institute (2013), "BS 8601:2013 Specification for subsoil and requirements for use".

[44] APEA (2018), "Guidance for Design, Construction, Modification, Maintenance and Decommissioning of Filling Stations".

[45] Hela Lacots PETEL 65/34 (2000), "Leak Detection in Tanks and Pipework".