2.6 Unexploded ordnance

A *Preliminary Unexploded Ordnance (UXO) Risk Assessment* obtained as part of the desk-based study indicated that two high explosive (HE) bombs fell within the site boundaries during the Second World War. The report concludes that there is a medium risk for UXO being encountered during any future intrusive ground works. Given that evidence suggests that Medius House was constructed prior to 1940, the risk of potential UXO is likely to relate to the land occupied by Castlewood House.

2.7 Environmental records

An environmental disclosure report obtained as part of the desk-based study provided the following key environmental information for the site.

- There are two potable groundwater abstractions within 1.8km to the north-east of the site.
- There are no surface water abstractions within 1km of the site.
- There is one discharge consent within 500m which relates to the discharge of cooling water onto land.
- The records indicate that there are three Local Authority Pollution and Prevention Controls within 500m of the site. The closest of these relate to a dry cleaning facility at an approximate distance of 240m south of the site.
- There have not been any pollution incidents within 500m of the site. The nearest pollution incident occurred some 550m north-east of the site and involved a release of fire water/ foam to an unknown waterbody.
- There is one historical landfill within 1km of the site. This is situated on Portugal Street, approximately 725m east of the site.
- Radon protection measures are not required in new dwellings.
- Trade directory entries indicate a range of activities (both active and inactive) within 250m of the site including dry cleaners, printers, electrical and lighting manufacture, concrete products etc.

The Contaminated Land Team at London Borough of Camden confirmed that Castlewood House (77-91 New Oxford Street) has been identified as a potential contamination risk by the Council as part of their investigation strategy under Part 2A of the Environmental Protection Act and has been deemed a high priority for inspection. The Council indicates that this is due to the historical industrial land uses that have been identified on or within 50m of the site.

2.8 Preliminary Conceptual Site Model (CSM)

The preliminary CSM based on the findings of the desk study noted a low risk to potentially sensitive receptors at the site of Medius House. This is due to the fact that the building covers the entire plot footprint and that no below ground works will be undertaken.

The site of Castlewood House was noted to pose a low to moderate risk. The greatest risks were noted to be to future site users and construction works due to the potential for contamination of near surface soils. A low to moderate risk was identified to neighbours from wind blow dust/vapours, underlying aquifers and buildings and services. It was therefore recommended that an intrusive site investigation was undertaken at the site of Castlewood House to confirm the ground and groundwater conditions and potential for contamination to be present.

3. FIELDWORK

3.1 Exploratory works

An intrusive ground investigation was undertaken by LMB in June 2018 under the instruction of COWI on behalf of the Client. According to the factual report produced by LMB (see Appendix B), the scope of the investigation strategy was designed based on discussions between LMB and COWI.

The scope of works comprised the drilling of 4 cable percussion boreholes (DABH101 to DABH104) to between 35m and 47m bgl with in-situ Standard Penetration Tests (SPTs) and 11 hand and machine excavated trial pits to a maximum depth of 1.95m bgl (DATP101 to DATP111). The trial pits were excavated in external and internal areas of the existing buildings and appear to be for the purpose of inspecting building footings and floor slabs etc. Samples were obtained for chemical and geotechnical laboratory analysis from the trial pits and boreholes and field screening of soil headspace testing was undertaken using a photo-ionisation detector (PID). Figure 2 below (taken from the LMB report in Appendix B) shows the exploratory hole locations.

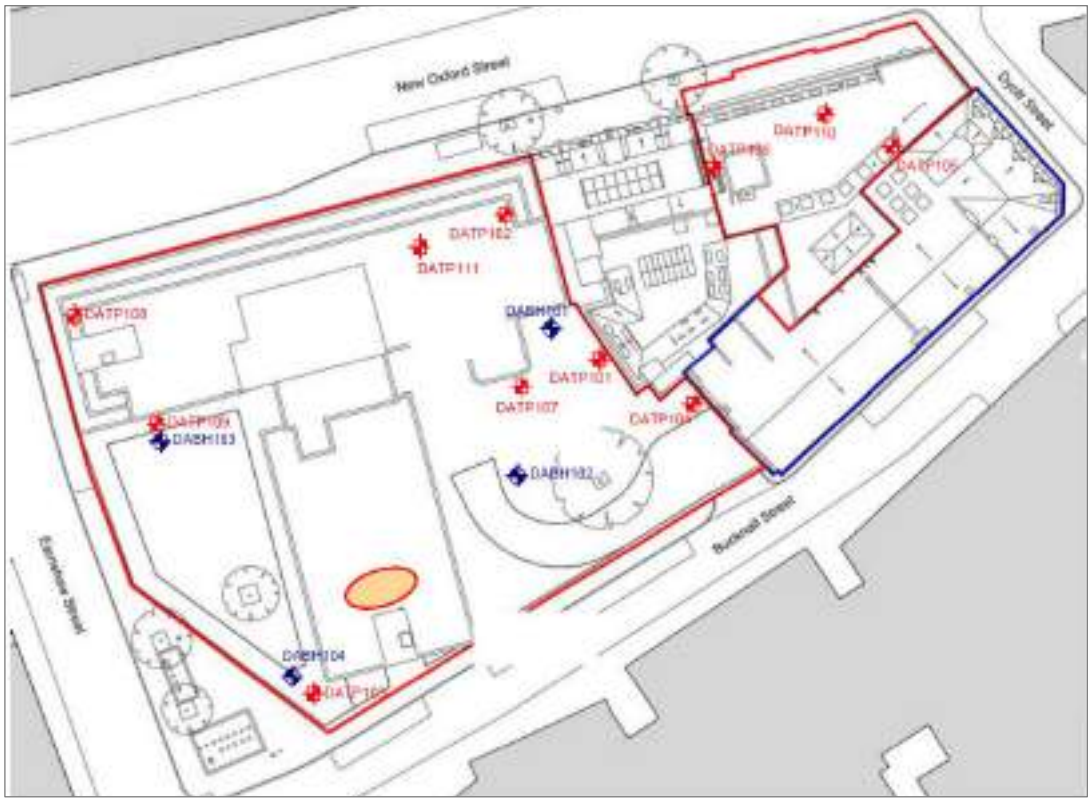

Figure 2: Exploratory hole location plan

Dual gas and groundwater monitoring wells were installed in all boreholes and return monitoring visits were undertaken on 3 occasions between 13th July and 1st August 2018. A summary of the well installations is provided in Table 1.

Table 1: Summary of gas/groundwater monitoring wells

Borehole reference	Screened depth (m bgl)	Screened lithology
BHDA-101 (Shallow)	0.5 – 4.0	MG/LHG
BHDA-101 (Deep)	41.0 – 42.0	LBG
BHDA-102 (Shallow)	1.0 – 4.0	LHG
BHDA-102 (Deep)	19.0 – 20.0	LCF
BHDA-103 (Shallow)	0.5 – 4.0	MG/LHG
BHDA-103 (Deep)	11.0 – 12.0	LCF
BHDA-104 (Shallow)	0.5 – 4.0	MG/LHG
BHDA-104 (Deep)	27.0 – 28.0	LBG

Note: MG = Made Ground; LHG = Lynch Hill Gravel; LCF = London Clay Formation; LBG = Lambeth Group

Probe holes were also drilled to determine the potential presence of an historic vault, though no such evidence was detected.

Boreholes were surveyed and levelled to Ordnance Datum. The factual report states that the works were supervised by a Geo-environmental Engineer.

3.2 Chemical laboratory analysis

A total of 16 samples were sent to the laboratory of i2 Analytical Limited (i2) for testing of the following parameters:

- Polyaromatic hydrocarbons (PAHs) – 6 samples
- BTEX compounds (benzene, toluene, ethylbenzene and xylenes) and methyl tertiary butyl ether (MTBE) – 4 samples
- Total petroleum hydrocarbons (TPH) with aliphatic / aromatic split – 7 samples
- SVOC suite (semi-volatile organic compounds) – 2 samples
- VOC suite (volatile organic compounds) – 3 samples

- Metals (As, B, Cd, Cr_{total}, Cu, Pb, Hg, Ni, Se and Zn) – 12 samples

Five samples underwent leachate analysis using either a laboratory in-house method or the National Rivers Authority (NRA) 10:1 extract method. Leachate samples underwent testing for PAHs, TPH, SVOCs, VOCs, BTEX, MTBE and metals.

Waste Acceptance Criteria (WAC) testing was also undertaken on two samples of shallow soils.

3.3 Geotechnical laboratory analysis

Geotechnical analysis of soil samples was also undertaken by i2. The following suite of testing was undertaken:

- Atterberg Limits – 17 samples
- Particle size distribution (PSD) – 12 samples
- Undrained triaxial compression – 34 samples
- pH and sulphate – 32 samples

3.4 Monitoring

Gas and groundwater level monitoring was undertaken on three occasions; 13th July 2018, 20th July 2018 and 1st August 2018.

Gas monitoring comprised the measurement of methane, carbon dioxide and oxygen at intervals of 60, 120 and 240 seconds. Measurement of flow rate and volatile organic compounds using a PID was also undertaken.

4. GROUND CONDITIONS

4.1 Summary of ground conditions

A summary of the ground conditions encountered beneath the site is provided in Table 2 and descriptions of each strata are provided in the following sections.

Table 2: Summary of ground conditions

Stratum description	Level at top of stratum (m OD)	Thickness (m)
[MADE GROUND] surfacing comprising block pavement, concrete and sub-base.	Ground level 22.26 to 22.4	0.06 to 0.27
[MADE GROUND] comprising brown clayey gravelly sand and slightly gravelly clay with brick and clinker gravel, brick and concrete cobbles and sub-angular to rounded fine to coarse flint.	22.02 to 22.2	0.84 to 1.8
Medium dense to dense brown to orange brown very sandy sub-angular to rounded fine to coarse flint and occasional quartz GRAVEL and gravelly fine to medium SAND with occasional flint cobbles. [LYNCH HILL GRAVEL MEMBER]	20.4 to 21.36	1.5 to 3.2
Firm becoming very stiff brown to dark grey and grey brown silty CLAY with closely spaced fissures. Occasional layers of very fine shell fragments and blue/grey veining (possible bioturbation). Occasional silty fine sand lenses at depth. Occasional moderately weak to moderately strong grey/brown MUDSTONE layers and mudstone gravel and cobbles. [LONDON CLAY FORMATION]	18.16 to 18.9	19.5 to 21
Stiff to very stiff red / orange brown, blue grey, purple red, brown mottled slightly silty slightly sandy CLAY with occasional calcarenite nodules and cemented layers. Rare fine shell fragments. Black silty laminations and rare pyrite nodules present at depth. Becoming a light grey very silty sandy CLAY/clayey silty find SAND with black rounded pebbles at depth. [LAMBETH GROUP]	-0.6 to -2.41	Proven to 24m thick

Generally, Made Ground was present in all borehole and trial pit locations beneath a surfacing of block paving, concrete or sub-base. The Made Ground ranged from approximately 1m to 2m thick and comprised a clayey gravelly sand and gravelly clay with gravel and cobbles of concrete, brick and clinker. The superficial Lynch Hill Gravel deposits lie beneath the Made Ground and consist of a medium dense to dense sandy gravel or gravelly sand with occasional cobbles. The gravel is noted to be typically 2m thick.

Bedrock comprises the London Clay Formation which is noted at approximately 3.5 to 4m bgl and occasionally contains mudstone layers and mudstone gravel/cobbles. The London Clay is approximately 20m thick and is underlain by the Lambeth Group which was proven to the base of the boreholes.

No visual or olfactory signs of contamination were noted during the fieldworks. LMB also undertook screening of soils during the works using a photo ionisation detector (PID) and it is noted that all readings were below the limit of detection.

4.2 Groundwater

Groundwater was not encountered during the fieldwork, but it is noted that water was added to assist drilling and this may have masked any potential strikes or seepages. As mentioned in Sections 4.1 and 4.4, groundwater monitoring was undertaken from standpipes installed in the boreholes. Table 3 summarises the findings of the groundwater monitoring visits.

Table 3: Summary of groundwater monitoring results

Borehole reference	Response zone	Screened depth (m bgl)	Depth to groundwater (m bgl)	Depth to groundwater (m OD)
BHDA-101 (Shallow)	MG/LHG	0.5 – 4.0	3.50 to 3.53	18.9 to 18.87
BHDA-101 (Deep)	LBG	41.0 – 42.0	29.4 to 29.7	-7.0 to -7.3
BHDA-102 (Shallow)	LHG	1.0 – 4.0	3.38 to 3.95	18.31 to 18.88
BHDA-102 (Deep)	LCF	19.0 – 20.0	12.08 to 12.12	10.18 to 10.14
BHDA-103 (Shallow)	MG/LHG	0.5 – 4.0	3.30 to 3.31	18.99 to 18.98
BHDA-103 (Deep)	LCF	11.0 – 12.0	3.35 to 3.53	18.94 to 18.76
BHDA-104 (Shallow)	MG/LHG	0.5 – 4.0	3.11 to 4.1	18.26 to 19.25
BHDA-104 (Deep)	LBG	27.0 – 28.0	20.24 to 20.3	2.12 to 2.06

Note: MG = Made Ground; LHG = Lynch Hill Gravel; LCF = London Clay Formation; LBG = Lambeth Group

The groundwater monitoring confirmed the presence of a consistent unconfined water table within the Lynch Hill Gravel between 18.31m and 19.25m OD (typically between 3.11m and 4.1m bgl).

Two wells, placed within the London Clay at 11-12m and 19-20mbgl, note the presence of perched groundwater (possibly associated with more sandy / silty layers) within this formation at depth. Resting water levels in the London clay vary between 10.14m and 18.94m OD (i.e. 3.35m and 12.12m bgl).

Two wells were also placed within the Lambeth Group at 27-28m and 41-42m bgl. Standing groundwater was noted in both wells between 2.12m and -7.3m OD (i.e. 20.24m to 29.7m bgl) and may be associated with pebble layers or cemented bands.

4.3 Soil gas

Gas monitoring was undertaken on three occasions from four wells screened within the Made Ground and/or Lynch Hill Gravel as discussed in Section 4.1 and included the measurement of organic vapours using a PID. Atmospheric pressure readings during the monitoring visits were high, ranging between 1016 and 1020mb. However, the visit on 1st August 2018 was undertaken during a period of falling atmospheric pressure. The gas monitoring results are summarised in Table 4.

Table 4: Summary of gas monitoring results

Borehole reference	Response zone	Concentration range (% volume in air)		Flow (l/hr)	PID (ppm)
		Methane	Carbon dioxide		
BHDA-101 (Shallow)	MG/LHG	0.0 to 0.1	0.2 to 0.8	0.0 to 0.1	0.8 to 9.3
BHDA-102 (Shallow)	LHG	0.0 to 0.1	0.1	0.0 to 0.1	0.0 to 1.6
BHDA-103 (Shallow)	MG/LHG	0.0	0.1 to 0.2	0.0 to 0.1	0.5 to 7.1
BHDA-104 (Shallow)	MG/LHG	0.0 to 0.1	1.3 to 1.8	0.0	0.0 to 9.0

5. CONTAMINATION ASSESSMENT

5.1 Risks to human health

The laboratory test results obtained by LMB have been compared to Generic Assessment Criteria (GAC) comprising the Suitable 4 Use Levels (S4ULs) for the *residential without home grown produce* land use category published by Land Quality Management (LQM) and the Chartered Institute of Environmental Health (CIEH)[6]. This land use scenario is considered to be suitable for the proposed redevelopment as described in Section 2.2. In the absence of a published S4UL, the soil results have been compared to Category 4 Screening Levels (C4SLs) published by the Department of Environment, Food and Rural Affairs (DEFRA). A soil organic matter (SOM) content of 1% has been used for the assessment.

A summary of the test results, together with the screening criteria that have been adopted are provided in Appendix C. The results indicate that all metals, polyaromatic hydrocarbons and petroleum hydrocarbons are either below the limit of laboratory detection or below the relevant GAC. BTEX compounds (benzene, toluene, ethyl benzene and xylenes), methyl tertiary butyl ether (MTBE), semi-volatile organic compounds (SVOC) and volatile organic compounds (VOC) were not detected in any of the samples tested. Asbestos was also not detected in the six samples that were tested.

5.2 Risks to controlled waters

Leachate test results have been compared to UK Drinking Water Standards (DWS) and Environmental Quality Standards set out in the Water Framework Directive (Standards & Classifications) Directions (England and Wales) 2015. In the absence of a UK DWS or an EQS, the World Health Organisation (WHO) Guidelines for Drinking Water Quality have been used. A summary of the results and the screening criteria is provided in Appendix C.

The results indicate the following exceedances of the screening criteria:

- A single exceedance of the DWS for arsenic is noted in trial pit TP107 at 0.4m bgl. All arsenic concentrations, including from TP107, were below the EQS.

[6] Nathanial et al (2015). *The LQM/CIEH S4ULs for Human Health Risk Assessment*. Land Quality Press.

- Exceedances of the EQS for copper and lead are noted in all samples. However, the DWS is not exceeded.

- The limit of laboratory detection for mercury exceeds the EQS. However, all samples are either below or at the limit of detection and do not exceed the DWS.

- One sample marginally exceeded the EQS for nickel. All samples were, however, below the DWS.

Leachable concentrations of TPH, PAH, BTEX compounds, SVOCs and VOCs were below the limit of laboratory detection in the samples tested.

5.3 Risks from soil gas

The three rounds of gas monitoring have detected generally low concentrations of methane and carbon dioxide and low gas flow rates. Gas Screening Values (GSV) have been calculated using the maximum methane and carbon dioxide concentrations and the maximum flow reading in accordance with CIRIA C665[7] and BS8485[8]. The results conform to *Characteristic Situation 1*, indicative of a very low hazard potential. The findings are consistent with the description of the Made Ground soils encountered at the site. Gas protection measures are therefore not considered necessary on the basis of the findings of the gas monitoring undertaken by LMB.

PID readings were low (up to 9.3ppm measured in the boreholes) and no visual or olfactory evidence of contamination was noted during fieldwork.

[7] Wilson, S et al (2007). *Assessing risks posed by hazardous ground gases to buildings*. C665. CIRIA, London.
[8] British Standards Institution (2016). *Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*. BS 8485:2015.